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# 5 Studies on Euphausiacea (Crustacea) of the Indian Ocean with special reference to the EEZ of India

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***ABSTRACT***

*The Euphausiacea an order of the sub-class Malacostraca (Class : Crustacea) is an abundantly occurring zooplankton group in the EEZ of India. Understanding the importance of this group in the marine economy, studies on their various aspects have been carried out in the Indian Ocean since 1886 and in the Indian waters since 1966. While there is substantial amount of knowledge on the distribution, ecology and biology of various species of euphausiids of the southwest coast and Lakshadweep seas there is dearth of information on euphausiids from the other parts of the EEZ. The present paper reviews the information available on euphausiids of the Indian ocean in general and the Indian EEZ in particular with special reference to the contributions of C.M.F.R.I.*

## Introduction

The Euphausiacea, an order under sub-class Malacostraca (Class Crustacea) has two families; Bentheuphausiidae and Euphausiidae together comprising 11 genera and about 100 species distributed in the epi, meso and bathypelagic realms of all the oceans. They are holoplanktonic forming a significant constitutent in the zooplankton and play a significant role in the marine economy offering themselves as food for a variety of animals such as fishes, cephalopods, whales and sea birds.

The euphausiid as a group in the zooplankton has attracted the attention of scientists the world over and as a result considerable amount of work has been carried out since 1886 on their taxonomy, distribution in space and time, reproduction, development, physiology, chemical composition, population dynamics, growth, resources and ecology especially of the Pacific and Atlantic oceans. However, the work on this group was practically nil in India

until the latter half of the sixties when the Central Marine Fisheries Research Institute and the Indian Ocean Biological Centre took up a series of studies. Since then substantial amount of work has been carried out and at present we have a fair knowledge on various aspects of these animals from the point of view of their economic importance. The present paper is a review of the investigations made on this zooplankton group in the Indian Ocean with special reference to the EEZ of India.

**Studies on Euphausiacea of the Indian Ocean in general**

The information we have on the Euphausiacea of the Indian Ocean is mainly based on the results of Expeditions such as the *Challenger* (1873-1876), *the Valdivia* (1898-1899), the *Sealark (Percy Sladen Trust Expedition)* (1905), *the John Murray* (1933-1934), the *Discovery* (1932,1937, 1950-1951) and of late the *International Indian Ocean Expedition* (IIOE) (1959-1965). The reports of all these expeditions except the *Discovery* and the *IIOE* give mostly faunistic accounts. A good deal of investigations on the Indian ocean euphausiids have been carried out during the sixties and seventies especially after the *IIOE*.

G.O. sars (1883 and 1885) in his reports on the Euphausiacea of the *Challenger* Expedition reported 9 species from the following localities in the southern Indian ocean: *Euphausia pellucida, E. splendens, Thysanoessa gregaria, Nematoscelis tenella* and *Stylocheiron longicorne* (south of Cape of Good Hope), *Thysanoessa macrura* (between Cape of Good Hope and Kerguelen), *E. murrayi* (off Kerguelen), *Bentheuphausia amblyops* and *E. spinifera* (south of Australia). Of the above species, *E. pellucida, E. splendens* and *E. murrayi* have been synonymised with other species by the later authors.

Wood-Mason and Alcock (1891) reported *Thysanopoda microphthalma* from the Bay of Bengal. Alcock and Anderson (1894) reported *T. obtusifrons* from the same waters. Subsequent to that in 1896, Anderson recorded *B. amblyops* from the Bay of Bengal. Tattersall (1906) recorded three species namely *E. mutica, Pseudeuphausia latifrons* and *Nemutoscelis microps* in the Sri Lanka (Ceylon) waters.

The first comprehensive collection of Euphausiacea from the Indian Ocean was that made by Prof. Stanley Gardiner during the *Sea Lark* Expedition (reported by Tattersall, 1912) which largely concentrated in the vicinity

of the oceanic Islands in the western Indian Ocean such as Chagos Archipelagos, Seychelles, Amirante and Mauritius. Twenty two species were present in those collections.

Colosi (1917) worked on the euphausid fauna of the Red Sea and the Arabian Sea. He described one new species namely *Stylocheiron armatum*. This species closely related to *S. carinatum* was established partly on Hansen's (1910), Sar's (1883,1885) and Ortamann's (1893) material and his own material from the Red Sea and the Arabian Sea. But at present *S. armatum* is not considered as a valid species on the ground that it lacks well marked differences from *S. carinatum*. However, it is to be mentioned here that a critical evaluation of *S. armatum* has not been done since Colosi's description. Now, after an examination of his description and considering the characters of the present material in comparison with Colosi's,it appears that *S. armatum* is a valid species (Mathew, 1980b). Another new species described by Colosi (1917) was *Euphausia messanensis* which is endemic to the Red Sea.

Further contribution to the Indian ocean euphausiids was that made by Tattersall (1925) from the South African waters (Natal). In 1930, Illig recorded 44 species of euphausiids belonging to 8 genera from the southern, central and northern Indian Ocean during the German Deep Sea Expedition *(Valdivia)*. Two species were represented by larvae only. Torelli (1934 a) could collect 15 species from the Red Sea and the neighbouring areas. Of them 2 species namely *Pseudeuphausia colosi* and *E. sanzoi* were new to science and are endemic to the Red Sea. Another two species namely *E. eximia* and *E. diomedeae* were recorded by Torelli (1934 b) from the Arabian Sea. Another major work on euphausiids of the Indian Ocean was by Tattersall (1939) who worked on the material collected during the *John Murray* Expedition. The major areas of investigation were Gulf of Oman, Gulf of Aden, northern, central and southern Arabian Sea including the Maldive and the Seychelles waters. Tattersall found that *E. distinguenda* (at present considered as *E. sibogae*) to be the most abundant species in the Arabian Sea.

Sheard (1953) listed 13 species including one unidentified species of the genus *Stylocheiron* from the western Australian waters during the *B.A.N.Z Antarctic* Expedition. Boden (1954) worked out the systematics of a number of species based on material obtained from the Indian ocean side of the South African waters. Pillai (1957) in his contributions to the pelagic crustaceans

off the coast of Travancore (southwest coast of India) described four species including the larval stages. Ponomareva *et al.* (1962) carried out some studies on the feeding habits of 14 species of euphausiids of the Indian ocean, north of the Equator. They found that the species fed on copepods, phytoplankton, tintinnids etc. Brinton (1963) discussed the distributional barriers of euphausiids between tropical Pacific and the Indian Ocean. Ponomareva (1964) listed the species encountered during the cruises of *R.V. Vityaz* (1960-1961) from the Arabian Sea (28 species) and the Bay of Bengal (25 species). A very interesting finding by her was that *E. distinguenda* (=*E. sibogae*) one of the most abundant and cosmopolitan species in the equatorial Indo-Pacific was not represented in the Bay of Bengal.

A substantial account on the latitudinal distribution of species of the genus *Euphausia* is given by Baker (1965) who worked on the material collected by the Discovery which cruised in the eastern Indian ocean between latitudes 00°54'S and 60°02'S and along and about 90°00' E longitude. Samples collected from few stations in the South Australian waters were also examined. Altogether 17 species have been studied of which *E. superba* and *E. crystallorophias* were from the Antarctic sector. This was the first major account which dealt with the ecological problems of the Indian Ocean euphausiids. In 1965 Grindley and Penrith recorded 18 species belonging to 6 genera namely *Thysanopoda, Euphausia, Thysanoessa, Nematoscelis, Nematobrachion* and *Stylocheiron* from the Indian Ocean side of South Africa. According to them *Thysanopoda cristata, T. orientalis, T. pectinata* and *E. longirostris* were new records to this area.

The seasonal distribution and ecology of 7 most abundant species of the genus *Thysanopoda* caught by the IKM Trawl from the southeastern Indian Ocean along 110°E during the period from August 1962 to August 1963 have been investigated by Roger (1966). Sebastian (1966) has reported 23 species of euphausiids from the southwest coast of India including the Lakshadweep and the Maldive Seas. In this report he has highlighted the use of thelycum as a means for identifying the species. While studying the food and feeding habits of baleen whales at Durban, South Africa, Bannister and Baker (1967) found 5 species of euphausiids form food for these whales in this area. The occurrence, abundance and distribution of the Euphausiacea of the Red Sea and the Gulf of Aden have been investigated by Ponomareva (1968) based on material collected in the summer of 1966, by the *R.V.*

*Academecian S. Vanilov*. The collections contained 22 species, of which 10 belonged to the Red Sea proper, others being distributed in the Gulf of Aden also. She could find *E. sanzoi* and *P. colosi* to be endemic to the Red Sea. The sex ratio and vertical migration in some selected species were also studied. Specimens of *E. distinguenda* (=*E. sibogae*) were obtained from the gut contents of *Carangoides malabaricus* (Bloch and Schneider) caught from the northwestern part of the Bay of Bengal (Reuben, 1968). This was the first record of the species from the Bay of Bengal north of 07°00'N.

Gopalakrishnan and Brinton (1969) gave an account of quantitative distribution of the euphausiid biomass of the Indian Ocean during two seasons; mid-April to mid-October and mid-October to mid-April the former season which includes the southwest monsoon, harbours rich populations of euphausiids especially off Arabia, Somaliland, tropical Africa, Gulf of Oman, southwest coast of India upto Sri Lanka and the Andaman and Nicobar Islands. During the latter season when the cold northerly Somali Current was no longer developed, the largest populations were nevertheless centered at the equator on the Somali coast. Off the coast of India the populations decreased considerably. In the same account Gopalakrishnan and Brinton have briefly dealt with the distribution of euphausiid species obtained during the *LUCIAD* Expedition from the equatorial Indian Ocean.

Mauchline and Fisher (1969) in their comprehensive work on the biology of euphausiids have reviewed the earlier investigations on the Indian Ocean euphausiids. Ponomareva (1969) described in brief and also illustrated some of the early larval stages of *E. diomedeae* and *S. carinatum*, two of the abundant species of the tropical Indian Ocean. The larvae were reared onboard *R.V. VITYAZ* during her cruises in the Indian Ocean . Youseff Halim (1969) reviewed the distribution of euphausiids of the Red Sea and stated that only about 31 per cent of the species known from the Indo-Pacific were represented in this sea. According to him except *E. messanensis* the populations of the Red Sea are entirely derived from the Indian Ocean.

Bradbury *et al.* (1971) studied the fauna associated with the deep scattering layers in the equatorial Indian Ocean during October and November, 1964. Weigmann (1970) defined five distinct areas based on euphausiids assemblage, namely the Arabian Sea proper with 24 species, the Gulf of Aden with 10 species, the Red Sea with 6 species, the Gulf of Oman with 5 species

and the Persian Gulf with one species. However, some of the highest concentrations were recorded in the Persian Gulf and consisted of a single species, *P. latifrons*. Similar patches were also recorded in some parts of the Malabar coast of southwest coast of India and in some parts of the Gulf of Aden. In 1971, Weigmann observed an isolated population of *P. latifrons* in the Persian Gulf which was morphologically distinct from the populations of the species in the Arabian Sea. A comparative study of *Pseudeuphausia colosi* made by Weigmann (1971) has shown that it was synonymous with *P. latifrons* (Sars, 1883). The circadian migration and feeding rhythm of some Indian Ocean euphausiids have been studied by Ponomareva (1971). The quantitative distribution of Euphausiacea of the Indian Ocean has been studied by Ponomoreva in 1972.

The euphausiid constituent of the DSL observed in the Lakshadweep Sea has been investigated by Silas (1972). He found that volumetrically the euphausiids formed the major group of animals but second only to the myctophid fishes. Fortynine species including one unidentified species of the genus *Euphausia* and the seasonal distribution charts of 26 species have been listed during the IIOE. De decker (1973) has recorded 34 species from the Agulhas Bank, off Cape Town between latitudes 32°S and 38°S and longitudes 14°E and 22°E. While discussing the plankton relations of the Red Sea, Persian Gulf and the Arabian Sea, Kimor (1973) has briefly reviewed the recent works on Euphausiacea of these areas and made an attempt to study their interrelationships. Knight (1973) while studying the larval development in *Thysanopoda tricuspidata* identified and described along with specimens caught from the pacific, the metanauplius of this species collected between 20°N and 20° S in the Indian Ocean. In 1974 Talbot showed that *T. tricuspidata, S. suhmi and S. microphthalma* to be indicators of the Agulhas Bank waters and *Nyctiphanes capensis* and *E. lucens* as indicators of waters of other origin.

A detailed study of the zoogeography of five out of seven species of the genus *Nematoscelis* namely *N. gracilis, N. megalops, N. atlantica, N. microps* and *N. tenella* occurring in the Indian Ocean was made by Gopalakrishanan (1974). He found that two forms ("old" and "new") of *N. gracilis* considered to be ecophenotypes, but distinguishable on the basis of morphological difference observed in the petasma, occupy the tropical indo-pacific. The "old" form according to him is most abundant in the oxygen minimum waters of the

Arabian Sea and the Bay of Bengal. He opined that the basins of the Timor and the Banda Seas and their associated straits in the Indo-Australian Archipelago allow inter-ocean gene flow among populations of *N. gracilis*, *N. microps* and *N. tenella*. A similar communication exists also between Atlantic and Indian Ocean populations of these species through the oceanic waters around the tip of the South Africa. During the studies on the distribution of euphausiids of the Red Sea Weigmann (1974) recorded 6 species namely *P. latiforms*, *E. diomedede*, *E. sibogae*, *E. sanzoi*, *S. affine* and *S. abbreviatum*.

Legand *et al.* (1975) recorded 6 species belonging to the genus *Thysanopoda* in the eastern Indian Ocean along 110° E between 09°S and 32°S. The seasonal abundance was also investigated for the genus as a whole.

Brinton (1975) while investigating the Euphausiacea of the southeast Asian waters, has studied the distrubution pattern of 33 species of the eastern Indian Ocean between latitudes 14°N and 18°S near the Indo-Australian Archipelagos. Of the species, 12 occurred only south of the Equator. All others had a widespread occurrence on both sides of the Equator. The material contained 3 "forms" of *S. affine* namely the "western eauatiorial", the "Indo-Australian" and the "central" forms and two "forms" of *S. longicorne* namely the "long" and "short" forms.

Ponomareva (1975) carried out investigations on the euphausiids of the Indian Ocean and the Red Sea. Data are presented on species composition, biology, vertical and quantitative distribution. According to her, the species most commonly occurring in the 0-200 m layer in the Indian Ocean are *E. iomedeae*, *E. distinguenda* (=*E. sibogae*), *S. carinatum* and *T. tricuspidata*. In the northern Indian Ocean eggs and larvae occurred from January to June. Taniguchi (1976) identified 32 species of euphausiids from 164 samples collected during the cruises of *T.S. Osho Maru* in the eastern Indian Ocean (west of Sumatra, south of Java Island, west of Western Australia and the Great Australian Bight).

McWilliam (1977) studied the ecology of euphausiids in the upper 200 m of the eastern Indian Ocean along 100° E meridian between latitudes 9°30-'N and 32°00.S for a period of one year. A total of 32 species belonging to 7 genera were obtained from the study area of which 26 were represented by adults, juveniles and larvae, while 3 species had adults and juveniles only. The rest 3 species had only larval stages. This study indicated that the day

samples contained many larvae and juveniles while the night samples had more adults. Pratap *et al.* (1977) recorded *S. suhmi* in the shallow water lagoon of Kavarathi, an island in the Lakshadweep group of Islands, off the southwest coast of India. Silas and Mathew (1977) made a critical review of the various approaches used in studies of larval euphausiids being supported by the larval material they obtained from the southwest coast of India. Win (1977) recorded *E. pacifica* an oceanic species from the coastal waters of Burma which according to Mauchline (1980) is a wrong record. Mauchline (1980) and Mauchline and Fisher (1969) gave a detailed review of the recent works on the euphausiids of the Indian Ocean. The spatial and structural evolution of euphausiid populations from the Antarctic to South Africa and from there along the eastern African coast to the Gulf of Aden, based on samples collected by the *MAGGA DAN* has been studied by Cassanova (1980) which permitted to deliniate three great faunistic areas; an Antarctic one comprising 4 species, a South African area with 14 species and an east African area with 35 species.

**Work in the Indian waters**

Substantial amount of work on various aspects of euphausiids of the Indian waters especially of the southwest coast of India has been carried out since 1966 at the instance of the C.M.F.R.I. These have thrown more light on the distribution, ecology and biology of this forage organism on which a variety of animals survive.

**Addition to fauna and re-assignment of species**

Because of the limited number of species in the order Euphausiacea and because thorough samplings have been carried out all over the oceans there is little scope for further addition to the euphausiid fauna. In spite of this limitation the discovery of a distinctly defined new species of the genus *Stylocheiron* from the continental slope of the southwest coast by Silas and Mathew (1967) is quite significant. The species was named *Stylocheiron indicus* which was later re-named as *S. indicum* by Manchline and Fisher (1969). The species was obtained from several localities where the water depth ranged between 180-320 m.

In the context of rapid speciation taking place in the genus *Stylocheiron* the species *S. carinatum* was critically examined by Mathew (1980). As a

result it was found that the species *S. carinatum* which was considered to be wide spread in the Indian seas has close affinities to *S. armatum* described by Colosi (1917) from the Mediterranean waters. The study helped to assign the Indian species to *S. armatum*. In order to help in the identification of the species of the genus *Stylocheiron*, a key for identification incorporating new characters was also prepared by Mathew (1980).

**Distribution**

A major contribution by the CMFRI to the study of euphausiids was on their distribution and abundance in space and time. The work was mainly concentrated to the southwest coast including the Lakshadweep Sea, Mathew (1980) studied the quantitative abundance and seasonal and spatial distribution of euphausiids within the continental shelf between Calicut and Karwar. The average numerical abundance was found to be 1980 per 1000 $m^3$ of water. According to the study the maximum abundance of euphausiids may be from August to October. The most common species and their peak period of occurrence may be as follows:

| | | |
|---|---|---|
| *Pseudeuphausia latifrons* | : | December to February |
| *Euphausia diomedeae* | : | February |
| *E. sibogae* | : | August to October |
| *Nematoscelis gracilis* | : | February |
| *Stylocheiron armatum* | : | October to April |
| *S. affine* | : | October to February |

Silas and Mathew (1986) studied the quantitative geographical distribution of 22 species of euphausiids of the southeastern Arabian Sea. The most commonly occurring species in the shelf and oceanic areas of the southwest coast are *Thysanopoda monacantha, T. tricuspidata, Euphausia diomedea E. sibogae, Stylocheiron armatum* and *S. affine.*

The larval euphausiids form a major portion of the euphausiid population and therefore their occurrence and abundance become very crucial in the food web. In view of this, Mathew (1989) made a separate study on the seasonal and spatial distribution of the larval euphausiids in the continental shelf waters of the southwest coast. According to the study an average of 1507 larvae may be present per 1000 $m^3$ of water. A monthly study made it clear that while the larvae were least abundant in June (36/1000$m^3$) they

were moderate in December (151-679/1000 $m^3$) and maximum in August to October. The larvae of *Stylocheiron affine* may be present throughout the year.

**Ecology**

The vigorous atmospheric and oceanic circulations during the south-west monsoon causes the development of intense upwelling in several places of the Indian ocean. The west coast of India between 7° N and 18° N is particularly characterised by strong upwelling. Studies have shown that the upwelling is directly controlled by the climatic conditions which bring about changes in the hydrographic parameters of an area which in turn influence the living organisms there. Bearing this in mind the distributional trends of six species of euphausiids of the southwest coast were studied in relation to environmental parameters by Mathew (1985). A gradual oscillation between the deeper and the shallower zones was evident in the case of all the six species and this was in accordance with the periodic changes brought about in the ecosystem. The coastal species *Pseudeuphausia latiforons* may try to avoid the upwelled waters which incur into the shallow areas from June to October. *Euphausia diomedeae* and *E. sibogae* may make a total withdrawl from the shelf in June when the upwelling is not very intense and the shelf waters maybe less saline. A similar retreat may be shown by *Nematoscelis gracilis* and *Stylocheiron armatum* from August to October. *Stylocheiron affine* and *E. sibogae* may extend their distribution towards the shallower areas in October while all the others may make a withdrawal.

The relationship of euphausiids with other zooplankton and primary productivity in the continental shelf waters of the southwest coast was studied by Mathew (1986). The study revealed that the depth of water column and nearness to the coast, coupled with the process of upwelling have profound influence on the quantam of production at the primary and secondary levels and the euphausiids available over the shelf region. While the study confirmed the positive relationship between phytoplankton and zooplankton such a correlation was not found between phytoplankton and euphausiids. As far as the euphausiids are concerned, it may be the evironmental factors that play a major role in controlling their geographic distribution and abundance, at least in the continental shelf area, the source of food either of plant or animal origin being only of secondary importance.

**Biology**

Considering the dearth of information on the larval development in euphausiids the world over, the euphausiid larval development occupied a major position in the research projects of CMFRI. The studies resulted in identifying and describing the full compliment of post-naupliar developmental stages of *Euphausia distinguenda* (=*E. sibogae*) and *E. diomedeae* and *Stylocheiron carinatum (S. armatum)* (Mathew, 1971, 1972, 1975). The larval stages of *Thysanopoda monacautha T. tricuspidata, Pseudeuphausia latifrons, Euphausia tenera, N. gracilis, Stylocheiron affine, S. suhmi* and *S. maximum* were also identified and their developmental pathways traced (Mathew, 1983). These studies enabled to fix the active breeding seasons of species to be December to April for *P. latifrons, E. diomedeae and S. armatum*, August to December for *S. sibogae* and October to December for *S. affine*.

The growth pattern among the post-naupliar stages of *E. diomedeae, E. sibogae* and *S. armatum* was studied by Mathew ( 1980 c ). The study revealed that the percentage of increase in body length in all the three species decreased considerably as development progressed. It was also found that the length in larvae and adult are not proportional. The accuracy of the identity of the larval stages and the larval developmental sequence was verified using the Brook's Law of larval growth.

Many of the euphausiid species are sexually dimorphic and hence the males are distinct from the females in their morphological characters. However, the degree of differences may vary from species to species and organ to organ. Mathew (1980 a) using statistical methods on the sexual dimorphic characters of *Stylocheiron indicum*, indicated that the 6th abdominal segment and the eye are dimorphic in the two sexes of the species.

The egg potential in two species namely *T. tricuspidata* and *S. indicum* is now known (Mathew, 1980d). In the former species the ovary may contain ova in the range of 328 to 414 of which the mature ova may number between 36 and 60. In the latter species the 2-3 eggs laid are carried by the female ventrally between the thorasic legs.

In view of the variations in the combination of larval characters in the similar stages of development of different species or even in the same species,

the classification and nomenclature of euphausiid larval stages have been a matter of controversy among the scientists. Therefore a critical study was taken up by Mathew (1977) to review the larval development in euphausiids. Phylogenetically the euphausiids being a less specialised group among the crustaceans, it was found that probably any set formula cannot be applied uniformly to all the species uniformly. Mathew (1977) traced the developmental pathway of *T. tricuspidata*, *E. diomedeae*, *E. sibogae*, *P. latifrons*, *S. armatum* and *S. affine* through all their typical stages and also the non-typical variant stages (by quantitative analysis) based on the theory of dominant stages and skipping of stages.

A study on the seasonal abundances of larvae of various species of euphausiids has made it possible to throw light on the breeding seasons of some common species (Mathew, 1989). In the case of *P. latifrons* the pattern of larval abundance suggested that the period from December to April could be their active breeding period with the peak from December to February. The peak breeding season of *E.diomedeae* may be from December to April. *E. sibogae* seems to be a continuous breeder the peak being from August to October. The breeding period of *N. gracilis* extends from December to April . Eventhough *S. armatum* may be called a continuous breeder its active breeding period may be between December and April.

A study was conducted by Mathew (1988) in the Indian seas to find out the degree of avoidance of net by adults, juveniles and larvae of euphausiids. It was found that the euphausiids in all stages of their development could avoid sampling net by visual means though the degree of such avoidance may be least among the larvae, moderate among the juveniles and maximum among the adults.

**Studies on Antarctic euphausiids**

The distribution and abundance of euphauaiids, especially the krill was a subject of study during the third Indian Expedition to Antarctica between lat. 67°30' and 68°30' S and between long. 14°00' and 20°00'E (Mathew, 1986 a,b) and in a linear track between Antarctic and Mauritius (Mathew and Vincent, 1986).

The study made in the coastal Antarctica (Mathew, 1986 a) showed that the euphausiids, constituted mainly by the krill (*Euphausia superba*), were caught in more number (as high as 830/1000 $m^3$ of water) towards the start of the Antarctic summer. Most of the individuals were larvae which indicate that the breeding started immediately after the winter.

The study of the geographical distribution of the krill (Mathew, 1986 b) was based on samples collected from pre-determined stations and not specifically from areas of krill swarming and therefore, areas of krill concentrations could not be covered. The average density of the krill was 4.45 cc/1000$m^3$ of water which may be equal to 212 specimens per 1000 $m^3$.

Mathew and Vincent (1986) made a study of the latitudinal distribution of euphausiids between Antarctica and Mauritius. The euphausiids constituted 13.67% of the total zooplankton by volume. A gravimetric estimation revealed that the euphausiids were relatively more in the Antractic and sub Antarctic waters which together claimed 89.30% of the total euphausiids obtained. When considered numerically the maximum number obtained was 4347/100 $m^3$) from a locality at 53°00' S, 48°00'E.

**Remarks**

The quantity at which the tertiary producers occur in the oceans has been found to be proportionate to the quantity of the secondary producers. This has been found true of the Indian EEZ also. Among the secondary producers quantitatively the euphausiids occupy a major position very often as equal to or even more than any other single group of zooplankton. The euphausiid has been found to be an important forage organism playing a key role in the production of epipelagic, mesopelagic and bathypelagic organisms of the tertiary level.

Our knowledge on these organisms in the southwest coast and Lakshadweep seas is fairly sound, but other areas in the EEZ remain less investigated. There are still gaps in our knowledge on the distribution, ecology and biology of the various species in the EEZ as a whole. Fortunately infrastructure facilities like ocean going vessels of longer endurance are available for an EEZ based study on this group. What requires is a strong will and a proper understanding, at the policy making levels, for such a study.

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