SOME OBSERVATIONS ON THE TREND OF ZOOPLANKTON AND ITS PROBABLE INFLUENCE ON LOCAL PELAGIC FISHERIES AT COLACHEL DURING 1973-74.

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ABSTRACT

The zooplankton standing crop showed three peaks of abundance, in March, September and December, the first two peaks during the periods of high salinity. In the order of abundance, the forms which constituted the bulk of the plankton were copepods, cladocerans, cirrepede larvae, *Lucifer*, chaetognaths and appendicularians. The copepod distribution was found to have characters common both to that of the adjacent coastal waters of Bay of Bengal on the southeast coast and to that of the Arabian sea on the southwest coast. The peak occurrence of cladocerans during May-July was followed by the appearance of juvenile mackerels in early August. Pelagic fish catch, consisting mostly of anchovies and lesser sardines, showed clear peaks, closely following the primary and secondary peaks of plankton. The peak occurrence of anchovies during September-October seems to be in prey-predator relationship with ribbonfish, the peak of which followed closely.

INTRODUCTION

The coast of the Kanyakumari district, which includes Colachel, is distinct both from the geographical and from the fisheries points of view, because the coast, though situates on the Arabian sea, is within a possible range of influence of both Indian ocean and Bay of Bengal. This inshore area is an important productive zone for pelagic fishes such as the lesser sardines, anchovies, mackerel and other quality fishes, which support a traditional artisanal fishery (Lazarus and Joel 1979). However, no information is available on the coastal plankton of this area. The zooplankton in the inshore waters of Colachel, an important fishing centre of the coast, was therefore studied during the period of January 1973 to February 1974 and an attempt was made to find the influence, if any, of its salient qualitative and quantitative characters on the local fisheries.

MATERIAL AND METHODS

Zooplankton samples were collected at weekly intervals from a fixed station in the traditional inshore fishing area (8°H'N., 77°15'E.) within the

20-m depth zone (Fig. 1). The samples were collected from the surface by towing for 15 mm. in the early hours a Nansen-type conical net of 0.5 m diameter made of 0.34-mm-mesh nylon bolting cloth. The net was operated from a dugout canoe at a speed kept as constant as possible. Hydrographic observations on salinity and temperature were also made from the surface. Data on the inshore fish landings were collected on each day of plankton collection following the standard random-sampling method. However, since the net used was No. 2, the samples might not contain a considerable variety of small plankters that could easily escape the net. But the samples taken could still give a dependable picture of the standing crop of those plankters which normally influence the fisheries.

Plankton standing crop, determined by the displacement method, is expressed in volume. But the individual groups are expressed numerically, after having estimated from the counts made from an aliquot 10% of the sample. The data thus obtained on all observation days of the month, so also the data on salinity and temperature, were pooled together and from their averages monthly values were derived.

HYDROGRAPHY

Rainfall: The climatic condition peculiar to this part of the west coast of India is that it is directly influenced by both the S.W. monsoon and the N.E. monsoon. From the rainfall data maintained at the local municipality it was found that, in 1973, the S.W. monsoon rains began at this centre about the middle of May, with a few premonsoon showers preceding in March-April. The rainfall was heaviest in June. After a progressive abatement during the subsequent two months, the S.W. monsoon came to a close by the middle of August. The N.E. monsoon, which had commenced by the last week of September, was active throughout October, and continued, though in a less intensity, till the beginning of January (Fig. 2).

Temperature: The surface temperature varied between 22.24°C and 29.65°C (Fig. 2), with the difference of 7.4°C between the two extremes. Two peaks in temperature values were noticed, one in April (29.65°) and the other in November (28.04°). From May, with the onset of S.W. monsoon, the temperature declined steadilly, reaching the lowest value of 22.24°C in August. After August it again showed an upward trend.

The daily fluctuations in surface temperature were wider during the S.W. monsoon than during the N.E. monsoon. Throughout the month of August a low temperature condition prevailed in the inshore waters, which might be due to up welling, a phenomenon occurring along the southwest coast during the S.W. monsoon (Fig. 2).

Salinity. The average monthly salinity varied from 31.61 %> (December) to 35.04 %> (February). Salinity showed a bimodal pattern of distribution similar to that of the temperature but, unlike the latter, the salinity had its primary peak in February (34.05 %>) and the secondary peak in September (34.79 %>) From March to June salinity showed a decreasing trend inversely proportionate

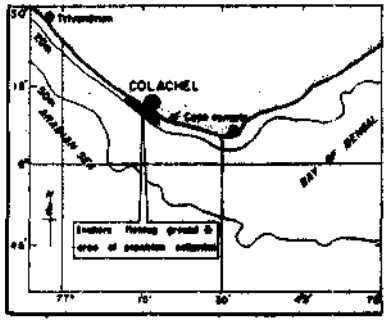

FIG. 1. Map showing area of investigation.

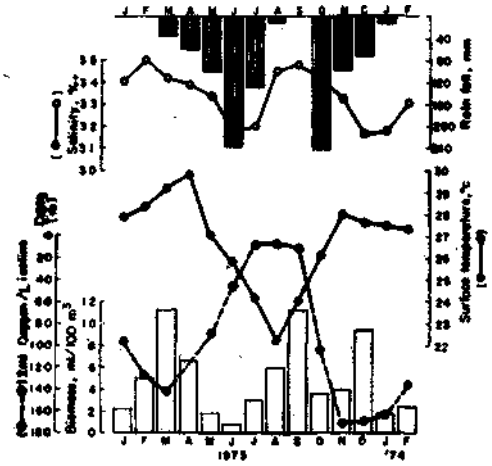

FIG. 2. Monthly abundance of zooplankton biomass in relation to salinity, temperature, upwelling intensity and rainfall in the inshore waters of Colachel, Jan., 1973 to Feb., 1974.

to the intensity of rains associated with the S.W. monsoon. The values rapidly increased again, in August when the S.W. monsoon subsided. With the commencement of the N.E. monsoon rains, the salinity values again decreased gradually from October resulting in another series of low values in December (Fig. 2).

ZOOPLANKTON STANDING CROP

The distribution of zooplankton showed three peaks of abundance. The primary peak was in March (11.2 ml|100 m^3), in the premonsoon period. Since April a declining trend was noticed in the displacement volume, recording the lowest value of 0.77 ml|100 m^3 in June, the peak period of S.W. monsoon. The zooplankton standing crop increased again from July onwards and reached a secondary maximum in September (11.10 ml|100 m^3). The third peak of zooplankton was observed in December (9.2 ml|100 m^3) (Fig. 2).

SEASONAL VARIATION OF ZOOPLANKTON

A total of 16 groups of holoplankters and 14 groups of meroplankters were identified from the samples. These two groups were followed separately

(Figs. 3, 4 & 5) in order to know whether there was a seasonality in breeding of holoplankters. The holoplankters was mainly constituted by copepods, cladocerans, *Lucifer,* chaetognaths and appendicularians, in the order of magnitude.

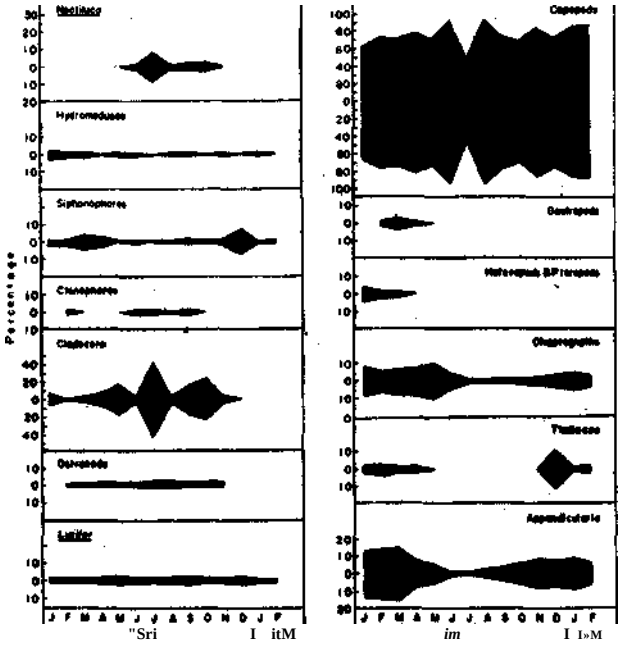

FIG. 3. Seasonal abundance of holoplankters, Jan., 1973 to Feb., 1974.

Holoplankters

Noctiluca: Noctiluca miliaris was present in considerable numbers during May to October with a peak in July.

Foraminifera: The most common species observed was *Globigerina bullodies.* The group, though was irregular in quantitative distribution, was occurring throughout the period of study.

Radiolaria: Radiolarians were represented by *Acanthochiasma,* which was observed only during the period January-February.

Hydromedusae; Hydromedusae were generally represented by the species of *Aequorea, Liriope* and *Leuckartiara.* They occurred in the samples throughout the period of observation, with maximum abundance in January. Since then there was a decreasing trend in their number till the lowest density was reached in July, well after the monsoon has begun. A secondary peak was noticed in November, in the postmonsoon period. Their predominance in the samples tended to coincide with high-saline water.

tiphonophora: Siphonophores were chiefly represented by *Lensia, Diphyes, igalma* and *Chelophyes.* Siphonophores were observed in the samples all hrough the year, registering a primary peak in March and a secondary peak in December. The lowest density was in July, during the monsoon period.

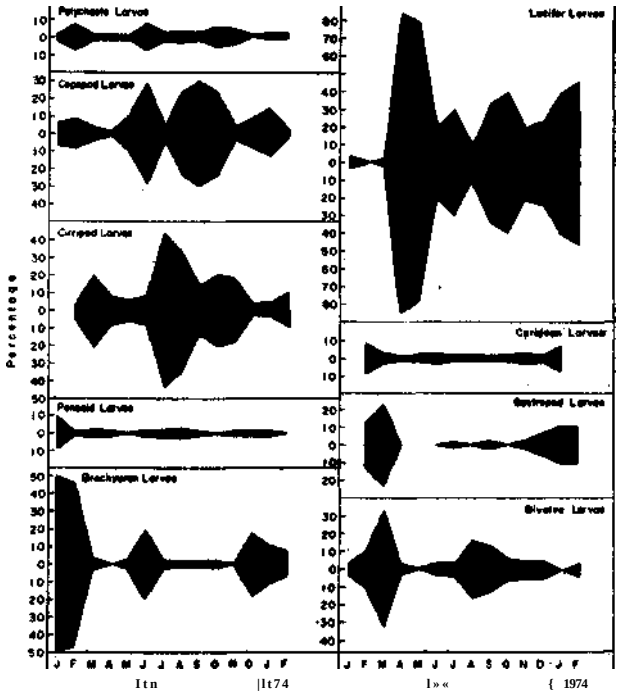

FIG. 4. Seasonal abundance of meroplankters, Jan., 1973 to Feb., 1974.

Ztenophora: Ctenophora was represented by *Pleurobrachia* and *Beroe,* which vere occurring during February to November.

Zladocera: Two species of cladocera, *Evadne tergestina* and *Penilia avirostris,* vere present during most of the period of observation. Three peaks of occurence were observed. Though cladocerans appeared abundantly in May, July and Jctober, their highest occurence was in July. The least occurrence was in December. An interesting character noticed of their occurrence was the abrupt ppearance in great abundance and the equally abrupt disappearance. However, n inverse relationship could be made out between temperature and their abunlance in general.

~)stracoda: The common ostracod in the samples was *Cypridinq,* which occurred hroughout the period of obsrvation. The maximum occurrence was in the S.W. nonsoon months of July and August, and the minimum was in September.

Copepoda: Pelagic copepods were the most predominant group in the plankton, both in numbers and in species composition, The common species were those belonging to the genera *Paracalanus, Canthocalanus, Temora, Calanopia, Labidocera, Acartia, Oithona* and *Euterpina.* The copepods exhibited a bimodal

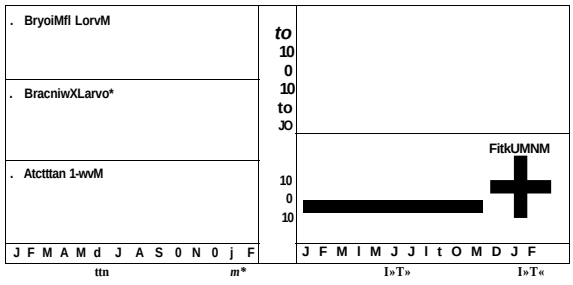

FIG. 5. Seasonal abundance of meroplankters, Jan., 1973 to Feb., 1974.

distribution, with a primary peak in June, which was followed by an abrupt decline in July, and a secondary peak in August. From August to February their abundance was continuing.

Amphipoda: Amphipods were rare in the plankton. Only *Hyperia* sp. was found now and then, that too in negligible numbers.

Mysidacea: Mysids were poorly represented. *Gastrosaccus* sp. occurred sporadically.

Lucifers: Lucifers in the samples were chiefly represented by *Lucifer hanseni.* They were numerically abundant during the receding phase of the monsoon and, especially, at the beginning of the postmonsoon period. Two peaks were noticed, one in May and the other in September. They were least in July.

Pelagic gastropods: Janthina appeared in the samples in the premonsoon period, particularly in March. *Atlanta* and *Cressis* were observed in January and during the premonsoon period. They,were almost absent during the other months.

Chaetognaths: The common species were *Sagitta enflata* and *S. bedoti.* The chaetognaths showed a primary peak in January and a secondary one in May. The minimum occurrence was in August and October, despite the high salinity values during these months.

Thaliacea: The thaliaceans were *Thalia democratica* and *Doliolum* sp., both of which appeared sporadically in the samples. They were fairly common during the postmonsoon and summer months, with peak occurrence in December. They were fewer in August and September and totally absent during the monsoons.

Appendicularia: A single genus *Oikopleura* represented the group and it appeared in varying numbers throughout the observation. They were abundant in March and sparse in June.

Meroplankters

Polychaete larvae: Larvae of the polychaetes such as spionids, polynoids and nereids, occurred throughout. There were three peaks of abundance, a primary one in February, a secondary one in June and a tertiary one in October. December was the poorest month.

Copepod nauplii and copepodites: Copepod larvae followed the same pattern of distribution as that of the adults, showing two peaks, first one in June and second and higher one in August. They were sparse during April to May.

Cirripede larvae: Barnacle larvae were met with during the entire period, with a primary peak in March and a secondary peak in July.

Protozoea of Lucifer: Protozoeal stages of *Lucifer hanseni* were recorded all through the period, and they formed a dominant group among meroplankters. There were three peaks, in April, July and October, the highest being in April.

Larvae of penaeid prawns: Protozoeal and mysis stages of penaeids were common throughout the year. They were more in January, less in August and least in May. The larvae of *Penaeus indicus* were the most common, followed by *Metapenaeus dobsoni* and *M. monoceros.*

Larvae of caridean prawns: Zoeae of some caridean prawns, especially palaemonidae, were noticed, mostly along with the larvae of penaeids.

Brachyutan zoea: The larvae and early juveniles of a portunid crab, *Portunus pelagicus,* were considerably abundant in the samples during January. A secondary peak was observed during June and a tertiary peak in December.

Gastropod larvae: Gastropod veligers were common throughout the year except January and May. A peak occurrence was seen in March and another one in December.

Lamellibranch larvae: Bivalve larvae were present in varying numbers. They showed a bimodal distribution with peaks in March and August.

Almost all the pelagic molluscs, as well as their larvae, exhibited a pattern of distribution inversely related to temperature. Appearance of swarms of pelagic molluscs and moUuscan larvae contributed much to the plankton biomass during periods of low temperature.

Other larvae: Larvae of *Ectoprocta* sp. appeared in relatively high concentration in February. *Brachiopod* larvae, mainly those of *Lingula* sp. were recorded during March. Ascidian "tadpoles" were more in January. Echinoderm larvae such as *Echinopluteus* and *Ophiopluteus* were in the samples in low densities.

Among other larval plankters, which appeared sporadically and in low densities, were the ephrya larvae of scyphozoa; arachnactis larvae of anthozoans; pilidium larvae of nemertes; *Acates* larvae; phyllosoma of *Panulirus homarus;* alima larvae of squilla and actinotrocha of *Phoronis* sp.

Fish eggs and larvae: Fish eggs were observed in the samples throughout the period of observation. Two distinct peaks were observed, a primary peak in June and a secondary one in November. The egg of *Stolephorus* spp., *Sardinella* spp. and carangids formed the bulk of the fish eggs. The lowest number of eggs recorded in the samples was in August. Fish larvae occurred equally in numbers with the eggs in all the months, except December when they were very few. The larvae of *Stolephorus* spp. were the commonest, followed by those of *Sardinella* spp. and carangids.

INSHORE FISHERY

The inshore waters of Colachel up to a depth of 20 m support an year-round traditional fishery of considerable magnitude. Indigenous gears, such as gill nets of different types, boat seines and shore seines, are employed, according to the availability of the particular fish for which each is meant. Among the gillnets, the drift gillnets, locally called *'Netholi valai'* (for whitebaits), *'chala vala'* and *'Keerichala valai'* (for sardines), operated from catamarans, are the most common.

An estimated 141 tonnes of fish were caught from this area during the period of study. The catches consisted of 63% pelagic fishes, such as anchovies, lesser sardines, mackerel, carangids, catfishes, pelagic sharks, tunas, pomfrets and ribbon fishes. Of the rest 37% other varieties, *Leiognathus* sp., *Lactarius* sp., *Upeneus* sp., *Otolithus* sp. and *Polynemus* sp. were common. The seasonal trends in the production of these groups are shown in Fig. 6. Fish landings were comparatively low in February and high in September-October. Lazarus and Joel (1979) had recorded peak landings of pelagic fishes during the period August-November along the adjacent coast of Kanyakumari district.

Anchovies: The anchovies, which are reported to be generally concentrating in somewhat deeper waters in July-August (Anon 1974) a little outside of the area of the present study, formed an important fishery in the inshore waters in September-October. The dominant species were *Stolephorus devisi, S. bataviensis, S. buccaneeri, S. indicus* and *S. commersonii.* The abundance of anchovies generally coincided with the plankton peaks.

The genus *Thryssa* sp. formed only 1% of the pelagic fishes and was represented by *T. mystax* and *T. setirostris,* which were caught in abundance during the premonsoon months of March and April.

Lesser sardines: The lesser sardines were represented by *Sardinella fimbriata, S. gibbosa* and *S. sirm.* These species constituted about 30% of the pelagic fish catch. They were abundant during October and November.

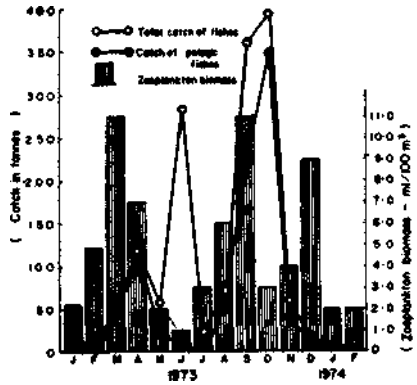

FIG. 6. Relationship of zooplankton biomass with the fish catch in the inshore area of Colachel, Jan.. 1973 to Feb., 1974.

Mackerel: Only the early juveniles of the mackerel, *Rastrelliger kanagurta,* appeared in the catches, that too only in August, forming about 1% of the pelagic fish catches. The type of abundance of early juveniles Lazarus and Joel (1979) had noticed in the boatseine and shoreseine catches off Kanyakumari in the June-Julys of three consecutive years was however not noticed in Colachel.

Carangids: Carangids constituted 7% of the pelagic fishes, and were mostly represented by *Megalaspis cordyla* and *Alepes djeddaba.* They were abaundant in the landings during the period August to October.

Ribbon fishes: Trichiurus sp. formed 26% of the total demersal and pelagic fish catch. They occurred in the fishery from June to November with peak landings during September-October.

DISCUSSION

A comparison of the pattern of seasonal distribution of standing crop of zooplankton at Colachel with the local rainfall data (Fig. 2) would indicate that the secondary and tertiary maxima of the plankters followed respectively the peaks of S.W. and N.E. monsoons. Also a positive correlation is possible between the high salinity and the first two maxima of zooplankton (primary and secondary).

Taking the zooplankters in general, there were three peaks of abundance observed in the inshore waters of Colachel, *i.e.,* in March, September and December. Divakaran et al (1980) had recorded peaks of numerical abundance of zooplankton during August to October but higher displacement volumes during

April, September and October in the northern inshore waters of Vizhinjam. Menon and George (1977) had stated that from July to September there occurs a uniform concentration of plankters outside the inshore region all along the southwest coast and that the concentration afterwards remains shifted shorewards until December.

They have also stated that the average pattern of plankton biomass distribution and the up welling have a close relationship. In our study, too, the picture emerged was that, following the upwelling intensities (Fig. 1), the standing stocks of zooplankters increased and reached peaks in September and March. This was in contrast to what was observed in the Gulf of Mannar (Prasad 1954), where a bimodal cycle was seen in the distribution of zooplankton, with one peak falling during February-April and the other in October.

Considering their seasonalty, the zooplankters of Colachel can be divided into three major groups. The first group, consisting of siphonophores, larvaceans, thaliaceans, radiolarians, ctenophores, ostracods, heteropods and pteropods and meroplankters such as the protozoea of *Lucifer hanseni,* larval brachyurans, gastropods, lamellibranchs, cyphonautes, ascidians and pluteus, showed distinct abundance during the premonsoon season (February-March). The second group, formed by *Noctiluca,* cladocerans, adults and larvae of copepods, cypris larvae and larval polychaetes, were abundant during the S.W. monsoon months. The third group, consisting of hydromedusae, lucifers and fish eggs and larvae, showed preponderance during the postmonsoon months (October-January).

The high abundance of *Noctiluca* during July seems to have affected adversely the distribution of copepod population as was observed by Kartha (1960) in Gulf of Mannar, where, however, it was during April to May.

Copepod being the most dominant group of zooplankton both in the southwest and southeast coasts and as its periodicities of abundance in these two areas are more or less governed respectively by the S.W. monsoon and the N.E. monsoon, a comparison of its abundance at Colachel with the abundance in these two areas might throw a light on the extent of influence of each of the monosoons on the secondary production at Colachel, being a place within the confluence of these two areas. The peak period of copepod abundance in the Gulf of Mannar has been reported to be during September-November, this area being under great influence of N.E. monsoon (Kartha 1960). At Vizhinjam inshore area, where the influence of S.W. monsoon is stronger, the peak period of copepod abundance is during August-October (Divakaran et al 1980). At Colachel, on the other hand, the copepod has a very protracted period of abundance, extending from June to February (except for a decline for a short period in July, which was due to the sudden swarming of *Noctiluca).* This probably indicates that Colachel is almost equally influenced by both S.W. and

N.E. monsoons. The preponderance of copepods that is initiated and supported by the conditions brought about by the S.W. monsoon continues till about February supported by the conditions brought about by the N.E. monsoon.

The cladoceran peaks were in May and July. Delia Croce and Venugopalan (1972), Sakthivel and Haridas (1974) and Purushan et al (1974) have all stated that cladocera occur in swarms abruptly. Some earlier authors have pointed out a direct relationship between cladoceran peaks and the mackerel fishery along the west coast of India. *(See* Pillai and Pillai 1975). Selvakumar (1970) has associated cladoceran swarms with the appearance of mackerel fishery at Karwar and Goa as in both the areas cladoceran swarms were followed by heavy catches of mackerel. It may be pointed out that whatever landings of early juveniles of mackerels at this centre were recorded (in the beginning of August) also were soon after the cladoceran maxima.

The continuous occurrence of most of the larval plankters in the collections suggest that breeding of zooplankters in this area takes place with definite periodicity and succession.

In the past, as a result of several attempts to correlate the plankton production with fish landings, it has been shown that the high values of plankton volumes were accompanied by increased catch of fish *(See* Mukundan 1971). In the present study, too, a strong correlation is discernible between the abundance of zooplankton biomass and that of pelagic fish. As could be seen from Fig. 6, the maximum catch of pelagic fish is obtained immediately following the primary and secondary peaks of the plankton abundance. In our study, it was observed that the peak occurrences of anchovies were followed by those of Trichiurids during September-October period, probably indicating a prey-predator relationship between the two. James (1967) observed *Stolephorus* spp. as one of the major food items of trichiurids along the southeast coast of India.

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REFERENCES

ANON. 1974. Progress Report, UNDP|FAO Pelagic Fishery Project, (IND 69|593) (6) pp. 141.

DELLA CROCE, N. AND P. VENUGOPAL. 1972. Distribution of marine cladocerans in the Indian Ocean. *Mar. Biol.,* 15: 132-138.

DIVAKARAN, O., M. ARUNACHALAM, N. B. NAIR AND K. G. PADMANABHAN. 1980. Studies on the zooplankton of the Vizhinjam inshore water, south-west coast of India. *Mahasagar, Bull. Nat. Inst., Oceanogr.* 13(4): 335-341.

JAMES, P. S. B. R. 1967. The ribbon-fishes of the family Trichiuridae of India". *Memoir* I, *Marine Biological Association of India,* 226 pp.

KARTHA K. N. KRISHNA. 1960. A study of the copepods of the inshore waters of Palk Bay and Gulf of Mannar. *Indian J. Fish.,* 6(2): 256-267.

LAZARUS, S. AND J. J. JOEL. 1979. The Pelagic fisheries resources of Kanyakumari district, Tamilnadu, South India. *Seafood Exp. J.,* 11(5): 9-28.

MENON, M. D. AND K. C. GEORGE. 1977. On the abundance of zooplankton along the south-west coast of India during the years 1971-75. *Proc. Symp. Warmwater zoopl.* NIO, Goa, 205-213.

MUKUNDAN, C- 1971. Plankton of the Calicut inshore waters and its relationship with coastal pelagic fisheries. *Indian J. Fish.,* 14: 271-292.

PIILAI P. PARAMESWARAN AND M. AYVAPPAN PILLAI. 1975. Ecology of the cladocerans of the plankton community in the Cochin backwater. *Bull. Dept. Mar. Sci., Univ., Cochin,* 7(1): 127-136.

PRASAD R. REGHU. 1954. The characteristics of the marine plankton at an inshore station in the Gulf of Mannar near Mandapam. *Indian J. Fish.,* 1: 1-36.

PURUSHAN, K. S., T. BALACHANDRAN AND M. SAKTHIVEL. 1974. Zooplankton abundance off the Kerala coast during February and April, 1970. *Mahasagar, Bull. Nat. Inst. Oceanogr.,* 7(3&4): 165-175.

SAKTHIVEL, M. AND P. HARIDAS. 1974. Synchronisation in the occurrence of a trichodesmium bloom and swarming of *Crescis acicula* Rang (Pectopods) and *Penilia avirostris* dana (Cladocera) in the area off Cochin. *Mahasagar,* Bull. Nat. Inst. *Oceanogr.* 7(1&2): 61-67.

SELVAKUMAR, R. A. 1970. Cladoceran swarms in relation to mackerel fishery along the west coast of India. *Curr. Sci.,* 39: 481-482.