

ZOOPLANKTON STUDIES IN THE INDIAN OCEAN

I. FROM BAY OF BENGAL DURING SOUTH-WEST MONSOON PERIOD

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ABSTRACT

Zooplankton abundance in the Bay of Bengal during the south-west monsoon period showed that areas close to the land are rich in zooplankton production. Biomass values were low for the northern most stations and gradually increased from north to south indicating the possibility of environmental factors influencing production in this area. Aggregates of different groups of zooplankton evidently contributed to higher biomass values towards the southern part. South-east coast was richest for decapod larvae, fish eggs and fish larvae. Decapod larvae were more abundant nearer to the coast and their density gradually decreased towards the open ocean. Zooplankton stratification in relation to thermocline suggested a preference for zooplankton to congregate above the discontinuity layer.

INTRODUCTION

The biology programme of the cruises of R. V. *Gaveshani* of the National Institute of Oceanography is organised to determine the biological productivity of coastal and offshore regions of India at various trophic levels. For evaluating the production at the second trophic level, zooplankton samples were collected. The present paper constitutes the first report on zooplankton from the series of the investigations from the Bay of Bengal during the latter half of the south-west monsoon period.

Zooplankton studies in the Indian Ocean have been reviewed by Panikkar and Rao (1973). The most important contribution in this field originates from the results of the International Indian Ocean Expedition (IIOE) which provide some basic information for further investigations. The results of the zooplankton analyses of the IIOE collections were utilised for

the preparation of a series of atlases showing the distribution of biomass and abundance of different groups of zooplankton in the Indian Ocean (Indian Ocean Biological Centre, 1968-1973). Later surveys in the north-western Indian Ocean (Menon and George, 1977; Paulinose and Aravindakshan, 1977 and Peter, Iyer, John and Radhakrishnan, 1977) have extended our knowledge on secondary production in that area. The present collections from the Bay of Bengal during the south-west monsoon period covered mostly the areas not sampled during the IIOE, making the investigations more interesting and important.

MATERIAL AND METHODS

Zooplankton samples collected during the cruises VII, VIII and IX of R. V. *Gaveshani* were used for the present study. The cruise tracks and station locations are shown in Fig. 1. The cruises lasted from 24th August to 2nd October, 1976.

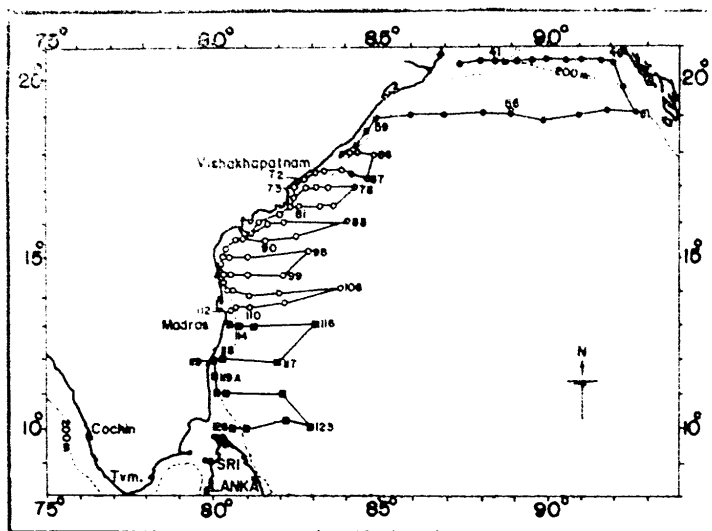


Fig. 1. Cruise tracks of R. V. Gaveshani Cruises VII, VIII and IX. Closed circles show stations occupied during the seventh cruise. Open circles indicate stations covered during the eighth cruise. Closed squares display stations for the ninth cruise.

Vertical zooplankton samples were collected from most of the stations using the Indian Ocean Standard Net (Currie, 1963). During the eighth cruise an HT net (Tranter, Devi and Balakrishnan, 1972) was also operated at a few stations. At shallow stations the whole water column was sampled and from deeper stations samples were collected from 500 m to the surface. From a few stations where a clear thermocline was present stratified sampling was made. From these stations two samples one from upper layer of thermocline to the surface and a second one from 500 m to the thermocline or from 500 m to the surface—were obtained.

Ninetyseven samples were analysed for the numerical abundance of copepods, chaetognaths, decapods, fish eggs and fish larvae by sorting out subsamples. Estimated abundance for the different

groups were represented as no./100 m³. Distribution charts for biomass and the different groups were prepared (Figs. 2-7). For the preparation of biomass chart, volumes of prawn larvae obtained from a few stations (90, 91, 91 A, 92, 118, 119 and 119 A) were not incorporated. For a comparative evaluation of the data, the region under investigation was divided into three areas: area 1 covering station 41 to 66 (between 17°55' to 20°32'N Lat.), area 2 covering stations 67 to 98 (between 15°10' to 17°55'N Lat.) and area 3 covering stations 99 to 126 (between 10° to 15°10'N Lat.)

HYDROGRAPHY

The cruises were conducted during the south-west monsoon prevalent in the north Indian Ocean. During this period, the current is from west to east. The

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environmental conditions in the Bay of Bengal are characterised by the large amount of precipitation and increase in the salinity from north to south (Gallagher, 1966). Surface salinity at the stations from north to south varied from 23.36–34.65‰. The 500 m water column included two water masses: the surface water mass extending to 100–150 m and sub-surface water mass below this. The former had a temperature range of 23–29°C and salinity range of 20–34‰ and the latter had a temperature range of 5–15°C and salinity remained quite constant between 34.1–35‰ (Gallagher, 1966). Differences in the surface values of temperature, salinity, oxygen and integrated inorganic phosphate values for the different regions are given in Table I. The environmental conditions at the time of collection also indicated differences between the three areas under investigation (Table I). Salinity and nutrient (PO₄-P) values showed gradual increase from north to south, while oxygen and temperature remained almost unchanged.

Biomass

Wet zooplankton displacement volumes, expressed as ml/100 m³, were considered as biomass and the values are represented in Fig. 2. In general, the stations close to the land mass and occupied within the 200 m line were richer in zooplankton biomass. Maximum value amounting to 60 ml/100 m³ was recorded from station 55, located in the northern Bay of Bengal.

Zooplankton production in the three regions were estimated separately. To eliminate the effect of extreme values obtained from a few stations geometric mean was worked out. The values were in the order of 7.81, 8.12 and 8.42 (Table I) for area 1, area 2 and area 3 respectively thus indicating a general increase in production from north to south.

To evaluate the effect of time of collection on the biomass of zooplankton, average biomass values were estimated for six hourly intervals. The data given

Table I. Environmental data for the surface water, integrated phosphate values and the mean biomass values for the three areas.

Environmental parameters / production	Area 1 stations 41-66 (north of 18°N lat)	Area 2 stations 67-98 (between 15°-18°N lat)	Area 3 stations 99-126 (south of 15°N lat)
Temperature °C	28.1 – 29.7	27.3 – 29.0	28.4 – 29.8
Salinity ‰	23.36 – 33.10 most values below 31.00	29.34 – 34.38 most values above 32.00	31.38 – 34.65 most values above 33.00
Oxygen ml/l	3.79 – 4.50	3.50 – 4.57	3.84 – 4.65
Inorganic Phosphate µg at/l (Integrated mean value)	41.74	46.1	102.98
Biomass ml/100 m ³	7.81	8.12	8.42

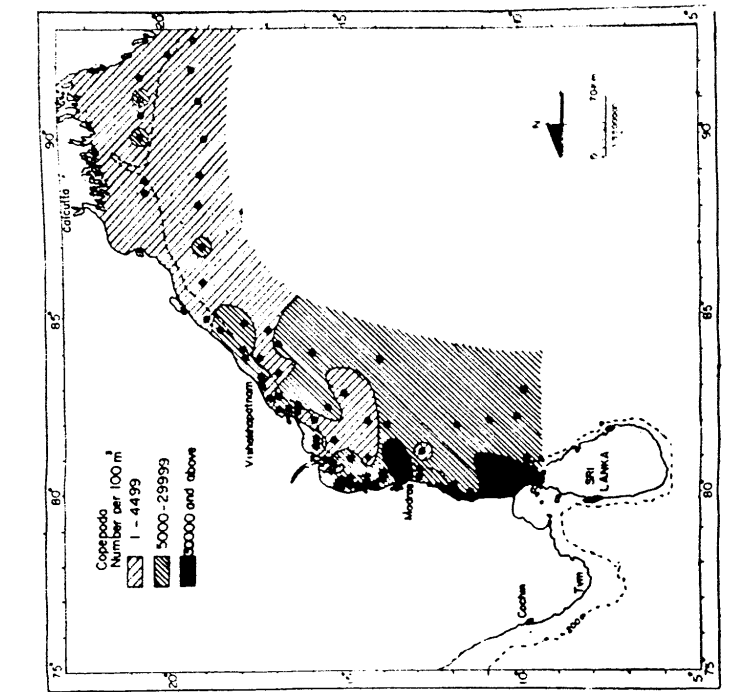


Fig. 3. Distribution of Copepoda in the Bay of Bengal.

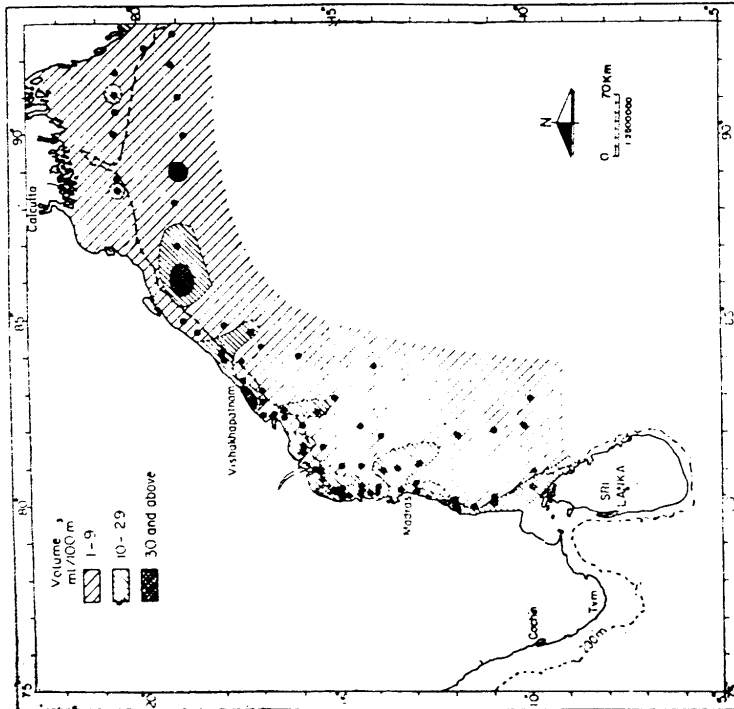


Fig. 2. Biomass distribution in the Bay of Bengal.

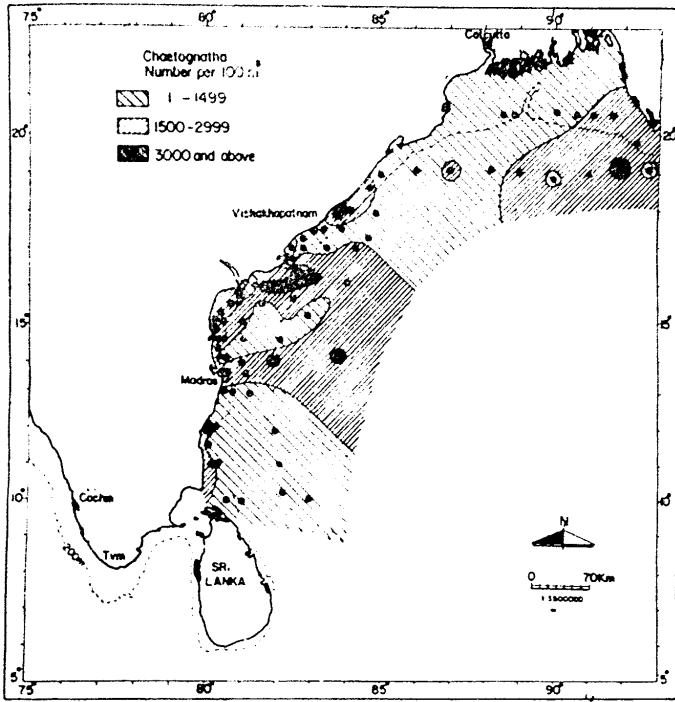


Fig. 4.
Distribution of
Chaetognatha in
the Bay of Bengal.

below indicated that biomass values were greater during the night hours.

Time of collection	Average biomass (ml/100 m ³)
0000 - 0600 hrs.	14.6
0600 - 1200 hrs.	7.9
1200 - 1800 hrs.	12.0
1800 - 0000 hrs.	12.2

Copepoda

Copepods were dominant in all the samples excepting at three stations. Spatial abundance of the group is represented in Fig. 3. High density was confined towards the areas 2 and 3 with scattered maximum values within this region. The highest recorded value was 90100/100 m³ from station 119.

Chaetognatha

This group was fairly well represented

in all the collections and was dominant at stations 72, 81 and 90. This group occurred in scattered areas of abundance (Fig. 4). However, chaetognaths sustained relatively higher values at the stations occupied between the coasts of Madras and Vishakhapatnam. Maximum chaetognath density of 5970/100m³ was encountered at station 119.

Decapoda

The larvae of decapods were found at most of the stations. The distribution chart (Fig. 5) indicated that the larvae were more abundant nearer to the coast and their population gradually decreased towards the open ocean. South-east coast was richest for the group. High density amounting to 4430/100 m³ and 1850/100 m³ were recorded from the stations 112 and 119 respectively.

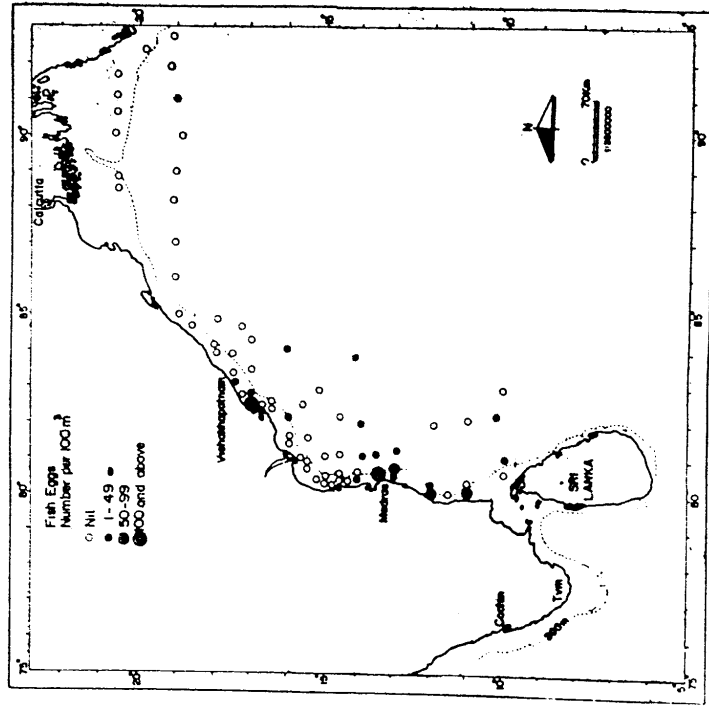


Fig. 6. Distribution of fish eggs in the Bay of Bengal.

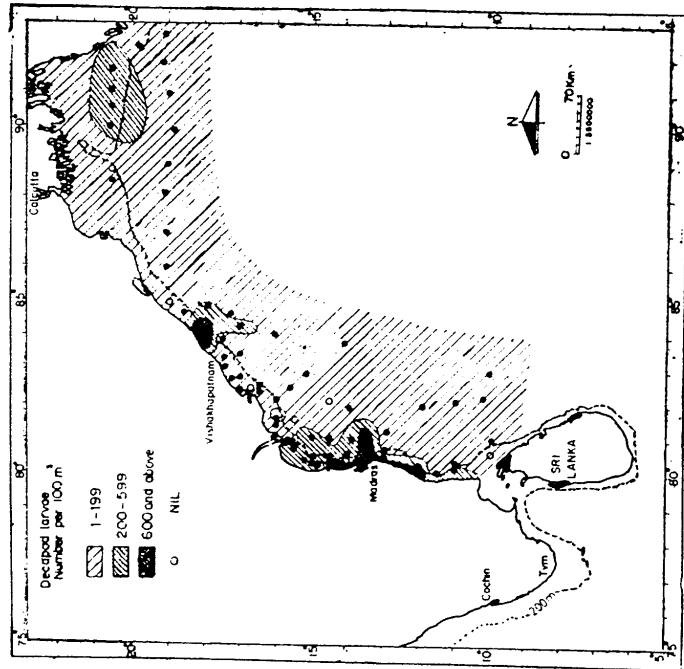


Fig. 5. Distribution of decapod larvae in the Bay of Bengal.

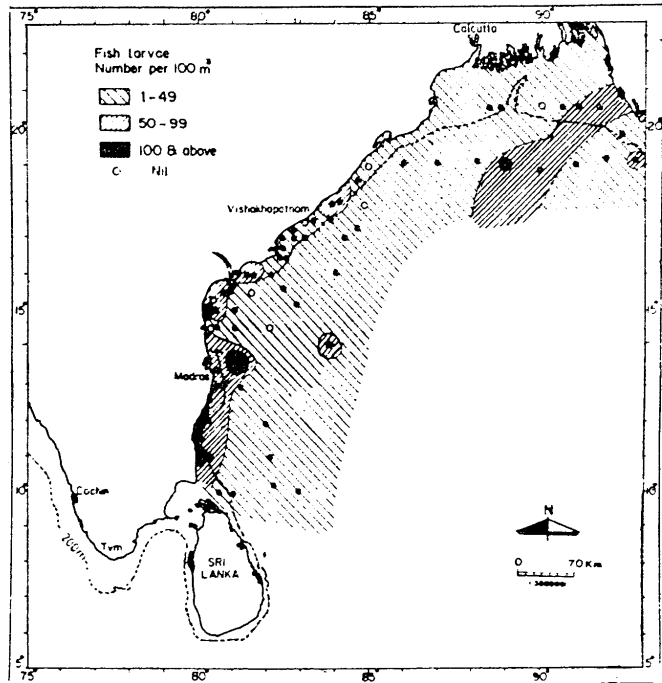


Fig. 7. Distribution of fish larvae in the Bay of Bengal.

Fish eggs

Among the 97 samples analysed, fish eggs were encountered only in approximately 20% of the collections. Fish eggs also showed a greater representation towards the southern part of the surveyed region (Fig. 6). Except for a single record they were absent in the northern part of the Bay of Bengal. Maximum value of 150/100 m³ was from the station 73.

Fish larvae

Fish larvae were represented in most of the samples. They also sustained relatively higher abundance towards the southern part (Fig. 7). The northeastern part of the Bay of Bengal had a fair abundance of fish larvae. Highest density of 580/100 m³ was recorded from the station 110.

Euphausiids

Instances of unusual abundance of euphausiids were noticed from stations 110, 114, 118 and 119 A. Their numerical abundance at these stations ranged from 415–2050/100 m³ and biomass was between 2.5 to 5.0 ml/100 m³. The total biomass values at these stations were relatively low with the result that euphausiids contributed to 30.7 to 58.8% of the total volume.

Stratification in relation to thermocline

Data pertaining to the stations having samples from the thermocline to the surface as well as from 500 m to the thermocline are given in Table II. Highest biomass values were obtained from the samples taken above the discontinuity layer, excepting at station 56. Copepods and

Table II. Stratification of zooplankton in relation to thermocline

Station	Depth m	Biomass ml/100m ³	Copepoda no./100m ³	Chaetognatha no/100m ³	Decapoda no/100m ³	Fish larvae no/100m ³	Fish egg no/100m ³
53	125-0	8.3	3600	1500	30	20	8
	500-125	0.3	230	5	-	-	-
54	70-0	6.0	3600	1100	140	50	-
	500-70	2.3	550	30	4	4	-
55	60-0	6.0	4100	2100	65	250	-
	500-60	0.4	300	40	1	1	-
56	100-0	5.0	4800	1400	140	40	-
	500-100	10.0	1400	40	1	1	-
57	70-0	26.0	27700	2700	-	-	-
	500-70	10.0	6100	1000	100	40	-
78	50-0	9.0	15100	2240	310	-	-
	500-50	3.3	2233	208	18	2	-

chaetognaths invariably sustained high density above the thermocline. Decapods with the exception of station 57 and fish larvae excluding station 57 and 78 occurred in larger numbers above the thermocline.

DISCUSSION

It is noticed that during the particular period of study, zooplankton production was low for the northern most stations of the Bay of Bengal suggesting the possibility of environmental factors influencing production in this area. At the head of the Bay, river discharge is maximum in the fall resulting in dilution and mixing of river water with high salinity water in the estuaries and continental shelf forming the northern Dilute Water (Gallagher, 1966). Among the three distinct water masses in the head of the Bay, (La Fond, 1958) the northern dilute water has the lowest density. Off the Waltair coast, Ganapati and Rao (1958) found clear cut season-

nal differences in the hydrobiological conditions and August to December period was less productive than the December to August period.

From north to south there was well defined increase in the surface salinity and integrated phosphate values (Table I). This is reflected from the biomass values indicating an increase in zooplankton production towards the southern part of the region surveyed. Aggregates of different groups of zooplankton evidently contributed to higher biomass values in this region.

The zooplankton abundance and its relation to thermocline suggest a preference for zooplankton to aggregate above the discontinuity layer. The water above the main discontinuity layer in most regions is vertically stirred by wind induced or convective mixing and the occurrence of oxygen maxima in wind mixed layer indicates that the biological activity is proceeding at a rapid rate (Banse, 1964). It seems that physically homogeneous

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water column provides a more congenial environment for zooplankton production.

ACKNOWLEDGEMENT

Authors are thankful to Dr. S. Z. Qasim, Director, NIO, for his keen inte-

rest in the progress of this work and also for his comments on the manuscript. They are indebted to Dr. M. J. George, Scientist, NIO, for his suggestions on the manuscript. They are also thankful to the Scientists on board R. V. *Gaveshani* who made this samples available.

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