

**RELATIONSHIP OF EUPHAUSIIDS WITH OTHER ZOOPLANKTON AND PRODUCTIVITY IN THE CONTINENTAL SHELF WATERS ALONG THE SOUTHWEST COAST OF INDIA**

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ABSTRACT

A study was made to understand the influence of phytoplankton on the abundance of zooplankton, and the relationship between zooplankton and euphausiids in the continental shelf waters of the southwest coast of India. The study revealed that the depth of the water column and nearness to the mainland coupled with the process of upwelling have profound influence on the quantum of production at the primary and secondary levels and the euphausiids available over the shelf area. While the total plankton showed an increase towards the shallower inshore areas, the euphausiids showed an increase in the deep neritic areas thus showing an inverse relationship.

INTRODUCTION

THE PRODUCTION at the various levels of the food web in the sea is inter-related and complementary to each other. The physicochemical properties of the marine environment play significant roles in establishing such inter-relationship. The phytoplankton being the basic producer, all the other living organisms have to depend upon them, either directly or indirectly for their survival. Therefore wherever favourable conditions encouraging production at the basic level exist, it is rather customary to meet with increased production at higher levels too.

The southwest coast of India is noted for intense upwelling during the southwest monsoon (Banse, 1959, 1968; Ramamirtham and Jayaraman, 1960; Ramasastry and Myrland, 1960; Panikkar and Jayaraman, 1966; Sharma, 1968, 1978; Anon., 1976). Consequently it is one of the richer grounds of production at the primary (Subramanyan, 1959; Kabanova, 1961; Nair, 1974), secondary (Silas, 1972; Lenz, 1973; Anon., 1976; Menon and George, 1977) and tertiary levels. With these in view, an attempt was made to find out the influence of phytoplankton on euphausiids

and the inter-relationship, in space and time, between zooplankton and euphausiids in the continental shelf waters along the southwest coast of India.

The author is extremely thankful to Dr. E. G. Silas, former Director of the Central Marine Fisheries Research Institute, Cochin for suggesting the problem, guidance and critically going through the manuscript. His sincere thanks are also due to Dr. P. S. B. R. James, Director of the Institute for his keen interest in this paper.

MATERIAL AND METHODS

Zooplankton samples were collected from 30 fixed stations for one year on a bimonthly basis from the continental shelf waters of the southwest coast of India between Calicut and Karwar using an Indian Ocean Standard Net of 0.33 mm mesh size as vertical hauls from 5-10 m above bottom to the surface. The volume of zooplankton was determined by displacement method and numerical counts were taken for the euphausiids. For a better comparison between the various aspects of the study, the area under investigation was divided into three depth zones such as (1)

shallow water area upto 25 m depth, (2) area of intermediate depth between 25 and 75 m depth and (3) deeper water area between 75 and 180 m depth. The samples falling under each depth zone were considered together for the zooplankton volumes and euphausiid numbers. These helped to find out (a) the zooplankton/euphausiid relationship in each depth zone and (b) the zooplankton/euphausiid relationship in the different months in each depth zone. For this the displacement volume of the zooplankton and the number of euphausiid obtained from the respective depth zone and the month were standardised to 1000 m<sup>3</sup> of water. The data for the phytoplankton productivity were taken from the published sources. In the first instance it is desired to examine in brief the pattern of production at the primary and secondary levels along the southwest coast of India and then compare these with the euphausiids.

*Seasonal variations in the rate of primary production along the southwest coast of India*

In the inshore areas along the southwest coast of India, Nair (1974) obtained primary productivity values of over 2 gC/m<sup>2</sup>/day within 50 m depth during the monsoon period (Fig. 1). Just below the surface the rate per unit volume was 12 mg C/m<sup>3</sup>/hour, suggesting a constant replenishment of nutrients. The monthly mean values for the west coast of India for two years are given in Fig. 2. Kabanova (1961) observed intense production off the Malabar coast, which extended seaward for a considerable distance. The summary of values for the different depth zones given in Table 1 (Nair, 1974) indicates that the level of organic production is high towards the coast, becomes less towards the edge of the continental shelf and is least outside the shelf.

The picture of primary productivity emerging out of the foregoing discussion is that (1) the west coast of India is highly productive

especially in areas of upwelling, (2) the near-shore areas are comparatively more productive than the offshore and oceanic areas and (3) the southwest monsoon and the post-monsoon months (upwelling period are more productive).

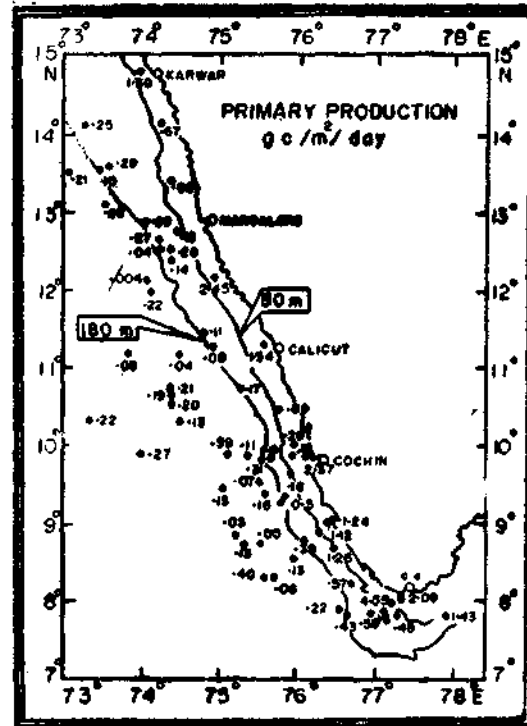


Fig. 1. Values of primary production (g C/m<sup>2</sup>/day) obtained for the water column at the respective stations along the southwest coast of India and the Lakshadweep Sea during 1965-1968 (after Nair, 1974).

*Production at the secondary level along the southwest coast of India*

Silas (1972) found that the peaks production in the shelf area along the west coast was in June and October (the period of intense upwelling in this region) when 761 and 717 cc of zooplankton per 1000 m<sup>3</sup> of water respectively was obtained. The corresponding minima were observed in January and February (the perio<sup>e</sup>

of sinking) with values 231 and 253 cc per 1000 m<sup>3</sup> of water. According to Anon. (1976) and Menon and George (1977) the zooplankton biomass was low on the shelf waters from January to April. Afterwards following the upwelling during the southwest monsoon, the zooplankton biomass increased to reach a peak during July to September period. Then

#### Zooplankton - euphausiid relationship in the study area

During the present investigations the average rate of zooplankton production in the shelf waters between Karwar and Calicut along the southwest coast of India from December, 1966 to December, 1967 has been estimated to be 208.92 cc per 1000 m<sup>3</sup> of water. This is comparable with the highest values obtained for the Indian Ocean during the International Indian Ocean Expedition (Prasad, 1966).

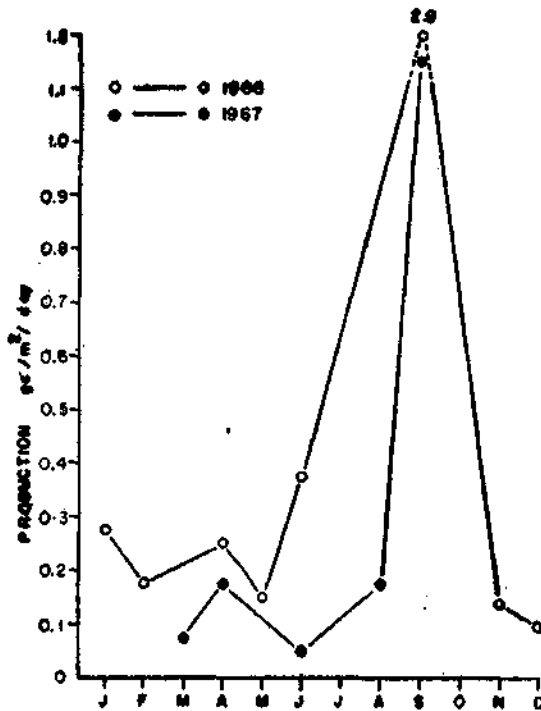


Fig. 2. Seasonal variation in the values of primary production (g C/m<sup>3</sup>/day) along the west coast of India, based on monthly averages (after Nair, 1974).

there was a uniform concentration of plankton slightly beyond the nearshore waters all along the coast. A secondary peak of production occurred in November. A shoreward drift of plankton could be observed during this period with a reduction in overall abundance. Plankton production and upwelling in this region was closely and directly related.

Fig. 3 gives the results of the study made on the relationship between the abundance in zooplankton and euphausiids in the shelf waters during the different months under observation. The largest number of euphausiids (5,250.33/1000 m<sup>3</sup> of water) was obtained in October which was the month of least abundance of zooplankton (159.49 cc/1000 m<sup>3</sup> of water). Similarly when only 160 euphausiids per 1000 m<sup>3</sup> of water were obtained in June, a rather high value of 252.40 cc of zooplankton was obtained. In the other months also a somewhat similar trend in the abundance of plankton and euphausiids was observed.

A consideration of the depth-wise abundance of zooplankton for the entire period of investigation showed that in the shallow water area the quantity of plankton per 1000 m<sup>3</sup> of water was 350 cc while it was 272.27 cc in the intermediate depth zone and only 123.45 cc in the deep neritic zone. In the earlier discussion on the variations in the rate of productivity at the primary level in accordance with the different bathymetric zones, a similar trend was found operating, being more in the shallower nearshore areas and less in the off shore and oceanic areas (Table 1). At the same time from a mere 83 euphausiids per 1000 m<sup>3</sup> of water in the shallow waters, it rose to 1,569 in the intermediate depth zone to reach the maximum of 2,542 specimens in the

deeper zone. Thus an inverse relationship was found to exist in the continental shelf area between plankton and euphausiids.

TABLE 1. Summary of primary production values along the west coast of India for the different depth zones in g C/m<sup>2</sup>/day and g C/m<sup>3</sup>/year (after Nair, 1974)

Depth zones	Total	Average	Annual
Upto 50 m	28.47	1.24	453
50-200 m	10.91	0.47	172
Above 200 m	7.21	0.18	66

Some attempts were made to understand the plankton-euphausiid relationship in the different months, again considered on the basis of distance from shore or increasing depth (Table 2).

to October, some euphausiids were present (Table 2).

In the intermediate depth zone, in each of the months under consideration the quantum of plankton present was comparatively less than in the shallower areas. On the other hand there was a drastic increase with regard to the euphausiid abundance. The periods of peak abundance of euphausiids in this depth zone were August and October (3,262 and 4,672 respectively per 1000 m<sup>3</sup> of water). When compared to the shallow water areas there was a change in the trend of plankton abundance in different months in the intermediate depth zone. The minimum quantity was recorded in February and the maximum in June from where onwards the quantity declined again until October (Table 2). Thus

TABLE 2. Depth-wise abundance of zooplankton (in cc) and euphausiids (in Nos.) in the continental shelf waters (estimated for 1000 m<sup>3</sup> of water)

Months	Depth zones (m)					
	Upto 25		26-75		76-180	
	Zooplankton	Euphausiids	Zooplankton	Euphausiids	Zooplankton	Euphausiids
December, 1966	388.00	—	298.07	866	165.32	605
February, 1967	201.92	—	182.53	972	111.47	2,319
April, 1967	352.00	—	329.08	123	185.93	987
June, 1967	140.00	—	365.53	89	152.80	236
August, 1967	426.87	299	280.17	3,262	166.55	5,728
October, 1967	376.67	200	214.46	4,672	73.92	6,027
December, 1967	420.00	—	315.14	592	80.51	1,159

In the shallow water areas the trend in secondary production showed an irregular pattern in the different months and the quantity ranged between 140.00 cc in June and 426.87 cc in August. As far as euphausiids were concerned, in the area under investigation where intense upwelling was noticed from August

while in the shallow water area, the months of upwelling seemed to be highly productive, in the intermediate depth zone the plankton production was relatively poor. However, the seasonal fluctuations in the rate of secondary production in the intermediate zone was not as pronounced as in the shallow areas.

In the third depth zone, the zone of deeper neritic waters, it was found that the rate of secondary production was low when compared to the other two zones and never showed any substantial fluctuations through various months except in October and December, 1967

1000 m<sup>3</sup> of water) and it was almost equally abundant in August also. The least number found was in June Table 2).

In summing up the discussions made above it may be stated that in all the months the

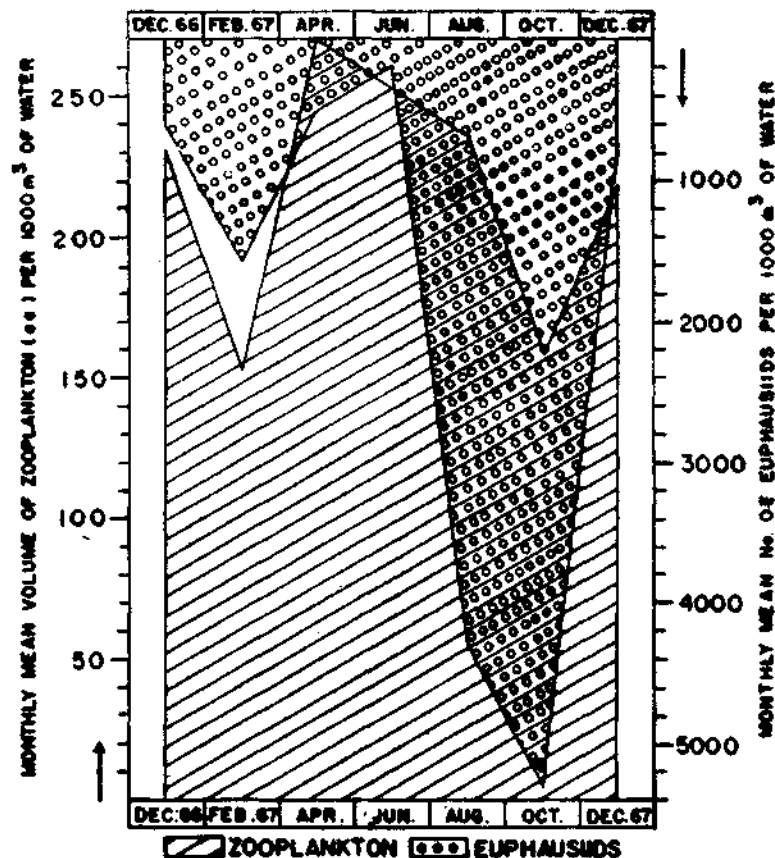


Fig. 3. Zooplankton - Euphausiid relationship in the continental shelf area of the southwest coast of India during the various months of observation.

(Table 2). The quantum of production ranged between 73.92 cc per 1000 m<sup>3</sup> of water in October and 185.93 cc per 1000 m<sup>3</sup> of water in April. The abundance of euphausiids showed great fluctuations. Its population in this depth zone was maximum in October, (6,027/

quantity of euphausiids was more in the deep neritic zone, moderate in the intermediate depth zone and least in the shallow inshore areas. The only exception to this general finding was December, 1966 in which there was only 604,62 euphausiids per 1000 m<sup>3</sup> of water

in the deep neritic zone whereas there were 866 specimens in the intermediate zone. With regard to the zooplankton, the trend of increase in their quantity with decreasing depth was more pronounced during the period from August to December while in February, April and June though the production was comparatively less in the deeper zone, it was comparable in the intermediate and shallower depth zones.

The foregoing account once again confirms the positive relationship between phytoplank-

ton and zooplankton. The increase or decrease of the former reflect on the distribution and abundance of the latter in space and time. However, such a positive correlation was not found with regard to euphausiids in the continental shelf waters. As far as these organisms are concerned it may be the physical environmental factors that play a major role in controlling their geographic distribution and abundance, at least, in the continental shelf areas, a rich supply of food either of plant or animal origin being of only secondary importance.

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