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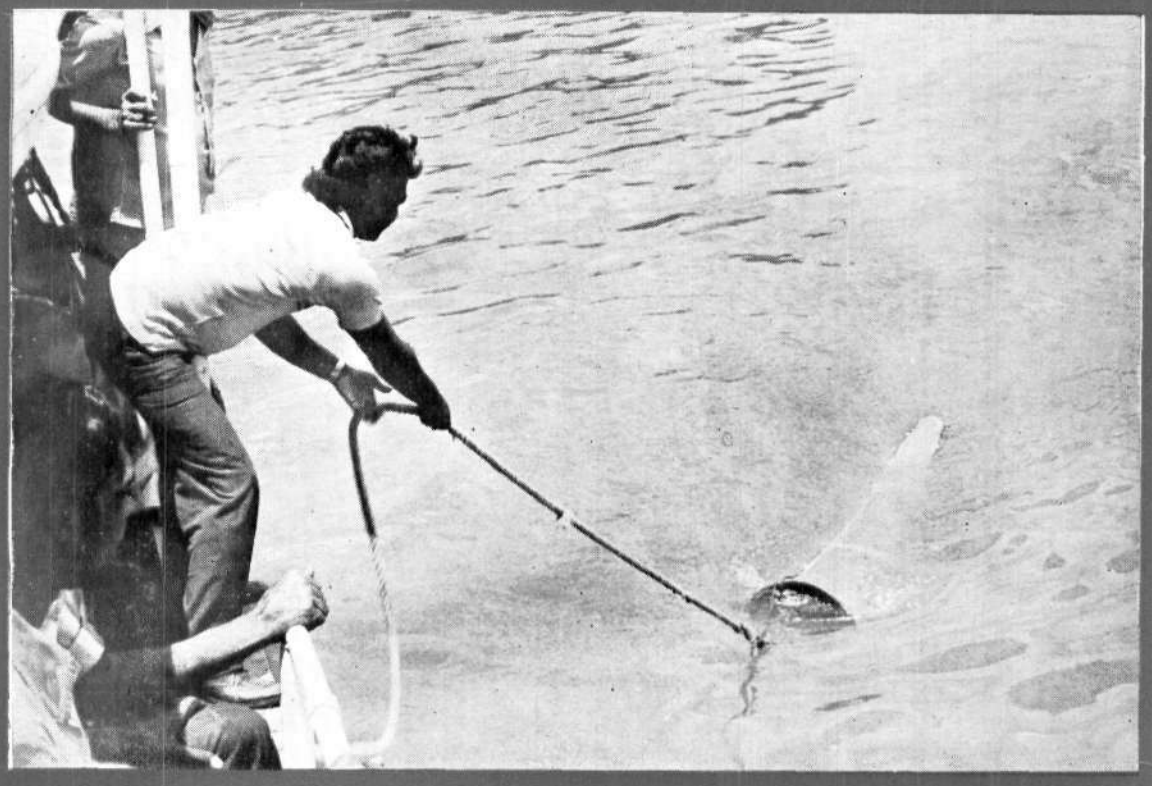

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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the Fishery Data Centre and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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Cover Photo: Collection of samples for studies in secondary production.

TRENDS IN SECONDARY PRODUCTION IN THE INSHORE WATERS OF THE SEAS AROUND INDIA

By K.G. Girijavallaban, S. Krishna Pillai, R. Marichamy, C.V. Mathew, T.S. Naomi, Pon Siraimeetan, K. Ramachandran Nair, Rani Mary Jacob, G.Subramanya Bhat, and K.J. Mathew.

Introduction

The availability of the right forage organisms, their quality and quantity, play a vital role in the sustenance of the living resources of the marine environment. Again, these microscopic organisms which belong to the categories of phyto and zooplankton being a reliable tool for the identification of areas prone to industrial and natural pollution and for understanding its extent and intensity, especially in the inshore areas, the studies on them have added significance. With these in view the Central Marine Fisheries Research Institute has been monitoring the inshore waters at selected centres along the indian coasts, for the seasonal variations in the rate of production at the primary as well as the secondary levels. Such studies help in foretelling any alarming situations developed in the living environment that may affect the commercially important resources adversely.

The following is an account of the pattern of the occurrence and abundance of zooplankton along the Indian coasts from Bombay on the west coast upto Madras on the east coast. Regular weekly or fortnightly samples of zooplankton were collected from fixed stations as surface tows for 10 minutes using a half metre ring net made of nylobolt of 0.4 mm mesh size. The estimates were made as number per 10 minutes haul for all the centres except Vizhinjam where the estimates were made as number per 100 m^3 of water. The samplings were carried out from motor boats at Bombay, Tuticorin, Mandapam and Madras. At Vizhinjam a catamaran was used for making the collections and at other centres country crafts were used for the purpose of plankton collections.

1. Bombay (Fig.1)

In the Bombay waters a study of the annual mean values of zooplankton production during the 3 year period from 1979 to 1982 showed that from a minimum of 3.32 cc per 10 mts. haul in 1979-80 the production of zooplankton rose to 8.43 cc in 1980 - 81 and to 8.08 cc in the subsequent year. Thus it may be stated that the trend in zooplankton production was almost stationery during the latter 2 years. However, the collections could not be made during the southwest monsoon months in the year 1981-82.

The temperature and salinity seemed to have some correlation with the abundance of zooplankton and it was observed that the highest value for plankton was obtained when the salinity was above 35 0/00 in January, 1982. But similar high values of salinity during February and March, 1982 did not coincide with a high yield of plankton. While the temperature showed a gradual decline from October, 1981 to January, 1982, the zooplankton became more abundant and as it went up again the signs of decline in production were noticed. The dissolved oxygen was always on the high rate.

In the plankton samples of the different months the copepods were the highly dominating group and their dominance reached as high as 97.47 per cent in April, 1981. In the other months also their percentage was of the order of 85.52 per cent in March, 1982 and 97.10 per cent in the previous month. The next in abundance was chaetognaths which constituted between 1.58 per cent in February, 1982 and 6.77 per cent in November, 1981 among the other. The decapod larvae contributed from 0.09 per cent in April, 1981 to 3.27 per cent in November, 1981. The above were the three groups whose representatives were present in all the months of sampling. Other zooplankters included medusae, pleurobrachia, lucifer, pteropods, appendicularians and fish eggs and larvae. Most of these groups occurred in the plankton during the period from October to December, 1981.

2. Karwar (Fig.2)

The annual mean values of production at the secondary level showed a declining trend during the 3 year period from 1979. While the mean value for 1979-80 was as much as 9.58 cc per 10 mts. haul it was only 6.78 cc in 1981-82.

The occurrence and abundance of zooplankton in the inshore waters of the Karwar coast were greately influenced by the environmental parameters especially the temperature and the salinity. The density of zooplankton was least during July-August period when the salinity was 6.56 and 5.58 0/00 respectively. Similarly, the lowest temperatures were also noticed during this period, being 26.4 °C and 25.7°C respectively. However, the temperature was

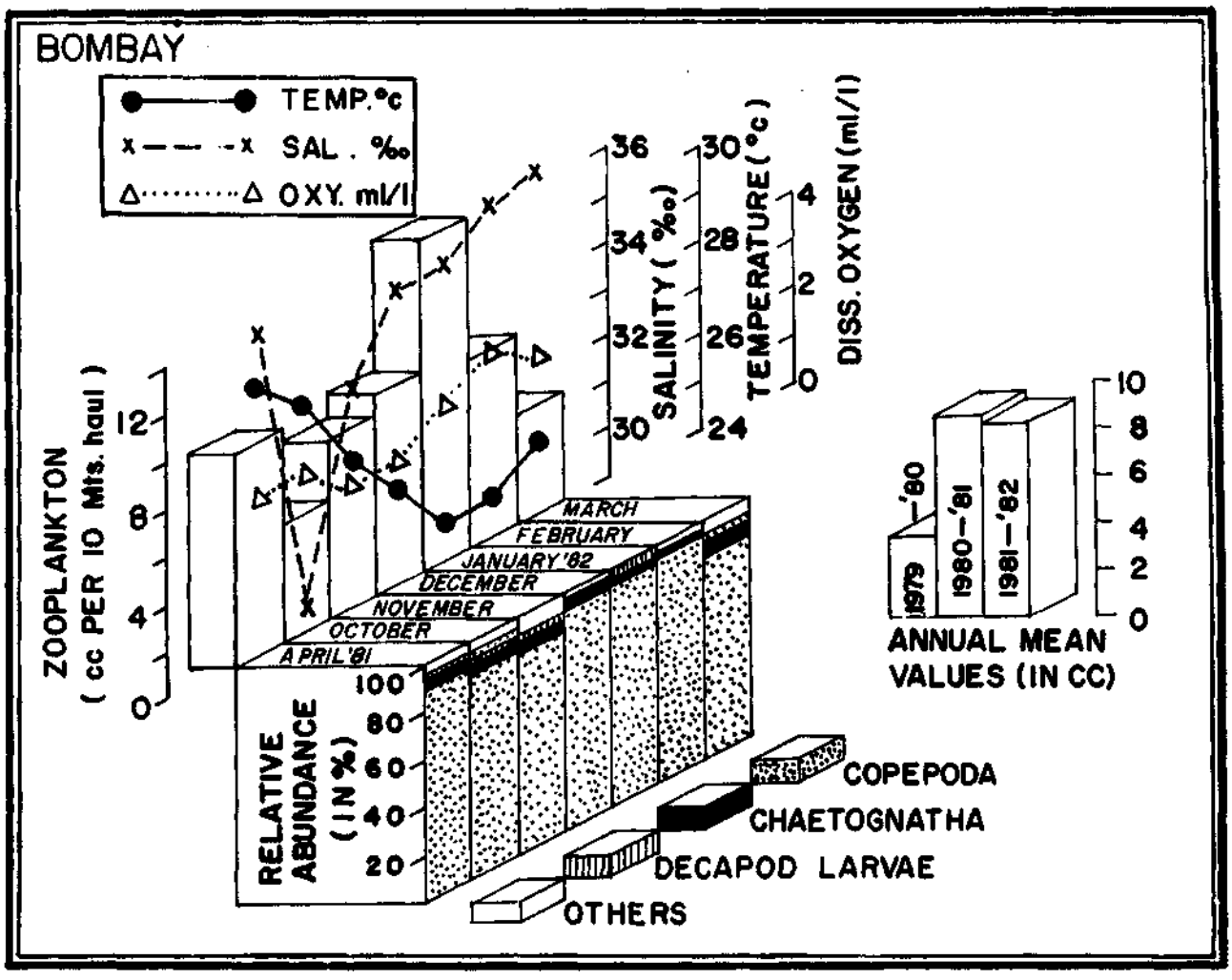

Fig. 1. Trends in secondary production at Bombay

not found to be a limiting factor as the highest value for zooplankton density was obtained in October when the average temperature was 26.6°C. In September eventhough the salinity showed considerable increase, the zooplankton value was low. The dissolved oxygen content of the water was always on the high and therefore it influenced the plankton to the least extent. The premonsoon period from January to April was found to be the most favourable season for the zooplankton in this area. The highest value for zooplankton production observed in October was mainly due to the swarming of the cladocerans.

The monthly variations in the relative abundance among the different groups of zooplankters presented a highly variable picture. The copepods dominated over the others in 8 months. Altogether 12 groups were represented by adults while the larval forms of 9 groups were obtained. The major groups represented in the plankton were copepods, cladocerans and decapod larvae. Eighteen other groups were also represented but in smaller quantities. Occasionally some of these groups swarmed the area and this was particularly observed with the cladocerans and the larvae of cirripede.

The zooplankton groups which were represented by smaller quantities included appendicularians, chaetognaths, lucifer, medusae, siphonophores, salps, doliolids, ctenophores, mysids, amphipods and the larvae of copepods, cirripedes, polychaetes, bryozoans, brachiopods, echinoderms, molluscs and fishes. The fish eggs were present in all months but were relatively more during the postmonsoon period. It was maximum in November when 29.49 per cent of the total zooplankton was constituted by them. The fish larvae were also relatively more in November when 22.41 per cent was present.

3. Calicut (Fig.3)

In the Calicut area the zooplankton collections were made during the premonsoon and the post -

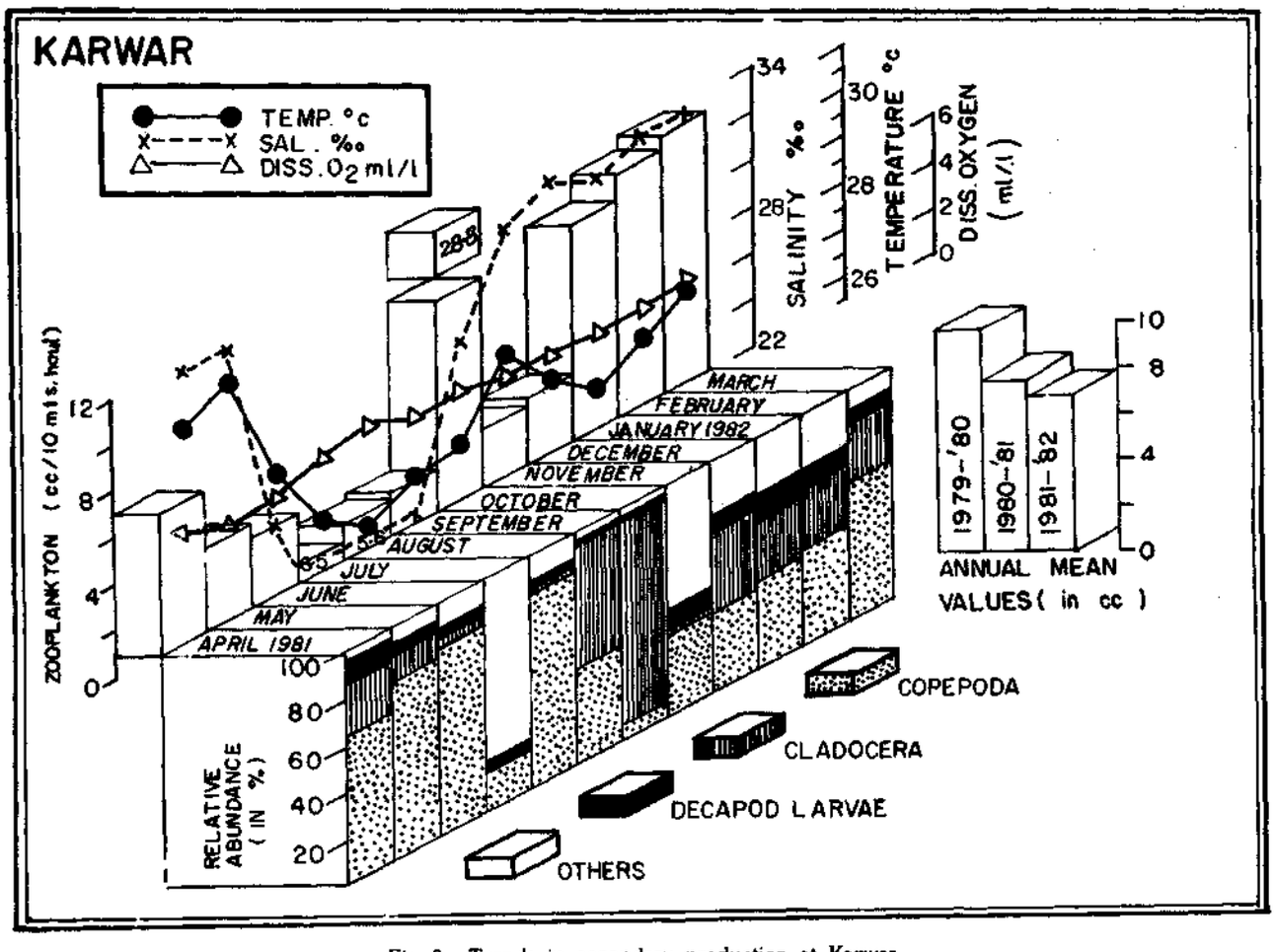

Fig. 2. Trends in secondary production at Karwar.

monsoon months only. As far as the annual fluctuations in the availability of plankton was concerned it came down from a peak of 7.3 cc per 10 mts. haul in 1980 to 3.1 cc in 1981-82. In the previous years of 1977 to 1979 also the density of zooplankton was relatively less.

The monthly variations in the quantitative occurrence of zooplankton were found to be directly correlated with the hydrological parameters, especially the temperature and the salinity. The temperature was found to be a limiting factor on the abundance of zooplankton. It was observed that there was a rhythmic oscillation in the abundance of zooplankton in accordance with the rise and fall of temperature, they being more whenever the temperature registered higher values. The highest quantity of 7.2 per 10 mts. haul was obtained in May, 1981 when the temperature was at the highest (31°C). Similarly, in the case of salinity also its increased values generally favoured a high production of zooplankton in the Calicut area. During the premonsoon months of April and May, 1981 when the salinity was above 35 0/00, the all time increase of zooplankton of the year was noticed. There was noderth of dissolved oxygen in the water in any of the months and therefore it had no role in the fluctuations in the rate of secondary production.

A consideration of the various zooplankton groups which occurred in the different months showed that more groups were present during the summer months of March and April. Cpoepods and chaetognaths were present in all the months of observations. The decapod larvae were absent in January, 1982 only. The other groups which were present in one month or the other were siphonophores, ostracods, appendicularians and eggs of invertebrates and fishes. In all the months the copepods dominated over the others forming 87.68 per cent in April, 1981 to 96.88 per cent in March, 1982. The chaetognaths always ranged between 0.71 per cent in March to 2.95 per cent in January, 1982. The ostracods although were poorly represented constituted 5 per cent of total plankton in November, 1981. Similarly, the decapod larvae also were relatively more in April, 1981 with a share of 6.35 per cent. The other groups of

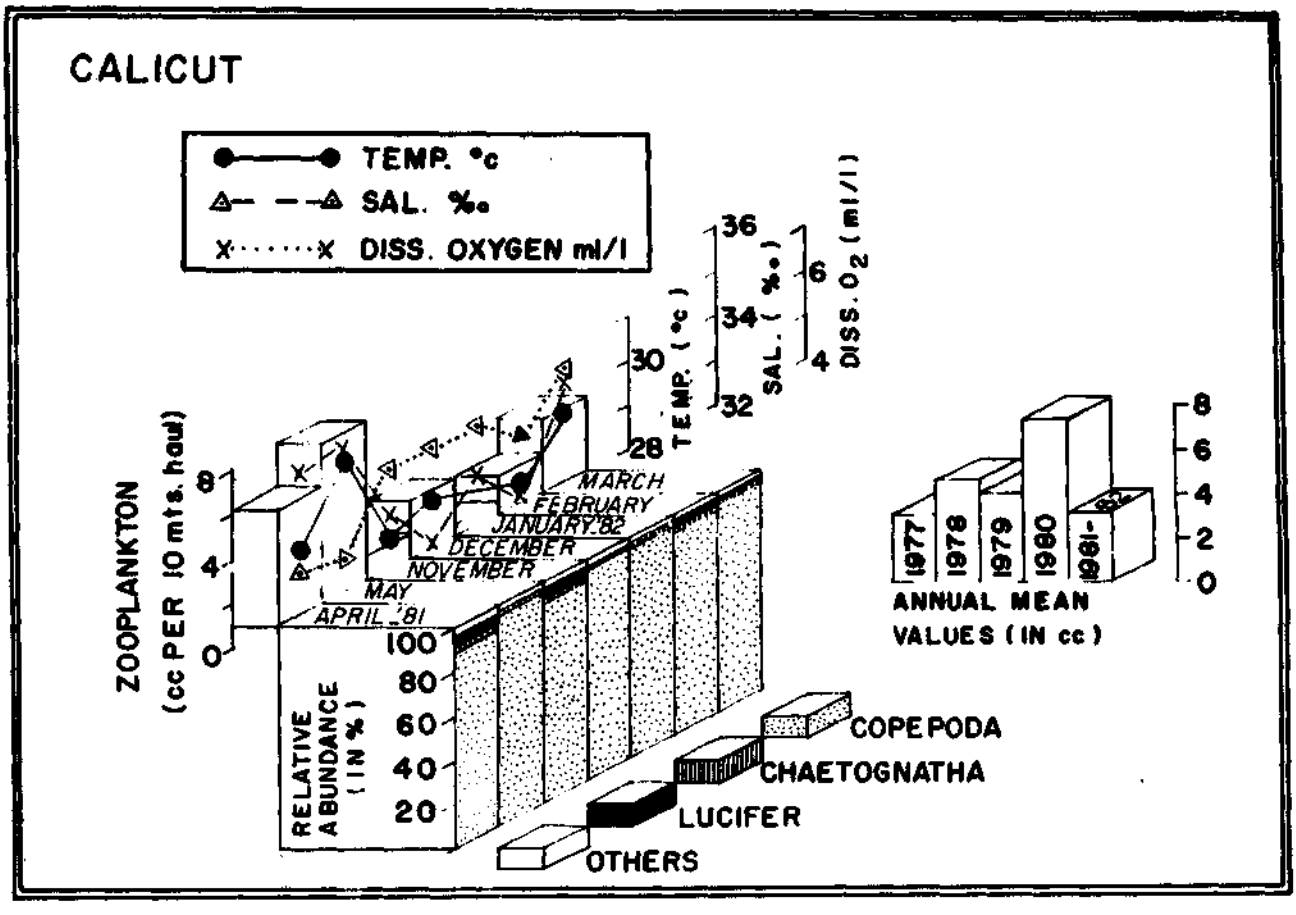

Fig. 3. Trends in secondary production at Calicut.

plankters when present constituted around 1 per cent of the total plankton.

4. Vizhinjam (Fig.4)

At Vizhinjam there was a mixed trend in the rate of production at the secondary level. The highest production was observed in April, 1981 when the average production was 31.05 cc per 100 m^3 of water. A sudden decline in zooplankton production was followed in the next month, when the lowest value of the year. 1981-82 (7.6 cc/10 mts haul) was recorded. From then onwards the alternate rise and fall in density of plankton was experienced at this centre. However, a proper correlation was not found between the plankton abundance and the hydrological features nor did the trend in production follow the changes in the climate. The least values in temperature and salinity were noticed in June, 1981 when the average plankton value was 18.47 cc per 100 m^3 of water. In the other months the temperature and salinity were more or less steady and were centered around 28.5°C and 34.5 0/00 respectively. On the other hand the zooplankton volume fluctuated over a wide margin in every month irrespective of the steady nature of the temperature and salinity values.

As far as the different groups of zooplankton were concerned the copepods dominated which were distantly followed by chaetognaths and decapod larvae. The relative abundance of the copepods among other plankters ranged between 58.71 per cent in June, 1981 and 91.93 per cent in the next month. The other groups were relatively less. The decapod larvae came next in abundance and their maximum of 18.14 per cent among the other zooplankters was observed in March, 1982. They were relatively less in the other months being contributed by 0.47 per cent in September to 5.58 per cent in April. The next in importance was chaetognaths which, however, contributed a small percentage of the total plankton. Thus while their maximum abundance was of the rate of 5.97 per cent in May they were representated in March, 1982 by a mere 0.13 per cent.

5. Tuticorin (Fig. 5)

The annual mean values in secondary production for a period of five years from 1977-82 showed that it maintained a rather steady nature with slight fall in 1978-79 and 1979-80. The 1981-82 value was found to be a little less than that of the previous year.

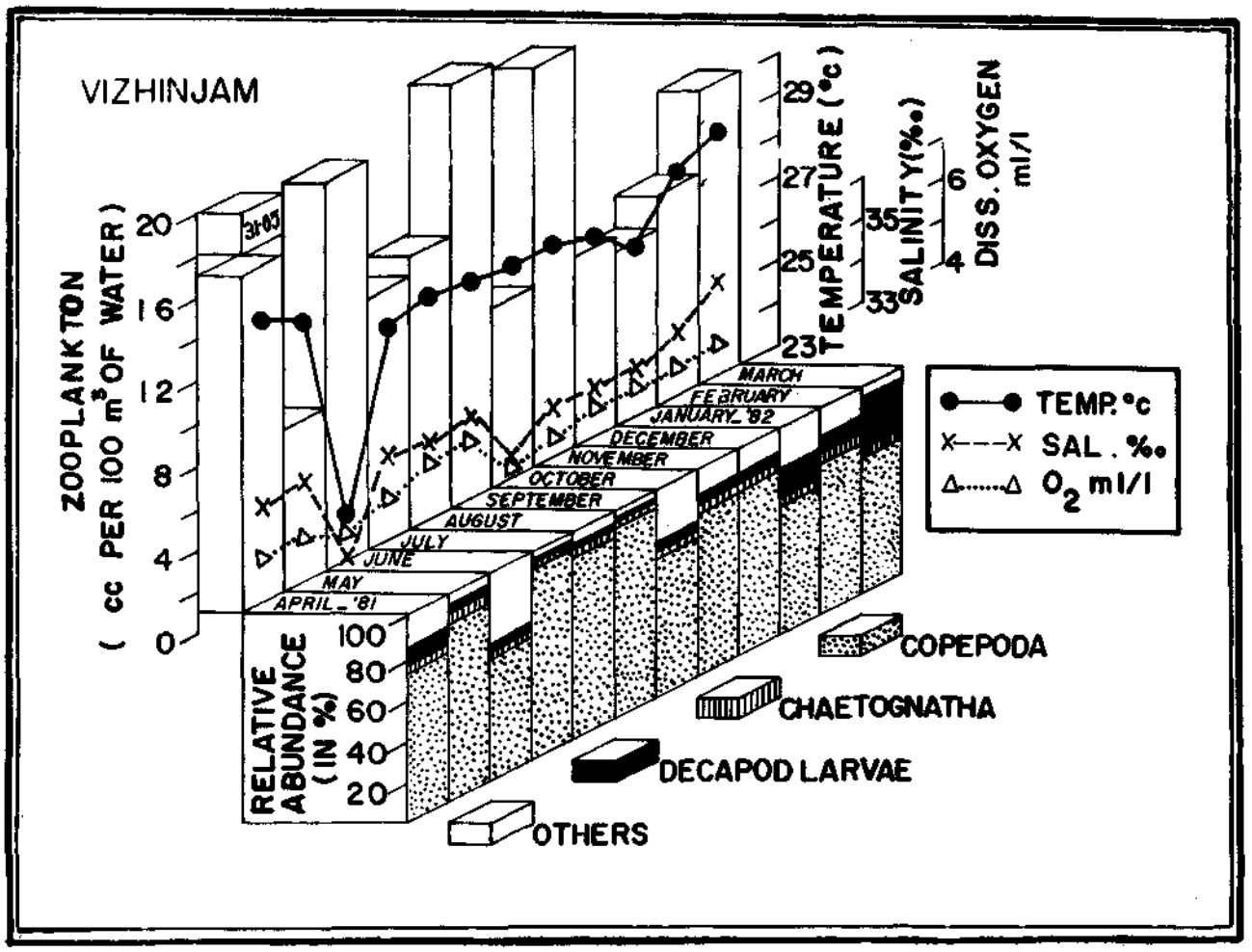

Fig. 4. Trends in secondary production at Vizhinjam.

The temperature ranged from 25.3°C in December, 1981 to 31.6°C in April, 1981. The range in salinity was from 29.93 0/00 in December, 1981 to 34.05 0/00 in March, 1982. The dissolved oxygen content always maintained higher values. The lowering of the temperature and salinity in December due to the northeast monsoon did not affect the overall production of zooplankters adversely. A quantity of 16.0 cc per 10 mts. haul was obtained in this month. However, in the following month when the temperature and salinity remained very low, the quantity of zooplankton came down to as low as 6.2 cc. In general a direct relationship was not noticed between the zooplankton abundance and the hydrological parameters.

One notable feature with regard to the relative abundance of various zooplankton groups in the Tuticorin waters was that the copepods never constituted a major group which was not the case in the other centres. Here their percentage in numerical abundance among the other groups came down as low as 6.0 in November, 1981 and except in May, August and September when they were over 80 per cent, their values were centred around 40 per cent or even less than that. This was mainly due to the sudden swarming of some group of plankters in certain months. Thus for example in November, 1981, 73.5 per cent of the zooplankton was constituted by decapod larvae and such a dominance had reduced the percentage of copepods to 10 per cent. Somewhat similar dominances of larvae of decapods were noticed in July, 1981 and February, 1982 also. A swarm of cladocerans appeared in April, 1981 when 45.7 per cent of the total zooplankton was composed of them. Lucifer was another group which contributed to the bulk of the plankton in July and December, 1981 and January, 1982. Similarly the pteropods dominated over all the other groups in December, 1981. The fish eggs and larvae were relatively more in January-March period.

6. Mandapam (Fig. 6)

The average values of zooplankton production in the Mandapam waters showed a highly declining

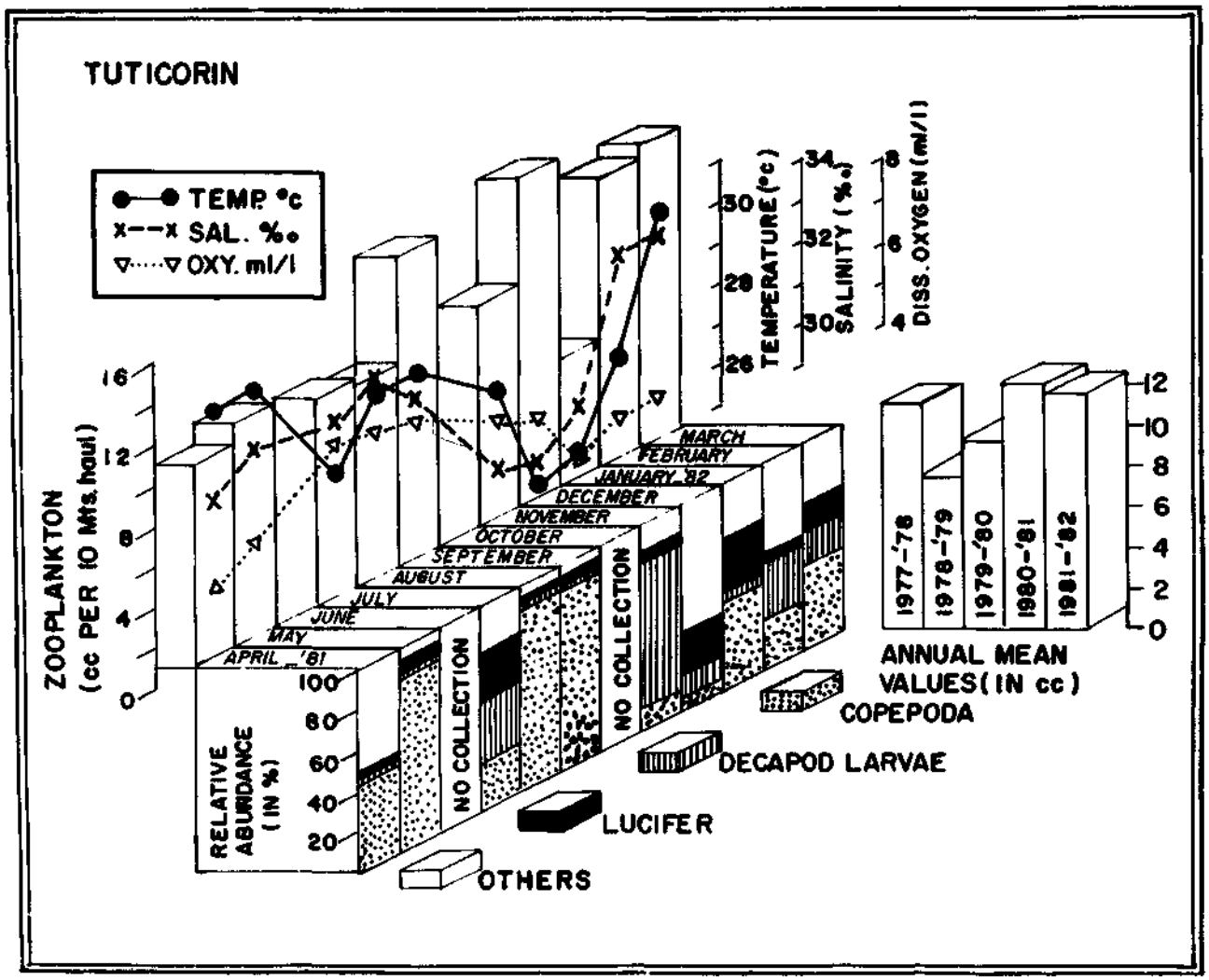

Fig. 5. Trends in secondary production at Tuticorin.

trend from 1979 to 1982. In the 3 years, the rate observed was 18.03 cc, 14.88 cc and 5.46 cc respectively per 10 mts. surface haul.

The monthly mean production of zooplankton during 1981-82 as given in the figure showed a close affinity to the changes in the hydrological features. The general trend was that whenever the temperature and salinity values rose there was a corresponding increase in the quantum of zooplankton. The dissolved oxygen content had no direct relationship with the abundance of zooplankton. Any sudden fluctuation in the quantitative distribution of zooplankton was not noticed in this centre except during November, 1981 and February, 1982 when the displacement volume of plankton was 8.2 cc and 12.3 cc respectively. In the other months it varied between 2.9 and 6.9 cc only with the lowest value in April, 1981.

A groupwise analysis of the major zooplankters for their relative abundance showed that the copepods ranged between 38.8 per cent in March, 1982 and 75.0 per cent in December, 1981 and January, 1982. The fish eggs constituted an important item in the plankton occurring in all the months, and in March, 1982 its number even surpassed that of the copepods. The chaetognaths were also abundant in all the months of observations. Eleven other groups were present in the plankton of the area, the important ones among them being chaetognaths, Lucifer, appendicularians and pteropods. However, these were not regular in their occurrence.

7. Madras (Fig. 7)

In Madras as far as the annual mean production of zooplankton was concerned an alternate pattern of decrease and increase was observed from 1977 onwards, the trend of decreasing or increasing being towards lower values. Therefore in the Madras waters the lowest of the mean production in the last 5 years was experienced in 1981-82 period with a quantity of

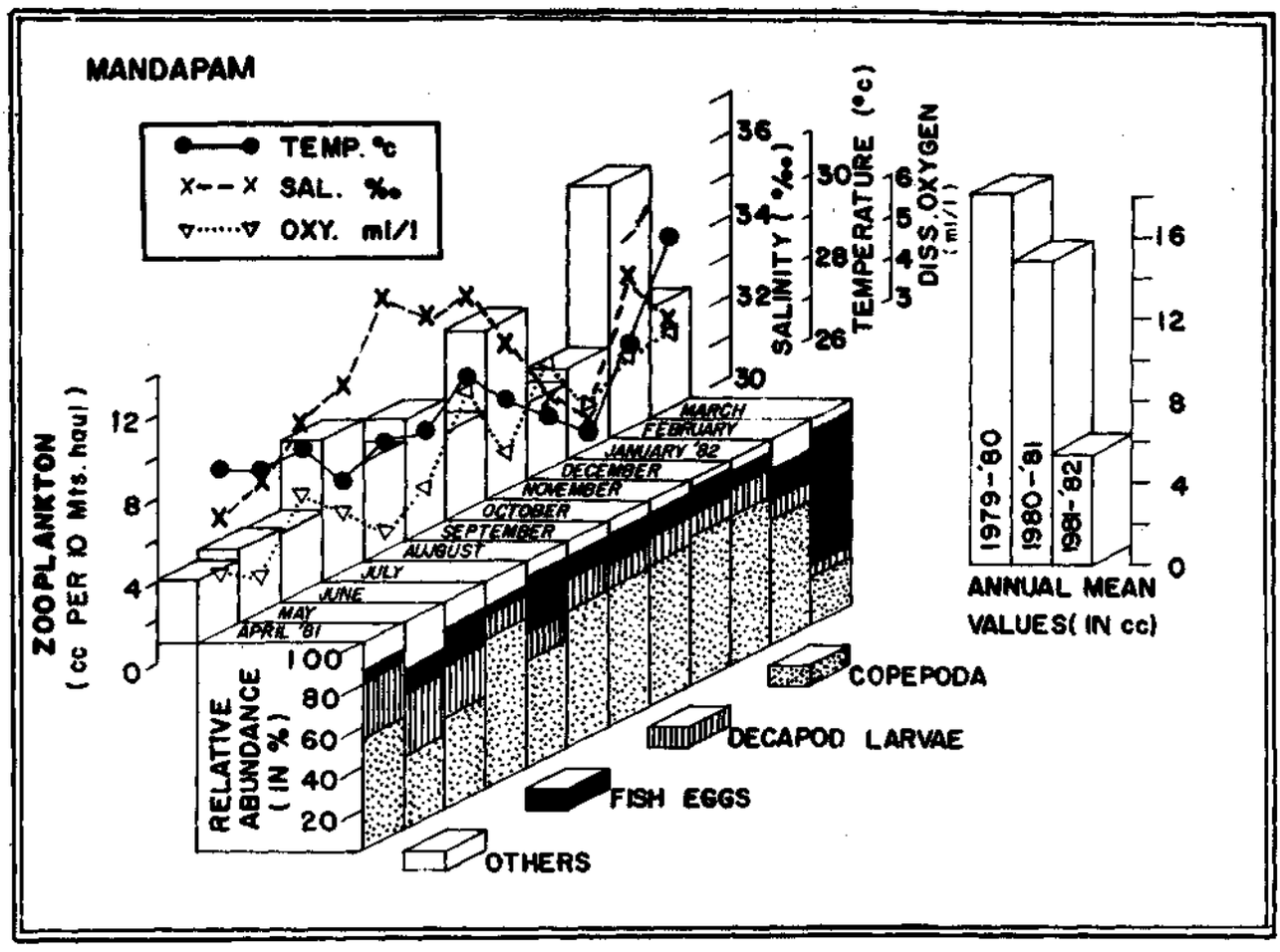

Fig. 6. Trends in secondary production at Mandapam.

5.94 cc per 10 mts. haul. The year of maximum production was 1978 when 13.95 cc of plankton per 10 mts. haul was obtained.

The monthly mean values for the year 1981-82 were found to be always moderate between 2 and 6 cc except in April, 1981 and February, 1982 when higher values at the rate of 16.4 cc and 11.0 cc respectively per 10 mts. haul were obtained. During the northeast monsoon period of November-January the quantum of plankton obtained was low. The environmental parameters such as the temperature, salinity and oxygen were found to have a direct correlation with the plankton abundance. It was generally found that an increase in any of these parameters always favoured an increased availability of the zooplankton.

The percentage composition of the major groups of plankters showed that the copepods formed the main constituent in all the months. Their quantity among others ranged between 43.39 per cent in April, 1981 and 82.13 per cent in October, 1981. Next to copepods the chaetognaths and decapod larvae dominated the plankton almost equally, but with variations in the different months. While the chaetognaths were absent in the plankton in December, 1981, the decapod larvae were absent in August and October, 1981 and March, 1982. Apart from these, 13 more groups comprised by medusae, siphonophores, Lucifer, amphipods, appendicularians, salps and doliolids, fish eggs etc were also present in the plankton.

Remarks:

In general the rate of secondary production on the west as well as on the east coasts during the 1981-82 period was comparatively lesser than during the previous year. It was more pronounced in Calicut Mandapam and Madras. In Madras, the year 1981-82 was the period of least production in the previous 5 years. Similarly in Mandapam the 1981-82 value was the lowest ever obtained during the previous 3 years time. In Madras in the last 5 year period the year 1978 registered the maximum production. But since then the trend was on the declining side until 1981-82 eventhough a slight increase was noticed in 1980-81

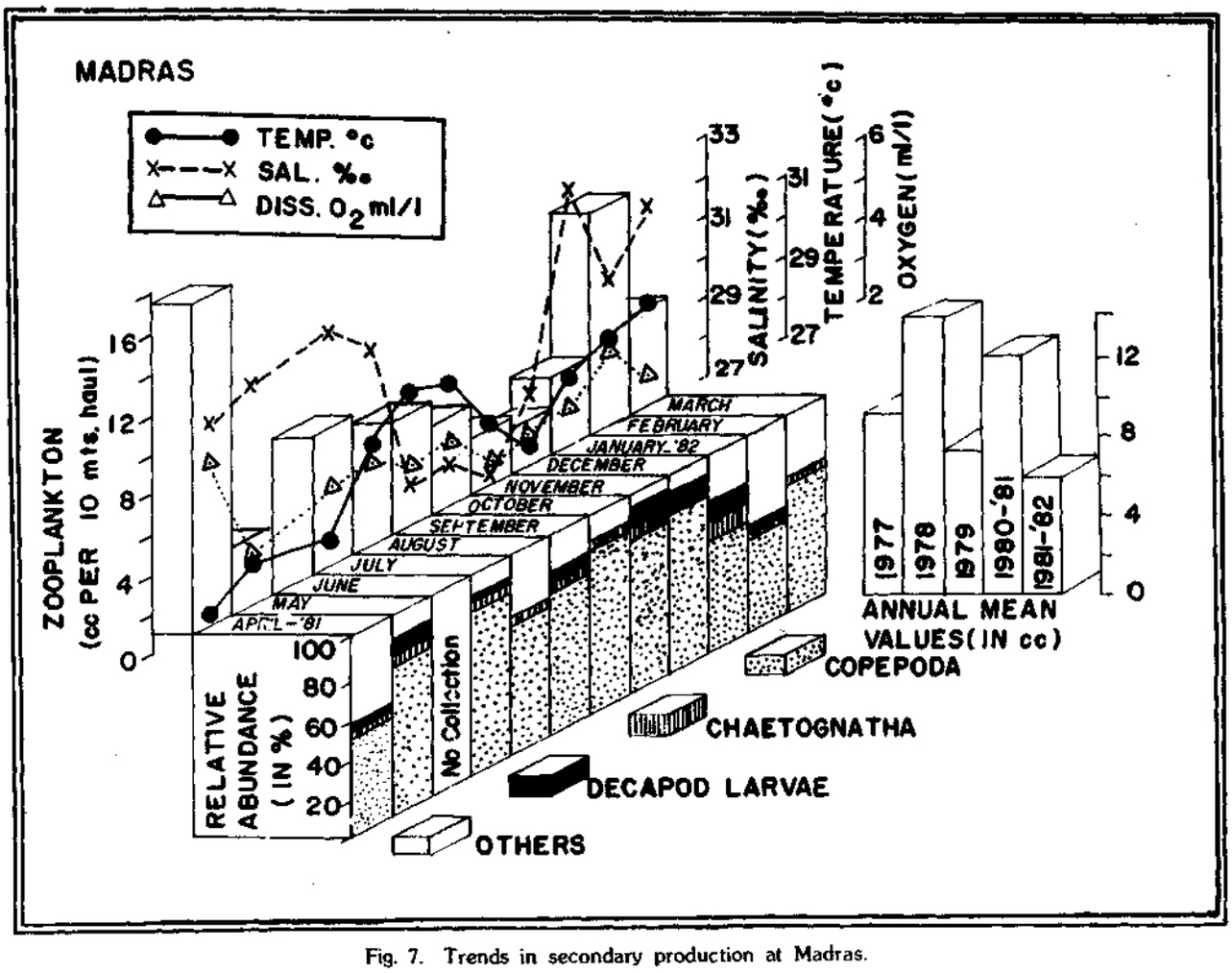

Fig. 7. Trends in secondary production at Madras.

period. In Tuticorin on the other hand the lowest rate of production was observed in 1977-78 from which it gradually improved until 1980-81 only to reduce a little in 1981-82. For the Bombay waters the available data on the annual mean production showed 1979-80 period to be the year of least production. In the ensuring year the quantum of production showed more than a two fold increase which was almost maintained during the 1980-81 period. However, collections were not made during the southwest monsoon months of 1981-82. In Calicut also the zooplankton production rate remained more or less steady during the 1977-82 period with a sudden increase in 1980. During the 5 year period the 1981 - 82 figure was the lowest.

KURUMA SHRIMP FROM BOMBAY WATERS — A NEW RESOURCE*

The prawn fishery of Maharashtra State has shown great strides in recent years and with the increasing introduction of mechanised trawlers of different sizes and their operations beyond the conventional zones exploited by the traditional fishery, more and more species growing to different sizes are appearing in the fishery. Thus from 1977 onwards one species of prawn belonging to the genus *Penaeus* has been increasingly represented in the catches of the trawl fishery of Bombay and landed at Sassoon Dock. Although not contributing to a very large fishery the species has been found in the catches sporadically in small quantities, amounting to nearly 10 to 15 tonnes annually. In view of the larger sizes of this prawn and the attractive colour bands resembling the Japanese prawn, there is great demand for the species from the processors exporting frozen shrimps especially to Japan. The species was later identified as *Penaeus japonicus* which is the favourite 'Kuruma shrimp' of Japanese waters. Since the occurrence of this prawn in fairly good quantities has come as a new resource not reported earlier, a close study of its fishery and biological aspects was undertaken based on the landings at Sassoon Dock and the results are reported in this contribution.

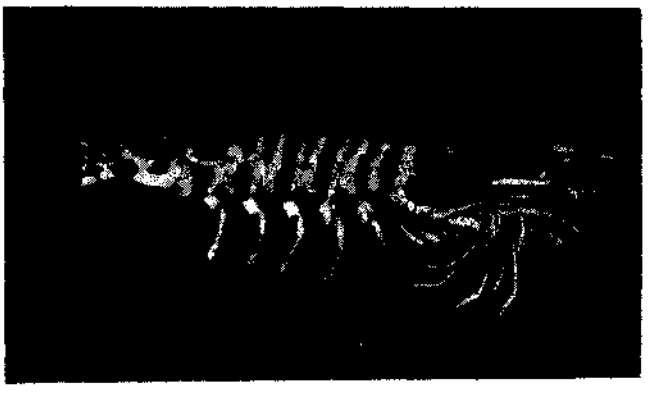

Fig 1. Kuruma Shrimp, *Penaeus japonicus*.

Systematics

Detailed examinations of the specimens collected from the catches showed that the species is *Penaeus japonicus* Bate. Considerable confusion exists regarding the identity of this species in Indian waters. The species is very closely allied to *P.canaliculatus* which was recently reported occurring in the fishery as a new resource in Quilon area in the Kerala coast (*Mar. Fish. Infor. Serv. T & E Ser.*, 35: 15-17, 1982). There are reports of *P.canaliculatus* as well as *P.japonicus* in stray numbers from other parts of Indian coast. Both species show very similar morphological features in the number of rostral teeth, extension of the adrostral sulcus or the groove on the dorsal aspect of the carapace to the posterior end of the carapace and the colour pattern. However, a closer examination would show that the two species are quite different. The most important diagnostic features which distinguish these species are: 1) while 3 pairs of spinules are present on the lateral sides of the telson in *P.japonicus* the spinules are absent in the telson of *P.canaliculatus, and* 2) the seminal receptacle in the thelycum is divided in *P.canaliculatus* while it is cylindrical in *P.japonicus*. With the help of these clearcut differences it has been possible to identify the species presently occurring in the fishery in Bombay as undoubtedly *P.japonicus*. It is quite possible that the record of *P.canaliculatus* from Bombay waters by Kunju (*Mar. Biol. Ass. India, Proc. Symp. Crust.IV:* 1382-97; 1967) may probably be *P.japonicus*.

Fig 2. A collection of *Penaeus japonicus* landed at Sassoon Dock, Bombay in June 1982.

The popular name given for the species by FAO is "Kuruma prawn" (L.B.Holthuis, FAO species Catalogue, *FAO Fish. Synop.* (125) Vol. 1: p.46, 1980). It is known under different popular names in different countries eg. Ginger prawn in South Africa, Flowery prawn in Hong Kong and India, Banded shrimp in Taiwan, Kuruma ebi in Japan, Oriental brown shrimp in Korea, Japanese king prawn in Australia and Kuruma shrimp in U.S.A. Recently some firms in Japan have imported the frozen prawns of the species under the trade name of bamboo prawn. The species has a wide distribution in Indo-west Pacific and in some parts of

*Prepared by M.Aravindakshan and J.P.Karbhari.

Eastern Atlantic. It is of major commercial importance in Japan, being the most valuable of the commercial shrimps there, both in trawl fishery as well as pond fishery.

Fishery in Bombay

P.japonicus was caught along with other penaeid prawns by the mechanised vessels using 18 and 22 m otter trawls operated at depths ranging from 40 to 60 m off Bombay coast. Small quantities have been noticed in the dol net catches also. The landings of the species at Sassoon Dock indicate that the fishery is highly fluctuating and also sporadic to a certain extent. The species was first noticed to have some magnitude of a fishery in 1977. The annual catch figures increased in subsequent years and in 1979 a catch of 15 tonnes was registered (Fig.1). Thereafter a decline was seen in the following years and in 1982 the catches registered 16.7 tonnes. The average landings at this centre amounted to 7.6 tonnes a year. The percentage of this species at this landing centre works out to about 1 in the total prawn landed. It is landed in very small quantities at New Ferry Wharf, Dabhol, Ratnagiri and some other centres also. The annual catch per unit at Sassoon Dock showed a maximum of 15.1 kg per unit in 1978 and minimum of 7.4 kg per unit in 1979.

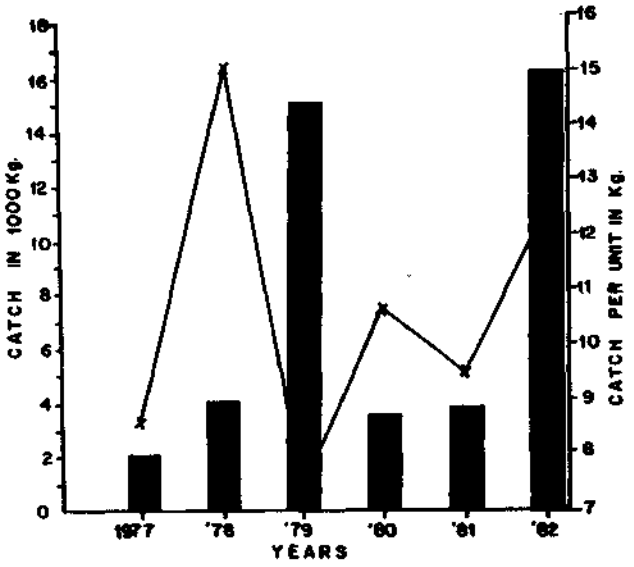

Fig. 1. Total catch and catch per unit of *Penaeus japonicus* at Sassoon Dock during 1977-1982.

The monthly trend of catches during 1977-1982 is presented in Table.1. In all the years the maximum landings are noted in June to September period except in 1979 when it continued in October, November months also. During the other months the fishery is at a low level, probably due to the fact that the trawlers operate in slightly deeper zones where the species is available in abundance during the May - August period and in shallower zones during October -December period. The catch per unit also shows the maximum in June to August period and the minimum in October to March period as in the case of total catch. The catch rate gave a maximum of 33.3 kg per unit in June 1979.

Size distribution

The sizes of these prawns represented in the catches ranged from 110 mm to 225 mm, the females as usual showing larger sizes. The largest male specimen noted measured 190 mm in total length and that of female specimen 225 mm. The annual picture of the length frequency distribution of the species in the fishery during the years, 1977-82 is depicted in Fig.2. In 1977 the dominant size groups were in the larger size range of 148-163 mm. In the next three years the major modal sizes went down to the size ranges of 118 -133 mm. In 1981, although the smaller sizes were dominant the larger size ranges of 148-163 were equally dominant, especially the females. In 1982 the smaller sizes were not noticed in the catches, large sized females being present in good quantities.

Food of the species

In order to get an idea about the food of this species the stomach contents of 240 specimens were examined. Based on this study, on an average 40% of the stomach contents were crustacean remains, 20% polycheate remains, 25% molluscan remains and the rest 15% sand grains and debris. The crustacean remains consisted mainly of decapods. The study reveals that *P.japonicus* is carnivorous in food habits and also bottom feeding. Similar results were obtained for the species from a study in Malaysian waters by Hall (*Fish. Publ. Colonial Off*, 17: 1-229. 1962).

Sex ratio

Females were noticed to be predominat in the catches during all the years, with the sex ratio of females to males 3:1. However, during June-July months when the catches were higher the ratio of females to males was 2:1. Males did not dominate in the catches at any time of the study.

Maturity and spawning

Mature male and female specimens were noticed in the catches in most of the months. However, gravid females were represented in maximum quantities in the months July, August and September, their percentage representation reaching from 60 to 80 in

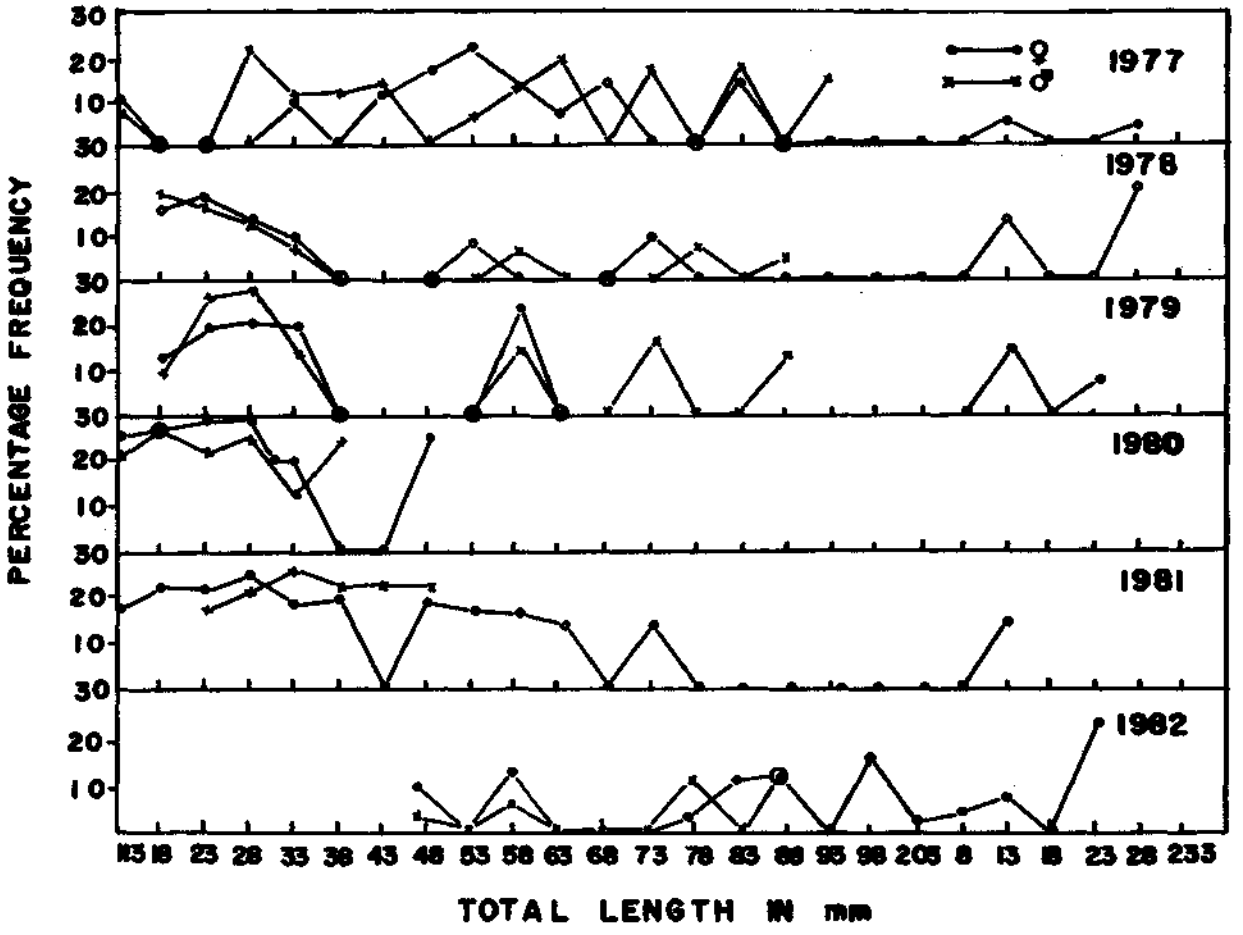

Fig. 2. Length frequency distribution of *Penaeus japonicus* at Sassoon Dock in 1977-1982

Table. 1. Catches of *Penaeus japonicus* at Sassoon Dock during 1977-82

Years	Months (catch in kg with catch per unit in paranthesis)												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1977	80	90	70	65	60	200	600	650	50	60	50	25	2,000
	(4)	(5.5)	(7)	(5)	(4)	(20)	(20)	(25)	(5)	(4)	(2)	(2)	(8.6)
1978	120	140	320	440	250	600	800	750	660	—	—	—	4,080
	(3)	(7)	(10)	(11)	(10)	(20)	(20)	(25)	(30)				(15.1)
1979	60	52	48	502	450	2,000	—	3,150	2,480	2,500	3,200	600	15,042
	(3)	(3)	(2)	(12)	(1.5)	(33.3)	—	(20)	(1.5)	(1.4)	(1.7)	(1.5)	(7.4)
1980	100	124	138	142	600	400	600	1,400	80	60	120	80	3,844
	(4)	(10)	(5)	(15)	(20)	(10)	(25)	(30)	(2)	(2)	(3)	(2)	(10.7)
1981	121	200	128	132	500	600	825	1,200	70	90	130	90	4,086
	(3.5)	(5)	(10.2)	(15)	(22)	(10)	(25)	(15)	(2.5)	(2)	(2)	(1.5)	(9.5)
1982	95	180	115	135	240	170	6,506	6,000	3,018	80	90	115	16,744
	(3.5)	(9)	(7.1)	(9)	(20)	(17)	(26)	(20)	(10.1)	(8)	(6)	(6.5)	(11.9)

these months. From this it appears that the peak spawning period in the offshore regions is in these months. The sizes of mature females, in general, ranged between 150 and 225 mm.

Exports

Upto 1980 *P.japonicus* was exported from Bombay, mostly to Japan, under the commercial packings known as "tiger" and "flower" which included species like *P.monodon, P.semisulcatus, P.penicillatus* and *P.japonicus*. M/s Castle Rock Fisheries and Castle Rock Sea foods (P) Ltd., Bombay and Tata Fisheries (P) Ltd were the chief exporters. Later Japan showed interest in importing *P.japonicus* their favourite species, packed exclusively. Therefore, these exporters located in Bombay packed this species, head on, and exported under the trade name "bamboo prawn" in 1981 and 1982, fetching higher unit value of upto 15 U.S. dollars per kg. Yearly 9 to 20 tonnes of export of the species has been made by these firms.

General Remarks

Penaeus japonicus is one of the penaeid prawns growing to fairly large sizes which are very much in demand from the industry. Being a species occurring in great abundance in Japanese waters and greatly sought after by the shrimp industry there, the species would be of great interest in the export market, especially to Japan. Therefore, the appearance of this species, hitherto not reported to contribute to any significant fishery anywhere along the coast of India, in the magnitude of a fishery in Bombay waters is very interesting. This prawn fetches premium prices in the Bombay market, 1 kg of the species costing Rs.80 to 100 even in the local auction sales at the landing centre, indicating the demand for export purposes. Now that the species has appeared in appreciable quantities in the trawl fishery in Bombay, it is likely that it is available in other areas along the coasts of India. Hence a proper assessment of the resources of this species in Indian waters would be useful.

Among the species of prawns cultured in the different parts of the world *P.japonicus* has an important place, being the first species of penaeid prawn subjected to laboratory spawning and pond culture. In Japan the complete early larval history of the species was worked out as early as 1942 and from that time onwards large scale commercial culture of the species is practiced in that country, in addition to the natural harvest from the sea. In the present fishery of the species from Bombay the presence of fully mature males and females indicates that aquaculture of this prawn could be developed to a very great advantage by collecting spawners, inducing them to spawn in controlled environment and adopting proper hatchery and rearing techniques. This would go a long way in satisfying the demand from the export industry for species growing to larger sizes and thus add to the foreign exchange earning of the country.

The authors are thankful to Dr.E.G. Silas, Director of CMFRI for his interest and encouragement and to Dr.M.J. George, Scientist S3 for guidance.

FARMING THE COASTAL LAND AT TUTICORIN*

Introduction

The need for the utilisation of derelict area for commercial culture of fishes and prawns has been stressed much in recent time as there is vast scope for the development of such high brine water along the southeast coast of India. A number of private farmers have put in efforts to develop culture practices along the ocastal villages of this zone. Among the various priority areas for research and development, the Tuticorin Research Centre of Central Marine Fisheries Research Institute devoted its attention in developing systems for the culture of fin fishes, prawns and crabs by establishing seed resources, identifying suitable water spreads and developing techniques of farming. 6.07 hectare (15 acre)of intertidal swampy flat on the edge of Tuticorin Bay, adjacent to the oyster farm and field laboratory in harbour link road have been converted into productive fish farm. This low land belongs to the Port Trust of Tuticorin and was acquired on terms of lease for 30 years. The outskirts of the site reveal all possibilities for quick development of mariculture practices. The present report describes the environmental features of the culture ground, the construction of coastal ponds, the results and problems and envisages the scope for further development of extensive, unutilized areas into productive farms.

Resources

The existence of seeds of considerable varieties of euryhaline, culturable species in the tidal inlets along the coast of Gulf of Mannar, that too, in different seasons of the year facilitated the start of fish farming experiments at Tuticorin. The seeds of milkfish occur in adequate quantities in the backwaters of Valinokkam, Punnakayal and Tiruchendur during April-May. The grounds and season for the collection of fingerlings of mullets like *Mugil cephalus* and *Liza macrolepis* have been identified. The tidal pools adjoining the creeks of Alangarathittu, Pullavali and Palayakayal are the resourceful beds for the mullet seeds. The seeds of the prawn *Penaeus inducus* are rich in coastal lagoons and estuarine belts and could be collected in 3 different seasons of the year. The young ones of the crab *Scylla serrata* are available in the tidal flats and mangrove swamp areas in Tuticorin, Pullavali and Sahurpuram and the best period for the maximum collection is July-September. All these species possess high reproductive capacity, short larval development, fast rate of growth, unique physiological features to adjust to wide environmental changes and fetch a good market price.

The water characteristics of the culture site are suitable for continuing the experiments, although the monthly average values of surface temperature, dissolved oxygen content and salinity of the ponds are always higher than that of the open sea. The temperature of the pond water varied from 27 to 31.5°C with the maximum noticed in hot sesons of May and October. The dissolved oxygen content is measured in the range 3.5-6.0 ml/L and fluctuates widely in rainy season . The salinity of the culture site varies from 17 to 50 ppm. The maximum is reached due to the poor tidal amplitude and the low exchange of water, particularly in the months May-September. The site does not face any drastic changes in the environment as there is no river or creek nearby.

Site development

The elevation of the site in relation to the tidal amplitude is the advantageous factor for the selection of culture bed in the protected bay. The area is very flat and exposed during low tide. The mangrove swamps are reclaimed by cutting down the plants *Avicinia* and raising the bunds with the mud excavated from the pond area as the soil has good water retention properties (Fig.1). The floor of the pond is levelled after the mangrove roots are pulled out and

Fig. 1. Construction of ponds in swampy land.

stumps eliminated. The ponds are filled and flushed on the tides, even though the tidal range is quite modest here. The area enjoys a diurnal tide with a range upto 120 cm at spring tide and 30 cm or even less during neap tides. The ponds are made in such a

*Prepared by R.Marichamy and S.Rajapackiam.

Fig. 2-3. Views of coastal ponds.

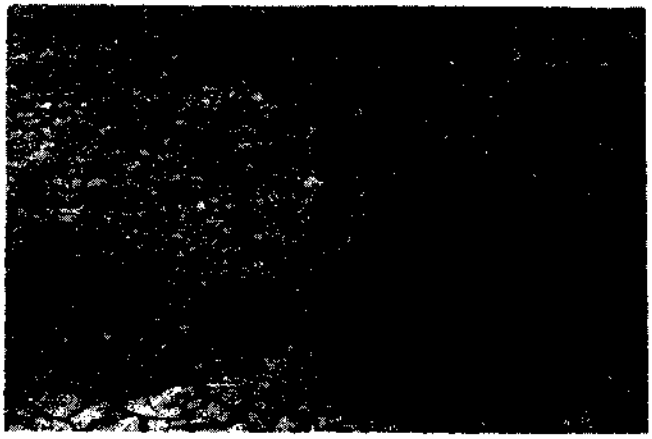

Fig. 4. Preparation of chanos pond by baking.

Fig. 5. Harvested fishes from ponds.

way that their bottom attains a level of 30 cm beneath the mean high-water spring. The sluice pipes are fixed on two sides of the pond at different levels so as to serve as inlets and outlets. The pond bottom slopes gently towards the outlet sluice and traversed by shallow radiating ditches orginating from the harvest basin or catching pit. Maximum exchange of water is possible during spring tide days around fullmoon and newmoon. The bottom consists of soft mud. This hydrophylic mud is biologically active and contains sufficient percentage of humus and large amounts of clay. Such soils provide an excellent environment for the development of algae along with the associated micro-organisms which form the main food of cultivable organisms.

The lay-out of ponds are planned according to the local topographical conditions. 14 ponds, each in the size of quarter hectare with a depth of 1.5 m are constructed. Two main feeder canals with a width of 2 m orginating from the bay on southern side of the site, one in the middle of the farm and the other along the road side, encircle the ponds (Fig.2-3). Radiating canals are arranged at an interval of two ponds. The ponds are provided with cement sluice pipes of 6" diameter which made control of the water level possible. 6-8 pipes are fitted on two side bunds of the pond and most of the ponds are connected with supply channel atleast on two sides. Velon screens tied at both ends of the sluice pipes serve as sieves. The entire farm is protected from open sea by strong embankment which stand one metre above the highest tide level. It is sufficiently broad to withstand the dynamic force of the tides and pressure. The bunds are constructed in stages by laying the excavated mud slabs, free from roots and twigs, in layers which are compacted and allowed to dry in the sun before adding the next layer. Fencing arrangements with special design are made to crab culture ponds. Mounts with mangrove vegetation are retained in these ponds so as to provide ample natural ecosystem.

Milkfish ponds need special preparation immediately after harvesting. The ponds are drained and exposed to air and sun for sufficiently long time to

make the soil surface cracked (Fig.4). Such baking procedure is deemed of paramount importance, since it destroys a variety of unwanted organisms and boosts up the mineralisation process in the top sediment layers and improve the fertility of the pond. Drying out is effective because of the provisions of a good net work of drainage ditches. Ponds which are never dried out gradually lose their value and their exploitation finally ceases to be profitable. This process is also necessary to carry out the essential repair works in ponds.

Culture practices

Experiments on the culture of the mullet *L.macrolepis* and the milk fish *Chanos chanos* were carried out in these ponds during the last three years. *P.indicus* and *S.serrata* were also reared separately in four ponds. The period of culture is normally 10 months and designed from May-February. The rest of the period is devoted towards maintenance and preparation works. The composite culture with compatible species like milkfish and mullet was found to give promising results. Monoculture practices done exclusively with milkfish or mullet in rest of the ponds with different stocking intensities have thrown light in determining the optimum stocking level for better yield. Rice bran and ground nut oil cake at the ratio of 2:1 were supplied to the stocks at 5% of the body weight. The predatory fishes like *Lates calcarifer*, *Terappon* spp., Elops sp., *Polynemus* sp., *Ophiocephalus* sp., *Arius* spp., were eradicated from the ponds periodically by employing the gill net and cast net. The results of the culture experiments were encouraging (Fig.5). Different sets of experiments were completed and the following are the salient features emerging from these preliminary experiments.

1. The growth of milkfish and mullet is slow during the beginning days of stocking due to the prevalence of high salinity in ponds in May-June. The growth is accelerated when a fall in salinity is noticed from July onwards and this is well noticed in milkfish.

2. A maximum overall growth of 30 mm/month and 24 mm/month is observed in *C.chanos* and *L.macrolepis* respectively when stocked at the optimum level of 1 seed/m^2.

3. The milkfish seed released at 28 mm have grown to 335 mm/226 g in a period of 10 months.

4. Better survival and production is noticed with *L.macrolepis*.

5. Poor growth resulted from overstocking besides the other causes like poor depth of water, increased temperature and increase in salinity.

6. The total production encountered in a polyculture experiment is 1644 kg/ha/yr.

7. Harvesting is comparatively easy when single size stocking is practiced.

Development prospects

The facilities for culturing prawns and fishes in coastal lands have been developed using very simple techniques. Farm engineering for marine aquaculture is comparatively a new field and innovative techniques to suit the local conditions need further improvements. Based on the preliminary experiments, several development efforts appear to be warranted for achievement of success. Adequate number of sluices in different dimensions are to be provided for a better exchange of water inside the ponds so that the depth and salinity can be maintained at required levels to promote growth. The shallow outskirts of the culture site are the common fishing ground and to avoid the threat of poaching, fencing arrangements around the fish farm as well as a constant watch and ward set up are the priority requirements for the success of the culture project. Effective system to control the entry of predatory fishes inside the ponds is to be evolved besides the efforts of eradication.

The prevalence of poor tidal amplitude in this region during June-August affects the culture results to a great extent and to solve this problem deepening of the feeder canal and some of the ponds are suggested. This may pose the problem of draining and harvesting. An alternate planning is the careful adjustment of the culture period whereby the adverse period can be avoided or prefixed.

Concerted efforts to tackle some of these problems would hasten the establishment of fish farms on the edge of the sea in these areas, greatly aiding the augmentation of fish production. The present experiments have indicated the possibility of large scale development of farming in the coastal flats.

OCCURRENCE OF WAHOO, ORIENTAL BONITO AND BIGEYE TUNA OFF KARWAR*

With the advent of purse seines in Karnataka, besides the traditional catches of oil sardine and mackerel, of late, other resources are coming to light in the coastal waters of this state.

On 1st October 1982, a purse seine landed a few numbers of seer fishes and amongst them was a lone Wahoo, *Acanthocybium solandri*. It measured 1 m in total length and weighed 5 kg. This is the first time that the occurrence of this species has been noticed in the inshore waters of the west coast other than at Vizhinjam and Colachel situated at the extreme southwest coast of India. This indicates a northern extension of the distribution of Wahoo along the west coast.

Purse seines landed considerable quantities of little tunny, *Euthynnus affinis* also on 8th October 1982 at Karwar. A closer examination of the catches resulted in the detection of three numbers of Oriental bonito, *Sarda orientalis*. They measured 272 mm, 280 mm and 292 mm in total length, weighing 225 g, 261 g and 332 g respectively, and all of them with sexes indeterminate.

A few numbers of bigeye tuna, *Thunnus obesus* were landed by driftnet units on 19th October at Karwar. Their total length and weight ranged from 375 mm to 425 mm and from 629 g to 833 g respectively.

The occurrence of *Sarda orientalis* from the coastal area of the west coast was also reported earlier from Vizhinjam and that of *T.obesus* from Kavarathi and Lakshadweep seas. The present observations tend to show that they have extended distribution in the coastal waters of the west coast and chances of these species coming into commercial exploitation cannot be ruled out.

Incidentally, *Acanthocybium solandri* and *Sarda orientalis* have also been reported from the area between 15° and 24° N. (55-360 m zone) during the exploratory surveys of M.T. *Murena (Bapat et al., Bull. Cent. mar. Fish. Res. Inst. 33, 1982).*

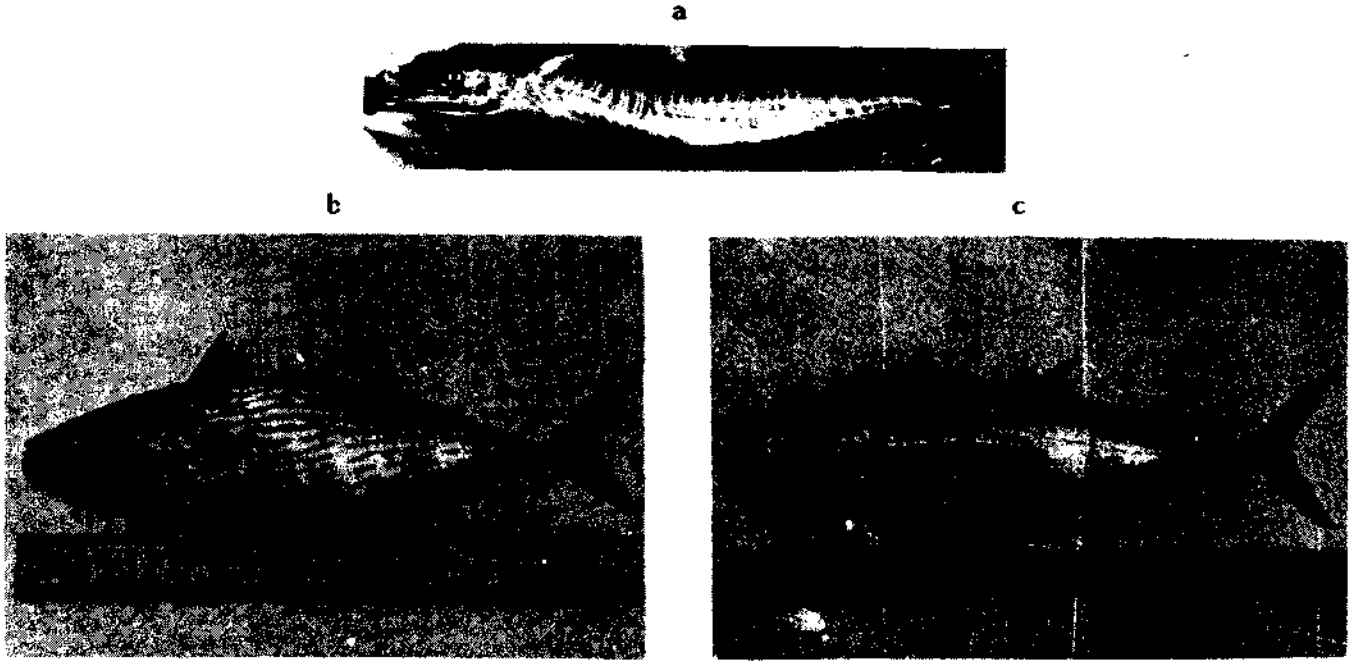

Fig.1. a) *Acanthocybium solandri*, b) *Sarda orientalis* c) *Thunnus obesus*

*Prepared by M.H.Dulkhed, G.G.Annigeri and G.M.Kulkarni.

PROVEN TECHNOLOGY

4. HATCHERY TECHNOLOGY FOR MASS PRODUCTION OF MARINE PRAWN SEEDS*

Highlights: Technology of rearing larval forms of marine prawns to stockable seed size has developed chiefly through Japanese efforts in recent years. Due to varying climatic conditions and occurrence of different candidate species in other parts of the world this technology could not be adopted *in toto* in other countries. It required adaptation to the local conditions. Due to the high priority given to development of prawn culture in our country it has become an imperative need to adapt this technology to our conditions. The Japanese technology relied on use of culture of the diatom *Skeletonema costatum* and the freshly hatched larvae of the brine shrimp *Artemia salina* for feeding the various larval stages. Although the species of diatom is available in the country, maintenance of cultures is rendered difficult due to the prevailing temperature regime. The brine shrimp eggs are too expensive. The method developed at the CMFRI obviates the use of both these organisms and instead relies on cultures of a locally available diatom, *Chaetoceros affinis* and a euryhaline strain of rotifer *Brachionus plicatilis*. Survival rate of 70% has been obtained by use of these organisms as larval feed.

Operational Details: The penaeid egg hatches out into a nauplius which passes through protozoea and mysis stages before it becomes a postlarva. The freshly hatched nauplii are stocked in 2 ton capacity plastic tanks containing settled and filtered seawater of salinity 30-32 ppt, at the rate of 50 larvae per litre. Vigorous aeration is provided from an oil free air compressor or blower throughout the rearing period. In the normal ambient temperature of 28°C the nauplius passes through 6 substages and transforms into protozoea after 2 days. In the last nauplius stage, separately cultured diatom, *Chaetoceros* (200,000 cells) per ml) is added at the rate of 200 litres per tank. This is done after reducing the water level of the tank to the extent of 200 litres. From protozoea I onwards the larvae begin to feed on the diatoms. The feeding operation is repeated every day. After a period of 3 - 4 days the protozoea, having passed through 3 substages, transforms into the mysis stage. At this stage in addition to the diatom culture, frozen rotifer *Brachionus plicatilis* (separately cultured, harvested and frozen into blocks) is also provided as food at the rate of 100 rotifers per larva per day. The mysis passes through 3 substages in as many days and metamorphoses into the first postlarva. At this stage the feeding of diatom is discontinued and frozen cladoceran, *Moina* sp. (separately cultured, harvested and frozen into blocks) is given as food at the rate of 20 per postlarva per day. Five days after they became postlarva they are harvested and counted before stocking in nursery or packing and despatching to the farmers who have nurseries.

From nauplius to postlarva an average survival rate of 70% is achieved although on several occasions survival rates as high as 95% have been recorded.

Fig 1. Live feed cultures at NPCL

Production: The magnitude of production depends on the facilities available. With the existing facilities available at the Narakkal Prawn Culture Laboratory (NPCL) of CMFRI, (6 rearing tanks of 2 ton capacity, 6 fibreglass tanks of 1 ton capacity for phytoplankton cultures, 1 rotifer tank of 40 ton capacity and 4 Moina tanks of 2.5 ton capacity) it is possible to rear 6,00,000 larvae per operation lasting 15 days i.e.1.2 million larvae per month. At the average rate of 70% survival 8,40,000 postlarvae can be produced per month. If 20 numbers of 10 ton capacity tanks are used for rearing and the other facilities are increased proportionately it should be possible to develop a system to produce 14 million prawn seeds per month.

Inventory and cost: It is to be clearly understood that the larval rearing technology is the most important aspect of prawn seed production but a unit of such production can function only along with other technological link-ups such as know-how for spawning prawns under controlled conditions, culturing and maintaining live feed for the larvae and mainte-

Fig 2. Larval rearing pools at NPCL of CMFRI.

Fig 3. A farmer taking consignment of prawn seeds.

nance of live prawn seeds for distribution. While considering a project for commercial production of prawn seeds all the above factors should be considered in an integrated pattern to work out the capital costs. For a unit aiming at a production of 14.0 million seeds per month for a period of 5 years the cost of chief equipments such as Pumps, Air compressors, Generators, Pools/tanks, refrigerator, deep freezer, Dinghies, Out-board motors, vehicles and lab equipments would be round Rs.1.5 million; land and buildings about Rs.1.0 million and contingencies including salaries, labour and maintenance expenditure about Rs.2.5 million (0.5 × 5) totalling Rs.5.0 million for 5 years.

It is difficult to work out the production cost based on the laboratory and small scale operations but on the basis of our experience the production cost of 1,000 seeds cannot exceed Rs.6.00.

Prospects: In the light of the present trend of development of prawn culture there is considerable scope for establishing hatcheries in the coastal districts of all maritime states of the country for distribution of prawn seeds to the farmers. There is also scope for development of export trade on live prawn seeds.

*Prepared by scientists of NPCL.

NEWS-INDIA AND OVERSEAS

New publication in Fishery Science

Tamil Nadu Agriculture University, Fisheries College at Tuticorin, Tamil Nadu, India is bringing out a new publication entitled Journal of Fishery Science. The first issue of the journal is scheduled to be published in January 1983. Annual subscription membership and research papers for publication are invited by the Chief Editor, Journal of Fishery Science, Fisheries College, Tuticorin 628 003. For further particulars kindly contact the Chief Editor.

Devil ray landed in Pondicherry

A huge devil ray was caught in a mechanised gill net operated at 40 m depth off Pudukkuppam, a fishing village in Pondicherry Union Territory, on 21st September 1982. The devil ray locally known as "Kambuthirukkai" was identified as *Manta birostris* with the following measurements:

Devil Ray.

Total length	3.29 m
Length of tail	0.80 m
Breadth	4.26 m
Length of cephalic horns	0.35 m
Distance between cephlic horns	0.70 m
Width of mouth	0.70 m

It weighed approximately 500 kg and the colour was darkish brown dorsally and whitish ventrally.

Reported by E. Palani and L. Chidambaram

Genetic blue lobsters produced

In a pilot aquaculture programme at Montauk, New York the first generations of exotic blue lobsters, representing a giant step in the development of a unique strain of the American lobster *Homarus americanus* have been produced. These animals are naturally brownish in colour. It is estimated that genetically blue lobsters occur in the wild at the rate of one in every 30 million. The brood of juveniles artificially produced from these extremely rare mutants match exactly the deep rich cobalt and pastel blue colouration of their parents.

The new tribe of aristocratic lobsters have resulted from seven years of trial and error research by Dr.Anthony D' Agostino, marine biologist in New York Ocean Science Laboratory. He has finally succeeded in demonstrating in his laboratory for the first time that blue lobsters can be bred with the filial generation faithfully inheriting the shell colour of the parents. He plans to designate the strains derived from the inbreeding of these blue lobsters as *Homarus americanus* var. DAG with the common name of "Montauk Genetic Blue Lobsters".

Aquaculture 8 (3) : 1982.

Energy from the Ocean

At a competition organised by the National Centre for Exploitation of Oceans (CNEXO) and the National Agency for Development of Research (ANVAR) in France, a project for the utilisation of ocean wave energy has been selected for further development. After preliminary trials small power stations of a few megawatts capacity will be developed. The design incorporates a platform with an inclined plane on which the waves break. The water rising above the surface level in this manner drives a turbine while returning to the sea.

GEDUST Bulletin, November 1982.

Compiled and prepared by M.J. George, G. Subbaraju and S.K. Dharmaraja.
Published by Dr. M.J. George, Senior Scientist on behalf of the Director, Central Marine Fisheries Research Institute, Cochin-682 018. Phototypeset and printed at PAICO, Cochin 31.