J. mar. biol. Ass. India, 1989, 31 (1 & 2) : 195-201

VARIATION IN MEROPLANKTON ALONG 78°E MERIDIAN

T. BALACHANDRAN AND K. J. PETER
National Institute of Oceanography, Regional Centre, Cochin-682 018

ABSTRACT

Variations along the meridian 78°E between 8°N and 25°S, based on 43 zooplankton samples were studied. Fish larvae exhibited fluctuations in abundance (26 to 57 specimens/IOSN haul) in the three zones studied (8°N—5°S, 5°S—15°S and 15°S—23°S). Fish eggs showed variations within the zones, having a maximum of 1 to 5 in Zone B. While greater variations of 1 to 4 were shown in Zone B by the bivalve larvae, it was less in other zones. Marked variations among the anthozoan, cephalopod and sipunculoid larvae were not discernible in the different zones owing to their low occurrence.

INTRODUCTION

'UMITAKA MARU' AND 'KAGOSHIMA MARU', two Japanese research vessels, during the International Indian Ocean Expedition (1960-65) took a series of collections along the meridian 78°E ; characterised by zonal temperature gradients. This study is aimed at assessing the variation of meroplankton caused perhaps by an year-to-year cyclic changes of the ecosystem.

The authors are grateful to the Director, National Institute of Oceanography, Dona Paula, Goa and to the Scientist-in-Charge, Regional Centre of NIO, Cochin for their help and encouragement in this work.

MATERIAL AND METHODS

As part of the International Indian Ocean Expedition, 'Umitaka Maru' Cruise 23 sampled the water column along the meridian 78°E between 8°N and 25°S during December 1962 and January 1963 and collected 20 zooplankton samples between 1900 and 2400 hours. Similarly 'Kagoshima Maru' Cruise 3 also sampled the same area during December 1963 and January 1964 and collected 23 samples between 1700 and 2100 hours. Thus most of the collections were made during 2000 and 2100 hours, from a water column 200 m to surface using IOS net. In the hauls where there was wire angle, more wire was paid out to reach a depth of 200 m, and in such cases a correction factor based on wire out was applied. The station list and sampling details are given in the IOBC Handbook (1969) and the station positions are shown in Fig. 1. Chlorophyll *a* data is taken from the phytoplankton production atlas of the IIOE (Krey and Babenerd, 1976). Night collections were made in order to avoid the effect of vertical migration and avoidance of surface waters during the day, if any, by the larvae. Based on the vertical temperature gradients and the occurrence and abundance of the majority of the taxa, 3 faunal zones were selected for latitudinal comparison and the mean number of organisms for each zone indicating their annual variation in abundance is given in Table 2. The vertical temperature gradient in the upper 100 m was very narrow at the Equator during both years. The stations upto the Equator was taken as Zone A, stations between the Equator and 15°S as Zone B

* Presented at the 'Symposium on Tropical Marine Living Resources' held by the Marine Biological Association of India at Cochin from January 12-16, 1988.

and the stations between 15°S and 25°S as Zone C. The data collected from each zone in the form of mean values for chlorophyll *a*, zooplankton displacement volume and fish larvae are given in Fig. 3 and the data collected from the 43 stations for chlorophyll *a* (mean value in the upper 200 m), zooplankton displacement volume and number of fish larvae are plotted in Fig. 2.

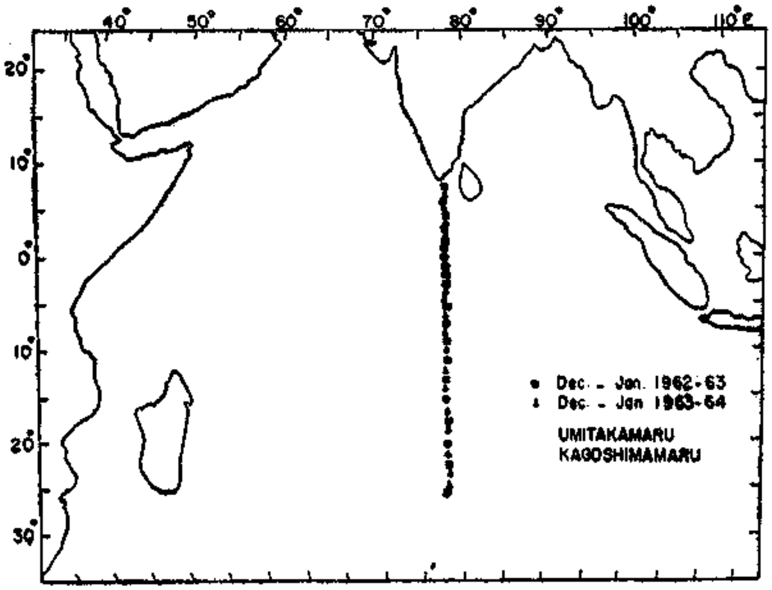

Fig. 1. Station positions along 78°E meridian.

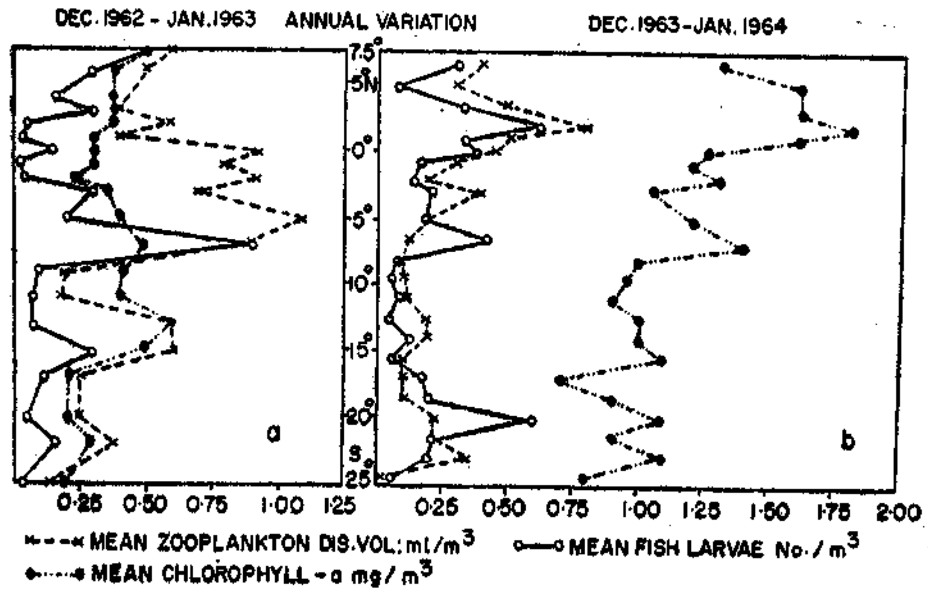

Fig. 2. Variation in abundance of fish larvae in relation to chlorophyll *a* and zooplankton displacement volume.

RESULTS AND DISCUSSION

The mean annual variation in fish eggs and larvae in relation to chlorophyll *a* and zooplankton displacement volume are given in Table 1.

Table 1 indicates high concentration of chlorophyll *a* in the second year, compared to the low concentration of zooplankton,

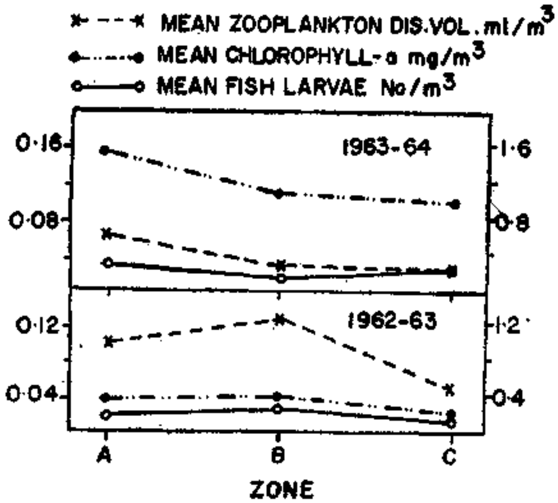

Fig. 3. Variation in abundance of fish larvae in relation to chlorophyll *a* and zooplankton displacement volume in three selected zones of the meridian 78°E.

grazing by zooplankton, had advanced to the extent that the secondary producers have established their population well in the environment. But in the second year, the grazing has just started and the zooplankton might have hardly reached the ground for grazing. The periodical changes in the set up of the irregular NE monsoon might have introduced this late or earlier bloom of the phytoplankton in succession of the changes in the properties of the environment. Suguwara and Saijo (1966) observed higher primary production in December 1962 and January 1963 than in the December 1963 and January 1964. Similarly distinct variation in abundance (Table 2) occurred with respect to all meroplankton groups, probably related to the movement of eddies and areas of divergence. The differences noted in the meroplankton population south of 15°S may be attributed to the boundary observed by Miyake and Sugiura (1966) at about 15°S on both sides of which the property of the ocean considerably differed.

Fish larvae numbering from 5 to 173 per haul were present in all the 43 stations sampled. In the first year average larval catch was 38 which rose to 55 in the second year. Compared to the considerable increase in the chlorophyll *a* value during the second year, mean number

TABLE 1. *Variation in abundance of fish eggs and larvae in relation to chlorophyll a and zooplankton displacement volume along 78°E*

	Mean Chlorophyll *a* (mg/m³)	Mean zooplankton displacement vol. (ml/m³)	Mean number of	
			Fish eggs (No./m³)	Fish larvae (No./m³)
December 1962 & January 1963 ..	0.034	0.053	0.02	0.20
December 1963 & January 1964 ..	0.118	0.025	0.0	0.23

caused perhaps by a shift in the production of phytoplankton bloom on which zooplankton depends. From the chlorophyll value and biomass of zooplankton, it appears that the phytoplankton bloom has started earlier and

of fish larvae showed only slight increase (Table 1). However, as fish larvae form one of the major components among secondary producers, they follow the general trend of zooplankton abundance (Fig. 3). While the northern and southern sectors showed an increase in the average number of fish larvae in the second year, middle sector recorded a lowering in the abundance of fish larvae (Fig. 2). This figure also indicates the pattern of annual variations in the abundance of fish larvae more or less dependent of chlorophyll *a* values and similar to values of zooplankton displacement volume. Fish larvae in the first year recorded one high peak and 4 to 5 small peaks only. Since fish eggs hatch out into larvae in one or two days, one can expect larval distribution pattern overlapping that of eggs plankton volumes. However, in the Gulf of Aden, Ali Khan (1972) recorded an inverse relationship between number of larvae and zooplankton volumes.

Fish eggs were present in 21 out of 43 collections along 78°E meridian. While 78 eggs were obtained from 10 stations in the first year, only 33 eggs were obtained from 11 stations in the second year. Thus considerable variation in the occurrence of fish eggs was noticed annually. The fish eggs during December 1962 and January 1963 showed two and half

TABLE 2. *Variation in abundance of certain meroplankton taxa along 78°E*

Larval Taxa	Average number of specimens/haul					
	Zone A		Zone B		Zone C	
	1962	1963	1962	1963	1962	1963
Fish eggs ..	4	2	5	1	2	1
Fish larvae ..	38	55	57	29	26	43
Bivalve ..	4	3	4	1	1	1
Anthozoa ..	2	2	3	3	1	1
Cephalopoda ..	1	2	2	1	1	1
Sipunculoidea ..	1	2	1	0	0	0

especially in density gradients. But the prevailing current pattern may carry the larvae to far off places away from the spawning areas and thus inspite of the discontinuous distribution of fish eggs recorded distribution of fish larvae is wide spread along the meridian with increased densities in certain water masses and varying with spawning activity of fishes. While Peter (1969) observed no clear or uniform volumetric relationship between plankton and fish larvae in the IIOE samples from the Indian Ocean, George (1979) recorded a general positive relationship between volume of plankton and the number of eggs and larvae collected from coastal waters of southwest coast of India. George (1979) also noted preceding peaks of eggs and larval numbers to those of times more eggs than during the corresponding months in 1963-64. Distribution studies along the north-south axis showed total absence of fish eggs north of 3°N in the first year and north of 5°N in the second year. Maximum eggs were obtained from the Arabian Sea water mass of high salinity, high temperature and low oxygen. West flowing South Equatorial Current and the central water mass had very few eggs in both years. From the results obtained it is clear that December 1963 and January 1964 fish eggs were considerably lower than in December 1962 and January 1963. George (1979) also noticed variations from the generalised patterns in the distribution of fish eggs in different years, 1971-75 along the southwest coast of India, in tune with the spawning activity of fishes.

Brachiopod larvae, having high tolerance to changes in salinity as indicated by their abundance in Bay of Bengal, Gulf of Aden and off southwest coast of India, were absent along the 78°E meridian. Muir-Wood (1959) has recorded a discontinuous distribution in the three genera of adult brachiopods of the Indian Ocean and observed the limited motility of larvae, generally living in congregation, for disposal even with the aid of currents and winds.

Generally enteropneusts tend to live in aggregations of the same or different species favouring warm and temperate waters. This may be the mere consequence of the settling of larval stages in favourable sites and their avoidance of other places. However, Tornaria larvae were not found along 78°E meridian. Also as no significant difference was noticed in the day and night collections, their absence cannot be attributed to the time of collection. While SW monsoon contributed significantly higher numbers than in NE monsoon, in the Indian Ocean, the absence of Tornaria larvae along the meridian 78°E may be due to restriction of collection during NE monsoon period only.

Phoronids in northern hemisphere breed in spring or summer months from March to December and in southern hemisphere from November to May (Brooks and Cowles, 1905). These benthic forms generally exist in the upper littoral zone (above 50 m) of tropical and temperate zones. So these larvae generally preferring low salinity waters were present in 80 (4.9%) out of the 1927 zooplankton samples collected from the Indian Ocean. They are rare in the Arabian Sea, central and eastern part of the Indian Ocean between Equator and latitude 30°S and longitude 68°E to 120°E (IIOE, 1973). However, the 3 specimens obtained in December 1962 from 3°N may be a chance collection by drifting.

Cirripedia larvae were obtained from 3 zooplankton collections out of 43 made along 78°E meridian. Of this one station at 3°30'N contained 43 larvae. The collections belonged to the Arabian Sea water mass of high salinity, high temperature and low oxygen. These larvae were absent south of Equator along 78°E meridian. Generally these larvae were found increasing in number with increasing temperature and increased availability of food. While 49 specimens were collected during December 1963, none was obtained during December, 1962.

The pelagic life of Phyllosoma larvae continues until 3 moults or Puerulus stage is attained. The larvae were absent in all the 43 collections made along the 78°E meridian, except for one specimen obtained from 15°S from the East Indies water mass of low salinity and high temperature. According to Tampi and George (1975), occurrence of these larvae very far from the main land masses is quite rare.

Of the 43 samples analysed, only 3 samples had stomatopod larvae. The stations located at 2°S, 3°30'N and 6°30'N were influenced by the Equatorial Current and Equatorial Counter Current. These larvae were collected in December 1963 only. They were absent beyond 2°S.

Saraswathy (1972) found 50% of samples having bivalve larvae. She also noticed their absence in the open ocean especially within an area between 60° and 100°E and 15° and 45°S. In the present study also bivalve larvae showed their absence south of 20°S. But larvae were present in large numbers in the Arabian Sea water mass of high temperature, high salinity and low oxygen along this meridian between 6°N and 10°S. On a north-south axis larval abundance decreased from 34 (6°N) to 4 (20°S). This reduction in the number of larvae far out in the open sea can be a reflection of shallow water habitat of the adult. These larvae collected far away from the coasts can possibly be those from the nearshore areas drifted along with the currents. While 63 larvae were collected from 6 stations in 1962-63, only 30 larvae were collected from 6 stations in 1963-64, exhibiting marked annual variation. In both years more larvae were present in the west flowing north Equatorial Current.

Of the 1927 collections from the Indian Ocean, cephalopod juveniles were present in 65% of total collections, the Bay of Bengal accommodating the largest nursery in the Indian Ocean (Aravindakshan and Sakthivel, 1973). Of the 43 collections along 78°E meridian, 17 had cephalopod juveniles. Of the 46 juveniles collected, 12 (from 7 stations) were obtained during December 1962 and January 1963 and 34 (from 10 stations) during December 1963 and January 1964 showing a three-fold variation. While in the first year only one specimen was collected during December 1962 and January 1963 from an area north of Equator, the corresponding months in the second year gave 22 specimens (from 6 stations). While in both years larvae were spread out south of 7°S, they were more abundant in the second year than in the first year.

According to Hyman (1959), Sipunculoids, adaptable to a range of depth and temperature are strictly benthic in habitat and inhabit mainly the littoral zone and extend to abyssal waters to a depth of 5000 m. Though cosmopolitan, they centre in warmer waters and have a number of endemic species. The Indo-West Pacific region being the home of numerous species (Hyman, 1959), during the IIOE, all the 1927 zooplankton samples collected had sipunculoid larvae in abundance. Spawning generally occurs in summer. Yet the larvae were present in only 8 out of the 43 stations sampled along 78°E meridian. But for one specimen collected from the Bay of Bengal water mass of low salinity and high temperature all the remaining 28 specimens were taken from the Arabian Sea water mass. Not a single specimen was obtained from south of 7°S. While they were not present in the east flowing Equatorial Current during December 1962, 19 larvae occurred in this current in December 1963. Also in December 1962, ten larvae were collected from the west flowing north Equatorial Current and the eddy formed in between 5°S and 10°S.

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