

Zooplankton from the Nearshore Waters of Karwar

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Zooplankton in the nearshore waters of Karwar was studied in samples collected from 3 stations during Oct. 1975 to Sept. 1976. Zooplankton biomass showed 2 peaks, one during postmonsoon and the other during the premonsoon period. General pattern in zooplankton abundance indicated the intermediate station to be more productive. Maximum zooplankton production in the area during postmonsoon months coincided with peak fishing season of the Karwar region. Copepods, cladocerans, decapod larvae, fish eggs and chaetognaths formed the major part of the zooplankton. Maximum incidence of fish eggs and larvae was recorded during November-December. Incidence of chaetognaths was observed throughout the period of investigation. However, typical marine species of chaetognaths and ostracods were recorded only during the premonsoon period. Larval stages of different taxa were found in most of the samples suggesting continuous breeding in the Bay and periods of intense breeding are superimposed on continuous breeding.

AS a part of the sponsored project for locating a suitable site for discharge of effluents of Ballarpur Industries at Karwar, the National Institute of Oceanography undertook a survey of the nearshore waters of that region in 1975-76. Investigations on the biological productivity in the area formed part of the programme. Zooplankton samples collected during this survey from Binge Bay near Karwar were studied.

Zooplankton investigations in the Indian coastal waters have been reviewed by Panikkar and Rao¹. After this, several studies²⁻⁶ have been made on the zooplankton of these waters. Apart from the report of Ramamurthy⁷ on the plankton of the North Kanara coast, including a sampling station off Karwar, there is no other work on zooplankton from this area.

Hydrographical conditions in the North Kanara coast were studied by Ramamurthy⁸ and Noble⁹. During the present investigation, observations were made to evaluate total zooplankton abundance, its composition and seasonal fluctuations. NIO project report¹⁰ included a preliminary report on the zooplankton from these collections.

Materials and Methods

The Binge Bay is a prominent Bay in the North Kanara. The sampling stations 1, 2 and 3 are located nearly 1, 3 and 5 km respectively, from the shore. The stations were selected between 14°45' to 14°47' N lat. and 74°05' to 74°08' E long. Monthly zooplankton samples were collected from Oct. 1975 to Sept. 1976 using a HT net (mouth area 0.25 m², mesh size 0.3 mm) with a flowmeter attached. Samples were collected in the forenoon by taking surface hauls for a duration of 5 min. After determining the total volume of zooplankton, 25% of each sample was analysed for the enumeration of different taxa encountered. The study was mainly numerical and density is

represented as No./100 m³ of water filtered. During March and May to July 1976, due to unavoidable reasons, the survey had to be suspended. Seasonal divisions considered in the text are monsoon (August-September), postmonsoon (October-January) and premonsoon (February-April) periods.

Hydrography — North of the Bay, the river Kali joins the Sea. Discharge from the river and seasonal upwelling on the west coast contribute to the general fertility of the area. Monthly variations in temperature, salinity, dissolved oxygen and pH based on NIO project report¹⁰ are shown in Table 1. The temperature distribution here had a seasonal pattern and local variations were not significant¹⁰. Important seasonal feature observed in temperature was a slow decrease from 26.3°C in Oct. 1975 to 26°C in Jan. 1976 and then an increase to 29.98°C by April 1976. Maximum salinity was recorded in April and minimum in August. Dissolved oxygen and per cent saturation of dissolved oxygen values showed that the area is saturated with dissolved oxygen. During the monsoon months

TABLE 1 — MONTHLY VARIATIONS IN SURFACE TEMPERATURE, SALINITY, OXYGEN AND pH FOR DIFFERENT MONTHS IN THE BINGE BAY

Month	Temperature °C	Salinity ‰	Dissolved oxygen ml/litre	Per cent saturation of dissolved oxygen	pH
Oct.	26.3	33.32	4.01	88.00	7.79
Nov.	—	34.73	3.88	98.22	7.89
Dec.	25.94	34.71	4.8	102	8.13
Jan.	26.04	34.65	6.07	131	8.12
Feb.	29.01	33.16	5.21	124	8.14
April	29.98	36.02	3.87	90	7.74
Aug.	27.86	25.46	4.52	132	7.78
Sept.	26.87	33.4	4.14	89	7.41

intrusion of upwelled water from the offshore area into the Bay seems to occur¹⁰.

Results

Pattern of variations in zooplankton biomass is presented in Fig. 1A. Zooplankton standing stock in the area was fairly high with 2 peak periods, one during postmonsoon period (October and December) and the other during the premonsoon month (February). In general, st. 2 sustained relatively high density of zooplankton throughout the period of investigation. Invariably, lowest biomass values were recorded from st. 1. St. 2 was approximately 3 times more productive than st. 1. St. 3 maintained intermediate values during different months. Copepods, cladocerans, decapod larvae, fish eggs, chaetognaths and fish larvae formed the common constituents of zooplankton in the Binge Bay.

Copepods—They dominated most of the collections except those during October to December at st. 1 and 3 and October and August at st. 2 when cladocerans were the most abundant group. The peak periods for copepods (Fig. 1B) coincided with that of total zooplankton volume. Maximum density of 43700/100 m³ was recorded at st. 3 in August.

Cladocera—Two species of cladocerans present in the samples were *Evadne tergestina* and *Penilia avirostris* of which the first one was more abundant (Fig. 2A and B). During the postmonsoon period, they sustained maximum density and even outnumbered the copepod population. Relatively, low density of this group was observed in April when the maximum salinity (36.02‰) and in August when the lowest salinity (25.46‰) were recorded.

Decapod larvae—They were very common in the Bay. At st. 2 in October, they were second in abundance. The larvae were abundant during the postmonsoon month and poor during the premonsoon

period. St. 2 and 3 were relatively richer for these larvae (Fig. 3A).

Fish eggs—Incidence of fish eggs in the Bay is shown in Fig. 3B. They were more common during September–November. At st. 2 during November, when the biomass was poor, the density of fish eggs amounted to 4150/100 m³ and was second in dominance.

Fish larvae—Even though fish larvae were encountered in most of the samples, their representation was numerically low. The peak abundance of fish larvae soon after the November peak of fish eggs was conspicuous (Fig. 3C). During the premonsoon period, larvae were sparsely represented in the samples.

Chaetognaths—In this coastal Bay, salinity fluctuations (25.46 to 36.02‰) did not affect the incidence of chaetognaths at any time during the period of investigation. However, during August, when salinity was relatively low, the typical estuarine species—*Sagitta bedoti* alone was encountered. Two prominent peaks were observed in January/February and October months (Fig. 4).

Eight species belonging to the genera *Krohnitta*, *Pterosagitta* and *Sagitta* were recorded. *S. bedoti* was the common species at st. 1 and *S. enflata* dominated most of the samples at st. 2 and 3. Other species occasionally encountered in the samples were *K. pacifica*, *P. draco*, *S. bipunctata*, *S. pacifica*, *S. pulchra* and *S. robusta*. These incidental species, common in the offshore waters of south west coast of India¹¹, were more abundant during February. St. 3 showed maximum species diversity numbering 8 and the other 2 sustained only 6 species.

Other groups—Numerical values of other taxa encountered in the collections are given in Table 2.

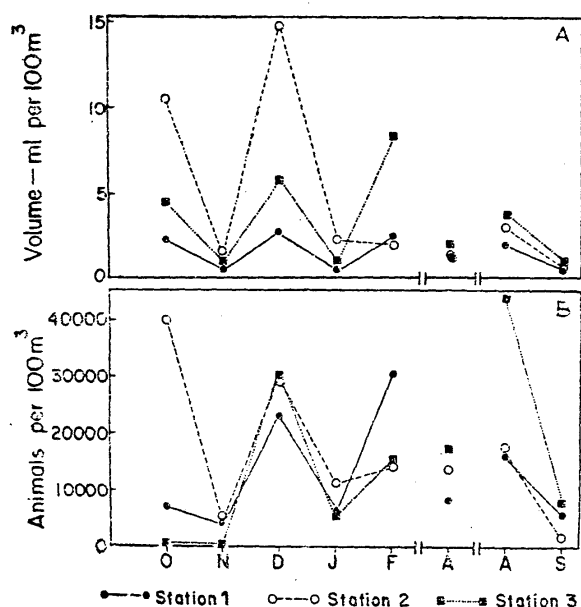


Fig. 1—Variations in the abundance of total zooplankton (A) and copepods (B) at 3 stations

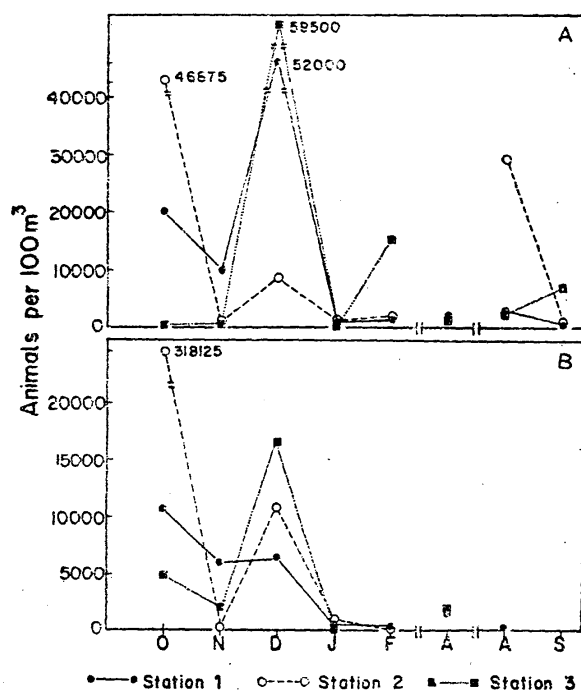


Fig. 2—Variations in the abundance of cladocerans [A, *E. tergestina*; B, *P. avirostris*] at 3 stations

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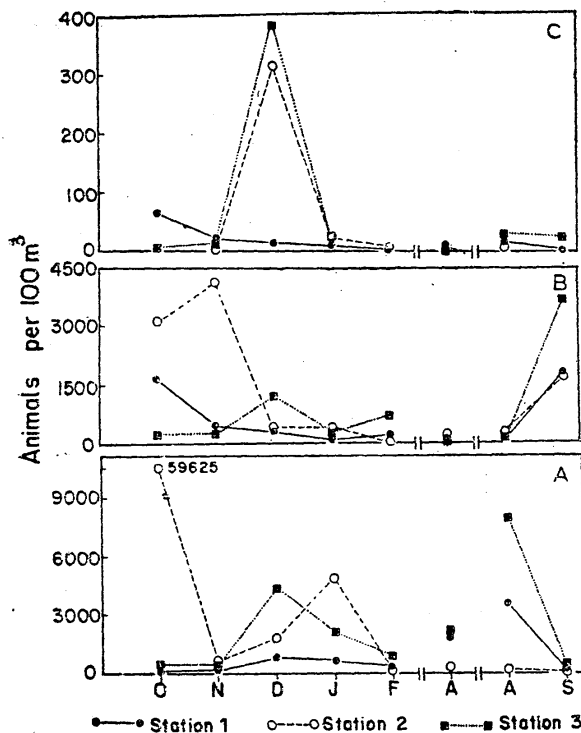


Fig. 3 — Variations in the abundance of decapod larvae (A), fish eggs (B) and fish larvae (C) at 3 stations

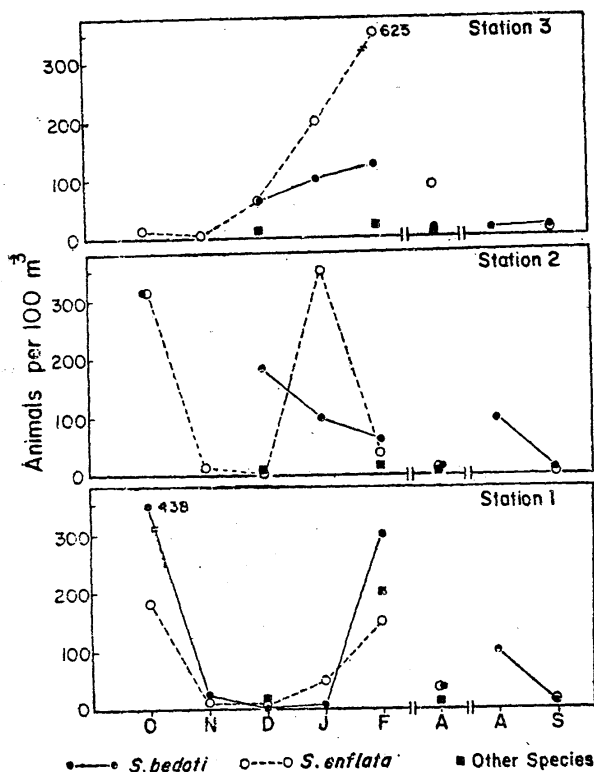


Fig. 4 — Variations in the abundance of chaetognaths at the 3 stations

Siphonophores were better represented at st. 3. Polychaetes were more at st. 1. Incidence of the ostracod species *Conchoecetta giesbrechti* was noted at st. 3 during April, when maximum temperature and salinity were recorded. Among the molluscs gastropods, lamellibranchiates and *Creseis* sp. were common during the postmonsoon period. In January, at st. 2 pteropods included a few specimens (50/100 m³) of *Cavolinia*. Appendicularians represented by the genus *Oikopleura* were relatively more abundant at st. 2 and 3.

Discussion

At a station off Karwar, Ramamurthy⁷ found 2 peaks in zooplankton production — a major peak in March-May and another in August-November. In the Binge Bay, maximum biomass was recorded in December, mainly contributed by cladocerans, copepods, decapod larvae, fish eggs, fish larvae and molluscan larvae. The renewal of nutrient by land drainage may well account for the maximum biomass noted during the postmonsoon month. Maximum densities for cladocerans, decapod larvae, fish eggs and fish larvae were obtained during the postmonsoon period when the lowest temperature range was recorded (Table 1).

In the Bay, seasonal changes on account of monsoon result in distinct periodicity in the incidence of some of the species. During the low salinity period, the typical estuarine species, *S. bedoti* alone among chaetognaths could tolerate conditions prevalent in the area. Typical marine species of chaetognaths and ostracods were noticed in February/April in the Bay extending even to the inshore waters.

Breeding in tropical waters is continuous and periods of intense breeding is superimposed on what may be called continuous breeding^{12,13}. Larval stages of different taxa were found in most of the samples indicating continuous breeding in the Bay. However, there is well-defined periodicity in the peak breeding periods of different groups as is evident from the abundance of different types of larval forms at particular months. Such peak breeding periods of *S. bedoti* and *S. enflata* were noticed in January/February and October when maximum number of juveniles were encountered in the samples. Gastropod and bivalve veligers were maximum in December. Maximum incidence of decapod larvae was recorded in October.

September-December period was noted for abundance of fish eggs and larvae with intense breeding in November/December months. The area around st. 2 and 3 seems to be more congenial for fish eggs and larvae than the turbid waters of st. 1 (Figs. 3B and C). Bapat and Bal^{14,15} studying the feeding habits of larvae of several species of fishes found that majority of them was surface plankton feeders in the early part of their lives. In the present collections, the maximum abundance of fish larvae coinciding with the major peak of total zooplankton in December is noteworthy.

Mackerals and oil sardines form the important pelagic fishery of Karwar region¹⁶. The fishing season commences in late September and continues

TABLE 2 — INCIDENCE OF DIFFERENT GROUPS OF ZOOPLANKTON IN THE BINGE BAY

(Values represent No./100 m³)

Month	Siphonophora	Medusae	Polychaeta	Amphipoda	Pteropoda	Gastropoda	Lamelli-branchiata	Appendicularia
STATION 1								
Oct.		13	63	813	63			188
Nov.				20				
Dec.	F	313	8	63		1250	3250	50
Jan.			25		75	20	63	13
Feb.		1	13	175		250	25	200
April	F		100		200	100	100	25
Aug.		100	200			2		
Sept.								
STATION 2								
Oct.*		625			12500		6500	938
Nov.				413			150	
Dec.†			2			1750	750	250
Jan.			100		500	500	150	
Feb.			13	63	100	850		113
April					175	150		200
Aug.	F	13						400
Sept.			13					25
STATION 3								
Oct.	F	63		13	3063			188
Nov.				2				
Dec.	F			1	20	3250	1500	
Jan.		50	13		2700	5		100
Feb.	F	1	3	313		1063	625	313
April‡	F	2			350	50	100	450
Aug.		3	1					200
Sept.								13

F = a few.

Present only in one month: *Atlantidae at st. 2 (63/100 m³).

†Cirripedia at st. 2 (63/100 m³).

‡Ostracoda at st. 3 (13/100 m³).

through May, with the peak in October-January. Ramamurthy⁷ observed that copepods, cladocerans, crustacean larvae and molluscan larvae constituted the major part of food items of mackerel and oil sardines. However, he could not find any correlation between the fishery and the plankton. On the contrary, direct relationship between zooplankton production and pelagic fisheries was reported by Prasad¹⁷ and Nair *et al.*¹⁸. This is supported by the results of the present study also, showing maximum zooplankton production in Karwar Bay during the postmonsoon period coinciding with the peak fishing period in the area.

Bainbridge¹⁹ after studying the zooplankton in the coastal waters of tropical West Africa found a gradual transition from a neritic to an oceanic fauna with increasing distance from the coast. This feature was observed in the distribution of chaetognath species and other groups which are predominantly oceanic. Again seasonal change in zooplankton in the Binge Bay had similarity to that reported from Biscayne Bay by Reeve²⁰. Both studies indicate that zooplankton in these Bays are characterized by high number and low species diversity compared to adjacent offshore waters,

permanent plankton composed largely of copepods and lesser density of carnivores and finally the temporary plankton consisting mainly of the larvae of molluscs, decapod crustaceans and polychaetous annelids.

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