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MARINE LIVING RESOURCES OF THE UNION TERRITORY OF LAKSHADWEEP —

An Indicative Survey With Suggestions For Development

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18. HYDROBIOLOGY OF LAGOONS

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ABSTRACT

The hydrography, productivity, zooplankton biomass and faunistic composition of the lagoons of Lakshadweep were studied during January-March 1987 period. The surface temperature of lagoon waters off Agatti and Kalpeni reached the maximum temperature of 38°C. Even during night period the temperature was in the range of 32-33°C in the Minicoy lagoon. Salinity values of surface samples of lagoons of Kalpitti, Bangaram and Kalpeni were in the range 36‰ to 39.39‰. Low dissolved oxygen value of 1-15 ml/litre was observed in Suhelipar lagoon. In most of the lagoons the secondary production was very poor but biomass of zooplankton from the seaward side of the lagoons was slightly higher suggesting that the oceanic zooplankton might be nourished by coral reef community. Minicoy lagoon is an exception where the biomass of zooplankton was very high being 61.25 ml and the biomass of samples collected from the sea was 9.5 ml. Swarming of *Lucifer* sp, Copepods and *Linglea* sp. (algae) has increased the standing crop of lagoon. In most of the lagoons, decapod larvae and copepods constituted the dominant items, other zooplankters like fish eggs, chaetognaths, siphonophores and appendicularians also occurred in small numbers. In lagoon samples of Bangaram and Kavaratti fish eggs formed 8.73% and 17.38% of total biomass respectively.

INTRODUCTION

The hydrobiological studies *viz.* physical, chemical and biological parameters of the marine environment of Lakshadweep islands have been studied by different groups of scientists based on the data collected during the survey of these islands and also during the oceanography cruises undertaken on board R. V. Varuna, R. V. Kalava, R. V. Gaveshani, R. V. Sagar Kanya. R. V. Bluefin and FORV. Sagar Sampada. A complete list of bibliography of marine biological and fisheries research in Lakshadweep is given in MFIS (1986) of which the following few are pertaining to environmental features of Lakshadweep seas. Jones (1959) reported the importance and special ecological conditions of this area. Cooper (1957) and Jayaraman *et al.* (1959, 1960) have studied the oceanographic conditions of this sea. The chemical characteristic of the Lakshadweep waters were studied by Sankaranarayanan (1973), Rao *et al.* (1966) Rao *et al.* (1970) Rao *et al.* (1976) reported the oceanographic conditions around Lakshadweep islands.

Primary productivity and secondary productions of this sea were studied by Nair and Pillay (1972), Gardiner (Ed) (1906), Wolfenden (1906), Prasad and Nair (1964) Qasim and Bhattathiri (1971), Silas (1972), Tranter and George (1972), Goswami (1973), Nair & Rao (1973), Madhu Pratap (1977), Silas *et al.* (1985) and Mathew (M. S).

The present studies are confined to lagoons of Lakshadweep islands during Jan. March '87. Three teams surveyed 13 islands *viz.* I team-Kadmat, Kiltan, Chetlat, and Amini during Jan. '87, II team-Agatti, Kalpitti, Bangaram and Bitra during February '87 and III team-Kavaratti, Suhelipar, Kalpeni, Androth and Minicoy during March '87 to study the fishery potential of the lagoons and coral reefs of Lakshadweep islands. Along with these investigations fishery environmental studies covering physicochemical conditions, productivity and plankton were also undertaken to get a complete picture of the lagoons during Jan. to March 1987.

MATERIALS AND METHODS

The physico-chemical conditions *viz.* temperature, salinity and dissolved oxygen of surface samples of different lagoons and open sea along with their maximum and minimum during 24 hours based on diurnal studies are given in Table 1. For Agatti, Kalpitti, Bangaram and Bitra islands, the maximum and minimum different physicochemical parameters during day time alone were given and diurnal studies could not be undertaken.

Table 1: Physico-Chemical Parameters (Min-Max) of Lagoons of Lakshadweep Islands

	Kadmat	Chetlat	Kiltan	Amini	Agatti	Kalpitti	Bangaram	Bitra	Kavaratti	Suheliper	Kalpeni	Minicoy
	January				February				March			
ATMOSPHERIC TEMPERATURE (MIN-MAX)°C	25-25.5	26-30	26-31.8	24-30	33-38	36	35-37	36-38	28.2-31.5		28-32	29-33
SURFACE TEMPERATURE (MIN-MAX)°C	27-29.2	28-31.3	27.5-31	26-31	34-38	36	34-36.2	35-36	25-31	29.2-30	30-38	30-35
SURFACE SALINITY‰	34-34.5	34.4-34.69	33.61 - 33.91 -	34.59- 35.48	33.4 - 39.5	39.2	36.2 - 36.9	37.2 38.2	29.5 - 34.4	33.38- 35	34.68 - 39.30	31.93 - 35.41
SURFACE DISSOLVED OXYGEN ml/litre	3.32 - 4.86	3 64 - 5.7	2.79 - 5.70	3.4 - 6.43	2.8 - 6.7	4.8	5.2 - 6.3	4.34 5.8	2.54 - 6.1	1.01 6.6	1.15 - 6.52	3.39 - 6.2

Productivity studies were also conducted in lagoons of some islands.

Surface townet collections of zooplankton of 10 minute duration were taken with ¼ meter plankton net at different stations of lagoons and also outside the reef to study the faunistic composition of zooplankton. Samples of lagoon and open sea are pooled separately and analysed and their average biomass and occurrence of major zooplankters are calculated and given in % for composition. Biomass was determined by displacement volume method and depending on the volume of zooplankton a set sample of 12½% to 25% was examined for numerical abundance and the number of organisms was calculated for the whole sample.

TABLE 2 Estimated average number of zooplankton (in percentage) per standard haul in the lagoons and open sea of Lakshadweep islands January 1987.

Organism	Kadmat		Kiltan		Chetlat	
	Lagoon	Sea	Lagoon	Sea	Lagoon	Sea
Displacement Volume	0.65	3.15	0.2	6.0	2.3	4.1
Copepod	13.59	69.0	33.37	35.80	5.95	50.83
Decapod	59.46	3.63	35.99	38.95	79.55	1.50
Alima larva	1.62	1.24	0.11	0.04	0.10	0.11
Appendicularia	—	3.08	5.81	1.52	—	0.27
Chaetognath	0.41	5.36	9.45	2.69	0.74	8.73
Cladocera	—	2.10	1.13	0.14	—	1.16
Doliolid	—	0.14	0.11	0.24	—	0.11
Heteropod	—	0.96	1.25	1.02	0,03	0.69
Lamellibranch	1.43	2.21	9.23	6.96	0.68	11.38
Medusa	—	0.04	9.11	0.07	—	0.11
Siphonophore	0.05	0.67	0.23	2.08	0.52	18.34
Gastropod	0.62	4.76	0.57	0·75	0.07	1.81
Pteropod	0.04	0.19	—	0.19	—	0.27
Foraminifera	22.48	4.33	1,03	0.50	12.02	0.58
Echinoderm Larva	—	0.05	—	0.02	—	0.08
Fish Eggs	0.11	1.88	—	8.60	0.11	2.77
Fish Larvae	0.10	0.13	0 46	0.07	0.09	0.23
Salp	0.01	0.01	0.01	0.04	—	0.08
Ostracod	0.06	—	0.34	0.05	—	0.04
Amphipod	0.01	0.01	0.46	0.08	0.03	0.35
Ctenophore	0.01	—	—	0.01	—	—
Lucifer	—	0.04	—	0.01	0.01	0.42
Polychaete	—	0.17	0.23	0.07	—	0.11

RESULTS

SURVEY TEAM I JANUARY '87. ISLANDS COVERED - KADMAT, KILTAN, CHETLAT AND AMINI (TABLE 1, 2)

KADMAT

Temperature: The surface temperature range in the lagoon was from 26.0° to 29 0°C. The minimum and maximum were observed at 04.00 hrs and 14.00-18.00 hrs respectively. The maximum atmospheric temperature of 27.5°C was observed during 10.00-14.00 hrs and the minimum of 24°C was noticed at 04.00 hrs.

Salinity: The salinity range in the lagoon was 34.20 to 34.50‰ In the sea the range was 34.40 to 34.89‰.

Dessolved oxygen: The range of dissolved oxygen in the sea was 3.76 to 4.25ml/l. In the windward side it was 4.49 to 5.34ml/l

In the lagoon reef the range was 4.37 to 4.9 ml/l. In the diurnal studies marked change was observed in the dissolved oxygen distribution inside the lagoon. The dissolved oxygen of 4.86 ml/l observed at 1800 hrs gradually decreased to 3.40 ml/l (minimum) at 08.00 hrs. and then gradually increased to 4.86 ml at 16.00 hrs.

Productivity : The estimated gross production of surface waters of lagoon was 154 mg C/m³/ day in January 1987.

Biomass and faunistic composition

The average zooplankton biomass in the lagoon was 0.65 ml indicating that the secondary production is poor whereas outside the reef in the sea it was 3.15 ml.

In the lagoon decapod constituted the dominant portion (59.46%) followed by foraminifera (22.48%), Copepod (13.59%), Lamellibranch (1.43) and the other groups chaetognath, siphonophore, gastropod, pteropod, salp, ostracod, amphipod, ctenophore, fish eggs and fish larve were less than 1% each. Appendicularia, cladocera doliolid, heteropod, madusa, echinoderm larva, lucifer and polychaete were absent (Table 2)

Table 3

Estimated average number of zooplankton (in percentage) per standard haul in the lagoons and open sea of Lakshadweep Islands February '87.

	Agatti		Kalpitti		Bangaram		Bitra	
	Lagoon	Open Sea	Lagoon	Open Sea	Lagoon	Open Sea	Lagoon	Open Sea
DISPLACEMENT VOLUME	Negligiable	5.8ml	—	1 ml.	0.5ml	—	0.6 ml	—
DECAPODS		93.10	—	23.4	90.13	—	73.4	—
COPEPODS	90.25	5.3	—	2.2	0.22	—	18.59	—
FISH EGGS	4.25	0.88	—	73.7	8.73	—	3.05	—
GASTROPODS	0.85	0.4	—	0.15	0.14	—	0.4	—
FISH LARVAE	0.85	0.001	—	0.2	0.09	—	0.08	—
APPENDICULARIA	0.40	0.03	—	—	—	—	—	—
LAMELLIBRANCH	0.85	0.4	—	—	0.15	—	0.39	—
FORAMINIFRA	0.85	0.8	—	—	0.31	—	0.53	—
MEDUSAE	1.7	0.001	—	—	0.01	—	—	—
POLYCHAETES	—	0.01	—	0.1	0.01	—	0.15	—
AMPHIPODS	—	0.01	—	0.1	0.11	—	0.04	—
CLADOCERA	—	0.05	—	—	—	—	0.59	—
CHAETOGNATH	—	0.36	—	—	—	—	2.45	—
ALIMA	—	0.01	—	—	0.04	—	0.53	—
HETEROPODS	—	0.01	—	0.05	—	—	0.06	—
PTEROPODS	—	0.002	—	0.1	0.5	—	—	—
SIPHONOPHORE	—	0.05	—	—	0.01	—	—	—
OSTRACOD	—	0.1	—	—	—	—	—	—
LUCIFER	—	0.01	—	—	—	—	—	—
CEPHALOPODS	—	0.003	—	—	—	—	—	—
DOLIOLUM	—	0.003	—	—	—	—	—	—
ECHINODERM LARVAE	—	—	—	—	—	—	—	—

In the sea the dominant group was copepod (69.0%) followed by chaetognath (5.36%), gastropod (4.76%), foraminifera (4.33%), decapod (3.63%), appendicularia (3.08%), lamellibranch (2.21%) cladocera (2.10%) fish egg (1.88%), alima larva (2.24%) and other groups (doliolid, heteropod, medusa, siphonophore, pteropod, echinoderm larva, salp, amphipod, *Lucifer* and polychaete, were less than 1% each (Table 2)

KILTAN

Temperature : The maximum temperature of surface water was 31.0°C at 1600-1800 hrs and the minimum was 27.5°C at 0600 hrs. The range of bottom temperature was 27.0°. From 30.0°C at 1800 hrs, it gradually came down to 27.5°C at early morning 0600 hrs and again gradually increased to 31.0°C during 0200–0400 hrs and it started increasing gradually to maximum (31.8°C) at 1200 hrs.

Salinity : The salinity range was 33.61 to 33.91‰ in the lagoon and 34.20‰ in the sea.

Dissolved Oxygen : The range of dissolved oxygen was 4.25 to 4.37 ml/l in the sea outside the lagoon. In the windward reef the range 3.88 to 4.25 ml/l. In the lagoon reef the oxygen range was 5.10 to 5.34 ml/l. In the diurnal studies from 1800 hrs to 1800 hrs, 5.34 ml/l observed at 1800 hrs gradually decrease to 2.79 ml/l (minimum) at 0.400 hrs and then it gradually increased to 5.22 ml/l at 1400 hrs and 5.70 ml/l (maximum) at 1800 hrs. A decrease in the oxygen level was observed in the night.

Productivity : The estimated gross production of surface waters of the lagoon were 238 mg C/m³/day in January 1987.

Biomass and faunistic composition

The average displacement volume of zooplankton in the lagoon was 0.2ml and in the sea it was 6.0ml.

In the plankton samples collected from the lagoon decopod larva (35.99%) and copepod (33.37%) dominated in the sample followed by chaetognath (9.45%), lamellibranch (9.23%), appendicularia (5.81%), heteropod (1.25%), cladocera (1.14%), foraminifera (1.03%) and others (alima larva, doliolid, medusa, siphonophore, gastropod, fish larvae, saelp, ostracod, amphipod and polychaete) less than 1% each.

In the sea, the major groups were decapod (38.95%) and copepod (35.80%) followed by fish eggs (8.60%), Lamellibranch (6.96%), chaethgnath (2.69%), siphonophore (2.08%) appendicularia (1.52%), heteropod (1.52%) and others (alima larva, cladocera, doliolid, salp, medusa, gastropod, pteropod, foraminifera, echinoderm larva, fish larva, ostracod, amphipod, ctenophore, lucifer, polychaetete) less than 1% each.

CHETLAT

Temperature: The water temperature in the lagoon ranged from minimum of 28.0°C during 2400 to 1000 hrs to 30.0° during 1400-1800. hrs The range of atmospheric temperature was 25.0°C to 30.0°C.

Salinity: The salinity range was 34.4 to 34.69‰ in the lagoon and 34.69‰ in the sea.

Dissolved Oxygen: The range of dissolved oxygen was 2.79 to 4.13 ml/l in the windward reef. In the lagoon reef the range was 5.34 to 7.28 ml/l. The maximum value was obtained from the area where live coral and seaweeds were found in very good numbers. The value in the sea was 3.88ml/l. In the diurnal studies conducted inside the lagoon the oxygen fluctuated between 3.13 to 5.70 ml l. The maximum (5.70 ml/l) was observed at 1800hrs. The oxygen gradually decreased to 4.13m/l (minimum) at 0600 hrs. Again it gradully increased 4.13ml at 1000 hrs, 4.86 ml/l at 1400 hrs and 5.10 ml/l at 1800 hrs.

Productivity: The estimated gross production and net production were 392 mg C/m³/day and 309 mg C/m³,day respectively.

Biomass and faunistic composition

The average displacement volume of zooplankton was 2.3 ml in the lagoon and 4.1 ml in the sea showing higher secondary production.

In the lagoon decapod (79.65%) was the dominant group followed by foraminifera (12.02%) copepod (5.95%) and others (alima larva, chaetognath, heteropod, lamellibranch, siphonophore, gastropod, fish eggs, fish larvae, amphipod and lucifer) less than 1% each.

In the sea major group was copepod (50.83%) followed by siphonophore (18.34), lamellibranch (11.38%), chaetognath (8.73%), fish eggs (2.77%), gastropod (1.81%) decapod (1.50%), cladocera (1.19%) and others each (alima larva, appendicularia, doliolid, salp, heteropod, medusa, pteropod, foraminifera, echinoderm larvae, fish larvae, ostracod, amphipod, lucifer, polychaete) less than 1%. The decapod which was 79.65% in the lagoon was only 1.50% in the sea.

AMINI

Temperature: The surface temperature in the lagoon was in the range of 26.5° to 30.0°C. The temperature at 1800 hrs (28.0°C) gradually decreased to 27.0°C at 2200 hrs and remained same upto 0400 hrs and came down to 26.5°C at 0600 hrs. Then it increased to 30.0°C at 1400 hrs and showed a decrease towards 1800 hrs. The atmospheric temperature was in the range of 24.0° to 30.0°C A drastic increase of 3°C was observed between 0600 and 0600 hrs.

Salinity: The salinity in in the lagoon was in the range of 34.40 to 34.79‰. The salinity range was 35.48 to 35.87‰ in the windward reef.

Dissolved Oxygen: The range of dissolved oxygen was 3.04 to 6.43ml/l in the windward reef In the lagoon reef the dissolved oxygen range was 4.49 to 5.70ml/l. During the diurnal studies the range was 3.16 to 6.43ml/1. From 4.61 ml/l at 1800 hrs, the dissolved oxygen value gradually came down to 3.16ml/l at 24.00 hrs. Then it gradually increased to 3.52 ml/l at 0400 hrs, 3.88ml/l at 1000 hrs, 6.43 ml/l at 1600 hrs and started coming down afterwards. Higher values were obtained during afternoon period and lower values in the night.

Due to shallowness of the lagoon of this island plankton net could not be operated in the lagoon.

Productivity

The estimated gross and net production of surface waters of Amini Island were 785mg C/m³/day and 154mg C/m³/day respectively.

SURVEY TEAM II: FEBRUARY '87, ISLANDS COVERED, AGATTI, KALPITTI, BANGARAM AND BITRA TABLE. 1 & 3

AGATTI

Temperature: The maximum and minimum temperature in the lagoon were 38.0°C and 33.0°C respectively.

Salinity: The salinity values of the surface waters of lagoon bluctuated between 34.4 and 39.5‰. In the open sea the range was 36.5 to 40.5‰.

Dissolved Oxygen: The dissolved oxygen level of surface water was in the range of 2.80 to 6.70ml/l in the lagoon. The samples collected from outside the reef showed wide fluctuations (3.80 to 7.60ml/l).

Biomass and Faunistic Composition

The biomass of plankton collected from the lagoon is very low where as in the open sea, outside the reef the average displacement volume of zooplankton was 5-8ml.

The order of abundance of zooplankton in the lagoon was decapod (90.25%), copepod (4.24%), foraminifera (1.7%) and others (gastropod, appendicularia, lamellibranch, fish eggs and fish larve) each less than 1%.

In the open sea the dominant group was decapods (93.13%) followed by copepod (5.3%) and othets (gastropod, appendicularia, lamellibranch, polychaete, madusa, amphipod, cladocera, chaetognath, alima, heteropod peteropod, siphonophore, ostracod, *Lucifer*, cephalopod, doliolid, fish eggs, and fish larvae) each less than 1%.

KALPITTI

Kalpitti is a tiny island situated inside the the lgoon of the Agatti Island.

Hydrography: Surface water samples collected from the lagoon in the forenoon showed temperature of 36.0°C, salinity and dissolved Oxygen values 39.2‰ and 4.80ml/l respectively.

Biomass and Faunistic Composition: The volume of zooplankton collected from the sea was 1.0ml and comprised of fish eggs (73.7%),

TABLE 4 Estimated average number of zooplankton (in percentage per standard haul) in the lagoons and open sea of Lakshadweep Islands. March - 1987

	Kavaratti		Suhelipar		Androth		Minicoy	
Lagoon	Open Sea	Lagoon	Open Sea	Lagoon	Open Sea	Lagoon	Open Sea	Lagoon	Open Sea
DISPLACEMENT VOL. ml.	3.33	0 9	2.66	2.5	0.89	3.5	3.3	61.25	9.5
MEDUSAE									
SIPHONOPHORE	1.6	0.43	4.35	5.68	—	2.42	6.0	1.78	5.69
POLYCHAETE LARVAE			3.75	—	—	—	—	—	—
EVADNE SP.	—	3.00	2.55	—	—	0.80	—	0.89	—
COPEPODS	25.50	55.25	17.65	27.93	46.66	86.65	45	34.88	57.55
AMPHIPODS	2.47	—	—	—	0.19	0.40	— —	—	—
DECAPOD LARVAE	50.42	22.50	56.30	52.68	41.64	0.40	— 10	11.65	5.0
ACETES									
LUCIFER SP.	—	0.66	—	0.21	0.85	0.80	—	23 82	6.00
GASTROPODS	—	1.63					4.27	18.62	6.66
BIVALVES							5.48		
CHAETOGNATHS	2.63	3.45	2.50	1.23	1.66	6.62	7 56	5.24	9.50
PELAGIC TUNICATES	—	—	1.45	0.3	—	1.31	3.27	—	—
FORAMINIFERA									
APPENDICULARIA	—	3.08	3.20	5.97	—	—	5 27	—	7.00
FISH EGGS	17.38	10.00	8.25	6.00	8.38	0.60	13	3.12	2.60
FISH LARVAE	—	—	—	—	0.62	—	0.15	—	—

decapod (23.4%), copepod (2.2%) and others (gastropod, fish larvae, polychaete, amphipod, heteropod and pteropod) each less than 1%.

BANGARAM

Hydrography

The minimum temperature record was 34.0°C and the maximum 36.2°C.

The minimum and maximum salinity values recorded were 36.2 and 36.9‰ respectively.

Dissolved oxygen values were in the range of 5. 2 to 6.3 ml/l.

Biomass and Faunistic Composition :

The average displacement volume of zooplankton was only 0.5 ml inside the lagoon.

The dominant group was decapod (90.13%) followed by fish eggs (8.73%). The other groups such as copepod, gastropod, fish larve, lamellibranch, foraminifera, polychaete, medusa, amphipod, alima, pteropod and siphonophora were each less than 1%.

BITRA

Temperature : The maximum and minimum temperatures recorded were 36.0° and 35.0°C respectively. Where as the maximum and minimum atmospheric temperatures recorded were 38.0°C and 36.0° respectively.

Salinity : The salinity values ranged between 37.2 and 38.2‰.

Dissolved oxygen : Dissolved oxygen of the surface water fluctuated between 4.34 and 5.89 ml/l.

Biomass and Faunistic Comp^mposition :

The average zooplankton displacement volume was 0.6 ml in the lagoon. The major group present was decapod (73.4%) followed by cropepod (18.59%), fish eggs (3.05%) and chaetognath (2.45%). The other groups each below 1% were gastropod, fish larva, lamelli-branch, foraminifera, polychaete, amphipod, cladocera, alima and heteropod.

SURVEY TEAM III MARCH-1987
ISLANDS COVERED - KAVARATTI, SUHELIPAR, KALPENI, ANDROTH AND MINICOY
Table 1 & 4

KAVARATTI

Temperature:- The maximum and minimum surface temperatue of lagoon waters recorded during 24hrs was 31.5°C and 28.2°C. The atmospheric temperature was in the range of 25°C to 31°C.

Salinity:- In the lagoon the maximum salinity value of 34.4‰ was recorded at 20.00 hrs and the minimum of 29.5‰ was noticed at 08.00 hrs. In the open sea the salinity of surface sea water was 32.28 to 32.45‰.

Dissolved Oxygen: The minimum and maximum values of dissolved oxygen recorded from the surface waters of lagoon were in the range 2.54/ml/litre to 6.1 ml/litre. In the surface waters of open sea it was 5.51 ml/litre.

Productivity: The estimated gross and net productivity values of lagoon waters of Kavaratti during March '87 were 294.44mg C/m³/day and 48.59mgC/m³/day respectively.

Biomass and Faunistic Composition:

The average displacement volume of plankton collected from lagoon is 3.33ml. Decapod larvae consitituted 50.42%, copepods 25.50%, fish eggs 17.38% and chaetognath 2.63%. The other organisms which occurred less than 5% were chaetognaths, amphipods, appendicularians, *Evadne* sp. and *Lucifer* sp. In the open sea samples collected outside the reef area, copepods were dominant (55.25%) and decapod larvae formed 22.50% followed by fish eggs which constituted 10.00%.

SUHELIPAR

Temperature: The surface temperature of lagoon water samples ranged between 29.2°C to 30°C.

Salinity: The salinity was within the range of 33.38 to 35.0‰.

Dissolved Oxygen: The dissolved oxygen values were in the range 1.01 ml/litre to 6.6ml/litre. The low values of 1.01ml/litre was noticed in the lagoon waters very close to shore. This was either due to decomposition or putrification of gut contents of tuna which were thrown into the sea by the fishermen before the fish is boiled and sundried for making mas. A close examination of the water samples and plankton collected from this area did not show the presence of any organisms which might cause red water phenomenon or depletion of dissolved oxygen.

Productivity: The estimated gross and net production values of Suhelipar lagoon surface water samples were 244.41mgC/m³/day and Nil respectively.

Biomass and faunstic Composition: The average displacement volume of plankton collected from the lagoon area was 2.66ml. Decapod larvae and copepods which constituted 56.30% and 17.65% were the two major groups of zooplankton. The other groups which occurred in less than 10% were fish eggs, siphonophores, chaetognaths, appendicularians, pelagic tunicates, gastropods and *Evadne* sp. In the open sea plankton collections also the decapod larvae and copepods were the dominant items which accounted for 52.68% and 27.93% respectively.

KALPENI

Temperature: The temperature of surface water samples of lagoons fluctuated between 30°C to 38°C within 24hrs of observation. From 02.00 hrs to 08.00 hrs the temperature was only 30°C and it increased to 32°C at 10.00 hrs and then there was a sudden increase to 36°C anb 38°C at 12.00 and 14.00 hrs respectively and it gradually decreased from 37°C at 16.00 hrs to 32°C at 24.00 hrs. The maximum and minimum atmospheric temperature recorded during 24 hrs of observation were 32°C and 28°C. The lagoon surface water sample has reached maximum temperature of 38°C higher than the maximum atmospheric temperature of 32°C.

Salinity : Salinity values of the surface water samples of lagoon showed high range within

24 hrs of diurnal studies The maximum recorded value was 39.39‰ and the minimum was 34.68‰ .

Dissolved Oxygen: The dissolved oxygen values fluctuated from minimum of 1.15 ml/litre. The low oxygen values were recorded during the hrs 02 00 to 08.00 when there was no sunlight or less light. But the higher values were recorded during the period 12.00 to 20.00 hrs.

Productivity :

The gross and net production of Kalpeni lagoon surface waters were 1072.30 mg/m³/day and 328 88 mgC/m³ day respectively during March '87.

Biomass and faunistic composition :

The standing crop of the plankton samples collected from lagoon area was just 0 89 ml and it is the lowest figure compared to lagoons of all the other islands. Decapod larvae and copepods formed 41.62% respectively. Fish eggs formed the third group in order of abundance (8.38%). In the open sea collections formed the bulk of plankton (86.55%) and chaetognaths constituted only 6.62%

ANDROTH

This is an island without lagoon. However plankton and water samples were taken from, a small area in between the shore and the coral reefs, areas outside the coral reef in the open sea, so as to study and compare the occurrence of various zooplankters in this island, with that of other islands.

Temperature : The temperature of surface waters of the inshore and open sea were in the range 31°C to 32.8°C during day time, coinciding with the atmospheric temperature.

Salinity : Salinity values of surface water samples were higher and fluctuated between 33.60 to 35.12‰.

Dissolved Oxygen : Dissolved oxygen of surface waters were in the range 3.18 ml/litre to 3 60 ml/litre.

Biomass and faunistic composition :

The displacement volume of plankton collected inshore area is 6 ml whereas the biomass was less in samples collected outside the reef in the open sea.

In the inshore area copepods constituted 44.99%, decapod larvae and chaetognaths constituted 11.24% and 10.44% respectively. Fish eggs formed 8 8% and siphonophores formed 8 5%. Other organisms which occurred in small numbers are *Limacina* sp. (a gastropod,) pelagic tunicates and appendicularians. The same trend was seen in samples collected from other stations outside the reef in the open sea, except fish eggs which occurred in slightly larger numbers ranging from 12.5% to 20%.

MINICOY

Temperature :- The surface water temperature of lagoon was maximum of 35°C at 16.00 hrs and minimum was 30°C at 06.00 hrs, 1200 hrs and 20.00 hrs The temperature was always 30°C and above throughout the day and night. The atmospheric temperature was in the range 29°C to 33°C.

Salinity :- The salinity fluctuated between 31 93 to 35.41‰ during different periods of day and night.

Dissolved Oxygen : The maximum dissolved oxygen value was noticed at 12.00 hours it being 6.2 ml/litre and the minimum of 3.39 ml/litre was noticed at 08.00 hrs.

Productivity : The surface water samples of lagoon collected during March '87 indicate that the gross and net productions were 551 mgc/m³/day and 369.36 mgc/m³/day respectively.

Biomass and faunistic composition :

The average standing crop of zooplankton samples collected from the lagoon area was very high during March '87 being 61.25 ml. This is mainly due to flowering of algae (*Lingbea* sp.) Other zooplankters which occurred in large numbers were copepods (34.88%) and *Lucifer* sp. (23.82%). The other minor constituents of plankton were gastropods (18.62%), decapod larvae (11.61%) and chaetognaths, fish eggs and siphonophores occurred in very meagre numbers. In the open sea samples collected outside the coral reef the volume of plankton was just 9.5 ml and *Lucifer* species and gastropods occurred only in less numbers (6.31%) and (6.66%) respectively.

DISCUSSION

The Lakshadweep sea comprising of 10 inhabited islands and 17 uninhabited islets with a total land area of 32 Sq. km with total extent of lagoon of almost 420 sq.km is an important zone in the fishery potential map of the Indian Ocean. A knowledge of the environmental conditions of the water in and around (including lagoons) Lakshadweep is essential for studying several problems of new and existing fishery resources.

The Central Marine Fishers Research Institute is a pioneer in starting detailed oceanographic investigations of the environmental conditions of Lakshadweep Sea (Jayaraman *et al.*, 1959, 1960) and since then several investigators have added more information on this aspect. A detailed uptodate riview of the literature on the environmental features of the Lakshadweep Sea has been given by James *et al.* (1986), Nair *et al.* (1986), which covers wind system, sea surface circulation, hydrographic conditions (Water masses, water movements, chemical charscteristics of waters, sea surface temperature, dissolved oxygen maxima and minima, water characteristics, convergence and divergence zones) and environmental features in relation to fishes.

The salient findings of physico-chemical conditions and plankton of lagoons and seas around the Lakshadweep islands based on the studies conducted by three survey teams during Jan, Feb and March '87 respectively are as follows.

The high value of 38°C temperature of surface waters observed in Agatti and Kalpeni lagoons during February and March is significant. In Minicoy the surface temperature of lagoon waters remained in the range 32°C to 33°C, higher than the atmospheric temperature even during the night time (20.00 hrs to 04.00 hrs) after sunset and before sunrise. Otherwise the sea surface temperature observed in the open Arabian sea was high during May-June period and low in the month of July '87.

During the period Jan.-March '87 the high salinity values of surface samples of lagoon waters observed were, Kalpitti lagoon (39.2‰), Bangaram (36‰), Bitra (38.2‰) and Kalpeni (39.39‰). These high salinity values could be attributed to heavy evaporation due to high atmospheric temperature and heat within the lagoon and also poor inflow of oceanic waters from outside the reef into the lagoon and maximum saturation of chemicals of the coral reef with the water masses inside the lagoon.

The minimum and maximum dissolved oxygen values of surface waters lagoon fluctuated between 2ml/litre to 6 ml/litre in most of the lagoons except Suhelipar where the minimum value of 1.16 ml/litre was noticed. This has resulted in the mortality of polychaetes, clams and crabs. The sudden changes in the same place might be due to water movements, circulation and mixing and different biological changes of different marine erganisms including phytoplankton, seaweeds and sea grass.

It is reported by Rao *et al.* (1966) that from the distribution of temperarure, salinity, dissolved oxygen and density that up welling occurrs during the Nov.-December period in the Lakshadweep Sea close to minicoy and this phenomenon is confined to only upper 150 metres depth. It is also found that a divergence vone (around 71°E and9°30 N) and a convergence zone (with an axis roughly along 79°E and 8°N) be in the same area.

The waters of lagoons of Lakshadweep are productive and production rate during Jan. March '87 showed wide variation in different islands (Table-1). Earlier reports (Tranter and George; 1972) indicate that inside the lagoon the secchi disc visibility is 27 metres and extenction coefficient is 0.017 and rate of production is 3.7gms c/m³/day. Nair *et al* (1986) reported that the euphotic zone of the Lakshadweep sea is almost over 90m. As such thd production per unit volume in the surface waters may not be high. However according to them the integrated value for the whole water column is of the range of almost 300mgC/m²/day and this high value is highly significant for oceanic waters.

different authors reported different aspects of secondary production in the lagoon and open sea of Lakshadweep Islands. Silas (1972) studied bioscattering in the shallower depths off Minicoy, Agatti, Pitty, Kavaratti, Kalpeni, and Androth islands and of Snheripar. According to him the estimated monthly mean standing crop of zooplankton varied between 26 and

144ml per 1000m³ of water in rhe sea around Lakshadweep. According to Mathew (MS) euphausid fauna is an important constituent in the DSL and it is the staple food for tunas and bill fishes which form the main fishery of Lakshadweep Sea. He has reported occurrence of 19 species of Euphausids from this area but according to him there has been no record of catching any of these species from the coral lagoons and atolls. Tranter and George (1972) who studied zooplankton abundance of Kavaratti and Kalpeni atolls during October and December period observed swar- of ostracods, *Cypridina* sp. According to them the biomass was greatest seaward of the western lagoon of Kavaratti and gets depleted enroute ocean to lagoon. From zooplankton samples collected from the lagoons of different islands during Jan-March'87, Eupshausid specimens could not be obtained. The biomass of zooplankton of most of the lagoons is negligible except Minicoy. The occurrence of *Lucifer* sp, copepod sp. and *Lingbea* (Algae) in the lagoon has increased the standing crop of zooplankton to 61.5ml. The lower values of biomass of the lagoon sample than the open sea sample might be due to feeding of zooplankton by reef communities during their transit across the reef to lagoon as reported by Tranter and George (1972). Goswamy (1973) studied the zooplankton assemblages of the lagoons and seas of Lakshsdweep. He has recorded very high value of 178ml of zooplankton biomass per 1000^{8} and encountered different species of copepods (52sp), chaetognaths (8sp), mysids (3sp) polychaetes (5sp) amphipods (28 sp) decapods, fish eggs and larvae. Most of the above mentioned organisms occurred in plankton samples collected from the Lakshadweep lagoons during this survey conducted during Jsn-March'87. In most of the lagoons decapod larvae and copepod the constituted the dominant items of zooplankton sample. The other zooplankters which occurred in moderate quantities were siphnophores, chaetognaths, fish eggs, bivalves and appendicularians. A plankton sample collected near Kalpitti, a tiny island, just outside the reef showed very high concentration of fish eggs (73.2%) followed by decapod larvae constituting 23.4%. The high precentage of decapod larvae in the lagoon or outside the reef samples show that the coral reefs form an ideal ground for settlement for crustaceans especially crabs. The occurrence of zoea and megalopa larvae is also an indication to show that the lagoon and adjacent areas are ideal breeding grounds for crabs and this is proved by the presence of berried crabs in coral reefs during the period Jan-March '87.

Other organisms which occurred in very small numbers in the plankon samples of lagoon were Pluteus larva, of Ophuroid and Echinoida, Bipinnaria larvae of starfishes and Auricularia larva of holothurians. *Evadne* sp, amphipods, polychaete larvae, pelagic tunicates, foraminifera, ostracods and fish larva also occurred in lesser numbers.

An intensive study of the physio-chemical conditions and productivity studies with special reference to various zooplankton asemblages of the lagoon during different seasons is essential to get a complete picture of marine fishery resources which include Tuna and Billfishes, ornamental fishes, echinoderms, sea weeds, sponges, molluscs, crustaceans and corals.

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