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ARE THERE ENOUGH SHRIMPS IN THE SEA?

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The subject on shrimps seems very timely indeed, because not a day passes without our hearing or reading something about the shortage of prawns in Kerala. There seems a general agreement amongst the fishermen and the fishery industrialists that the shrimp stocks are on the decline. Such a complete agreement, however, does not exist among the fishery scientists. A considerable apprehension is also being expressed by the other maritime states of India, for they feel that what Kerala is facing today, they might have to face later on. It seems, therefore, important at the outset, before treating the more specific aspects of the topic of this article, to look for the main factors which have led to the existing situation.

Let us assume that there is an acute shortage of prawns in Kerala waters. Was this really unexpected? If the answer is 'no', did we do something about it? Surely, it would be most incorrect on my part to say that it was unexpected, because for the last 8 years or so that I have spent in Cochin, practically every year I have been hearing about the dissatisfaction which the prawn exporters have been expressing towards the availability of prawns, despite the fact that the export figures have been increasing sharply. The answer to my next question, I fear, is difficult; and an answer may perhaps be in the form of another question — what in fact could we do? Let us examine the second question in greater detail.

Early man on this earth, primitive and wild as he was, went about hunting for fish as and when he desired, without impoverishing or modifying the environment. He imposed no undue pressure on the animal communities, which formed his food. Civilized man, on the other hand, from the very beginning introduced changes in the environment which were disproportionate. His interference brought radical changes in the environment which he tried to counter-balance by his scientific knowledge. He succeeded in many and failed miserably in some. To-day, human population is so large, that it is only by the most efficient use of the resources of the sea and land its needs can adequately be supported.

The major problem created by the growth of population is the increased need for animal food and products. The risk has already become apparent with reference to prawns that man's predatory activities, enlarged and intensified as they are by technological advances, may destroy the very stocks on which he is dependent.

Persons involved in business of prawns always thought that this commodity of the sea is free and what they have to do is to go and catch them. Bigger effort would mean still bigger business. They seldom realized that the prawn populations are a part of an ecological system in which physical, chemical and biological forces of great complexity operate and fluctuate year after year. The extent to which these forces lead to the reproduction, survival and growth of not only prawns but of the other constituents in the ecological system on which the prawns are dependent, is the branch of science I have been most interested in for the past several years.

From the data on physical and chemical oceanography which are available now, it appears that the areas of greatest stock density of fish or prawns are normally those which have a high production of microscopic plants (phytoplankton or primary producers). From these data it also appears that the Arabian Sea is more productive than the Bay of Bengal. Even in the Arabian Sea, the coastal waters, where most of our conventional fisheries lie, are many times more productive than the open ocean. One of the most important features of the Indian Ocean is that it is greatly influenced by the monsoon system. During the south-west monsoon, a clockwise circulation of water is established in the sea, but during the north-east monsoon the circulation is reversed *i.e.*, it becomes anti-clockwise. During the premonsoon months (March–April), there is very little mixing of the sub-surface and deeper waters. The mechanism with which mixing occurs, *i.e.* the bottom water from great depths is ultimately brought up to the surface, is called "upwelling"; and this phenomenon is of wide occurrence during the monsoon months along the west coast of India. The upwelled water, though extremely rich in nutrients (phosphate, nitrate etc.), has very little dissolved oxygen; and since it comes very close to the shore, it has a profound influence on the fish and prawn populations. The seasonal upwelling and the associated upward movement of oxygen-deficient water is no doubt a very important factor in replenishing the nutrients of the topmost layers of water and increasing its productivity, but its influence during the season initially becomes a deterrent to fish and prawn life. It very often leads to fish mortality by sudden changes in temperature, salinity or due to the influx of oxygen-deficient water. The enrichment of water with nutrients, following upwelling, produces an accelerated growth of phytoplankton; very often it appears in dense concentrations commonly known as 'red tides', whose decay within the system leads to anaerobic conditions, which become a further threat to animal life. Fish mortality associated with red tides have frequently been reported both from the west and east coasts of India.

The main fishing season along the west coast (leaving aside the bigger boats of 50 ft. and above, which operate throughout the year) generally starts in October and ends in May. The termination of the fishing season is because the sea becomes rough and the weather due to heavy rains is unfavourable for fishing; there is also a general feeling amongst the fishermen that due to lack of fish, fishing in the inshore waters is not very economical. The disappearance of fish shoals from one locality is probably to avoid the poorly oxygenated water, which is very predominant during the monsoon season. Fish seem to migrate towards the other coastal or deeper regions, where dissolved oxygen is not so very low. Trawling, therefore, in such areas where the oxygen concentration is very low is expected to give poor results. If however, to avoid the oxygen-deficient water, the fish migration has taken place towards the surface, the use of indigenous craft and gear, the working range of which is limited to a few metres below the surface, would be very useful, particularly for prawns which have a limited migratory power.

The question again arises, up to what depth does this poorly oxygenated water occur and how long does such a situation last? We have found this oxygen-deficient water from a depth of about 10 metres to 100 metres. It starts from about July and continues till about September; but strictly speaking the areas, depth and time for the occurrence of this type of water are not fully known. Certainly, the upwelling does not seem to be repeated with utmost accuracy year after year. In this respect, the year 1971 was rather exceptional, as the poorly oxygenated water continued to occur from Cochin to Karwar right up to the end of October or early November. It was recorded in exceptionally shallow areas (8 metres or less) this year. Thus, the scarcity of prawns in areas below 10 metres (within the trawling range), in the beginning of the fishing season of 1971, is partly explained.

The most interesting feature of this oxygen-deficient water is that it does not affect the fishery of the oil sardine or mackerel. These fishes being fast swimmers remain within the topmost layers, where the water is well oxygenated (within 10 metres or so) and are generally fished in this zone. It must, however, be noted that as regards hydrographical and meteorological conditions, no two days in the sea are absolutely alike, let alone weeks, months, seasons or years. Therefore, a bad fishery season or its total failure in one year provides no indication whatsoever that it will be repeated the same way during the following years.

Let us now see how the sea conditions influence the life history of shrimps. Prawns are broadly divided into two main groups: (1) Penaeid and (2) Non-penaeid. The former includes those which shed their eggs and sperms in the sea and the latter group is known to carry fertilized eggs attached to the abdomen on the ventral side. The former group forms the chief commodity for export to countries like the U. S. A., Japan and Australia.

Penaeid prawns lay their eggs in the sea, at least 20 to 25 kilometres away from the coast. Each female lays approximately 50,000 eggs. These eggs remain suspended in water for a few hours, and then, from each egg a baby prawn, called larva, hatches out. This larva looks entirely different from the adult prawn. It normally feeds on small microscopic plants by gulping seawater through its mouth and filtering it out through its gills. It changes its form and shape several times, and as growth proceeds, it sheds its outer coat periodically. After about three weeks, it begins to look like a small prawn. This stage is called post-larva. Millions of these post-larvae migrate into the inshore water and estuaries. Very large numbers come to the backwaters every year. In these areas, they feed on all sorts of living and dead material. They grow fairly quickly on the type of food that is available in coastal and backwaters, and when they begin to get mature, they leave the estuaries and coastal waters and go to the open sea for breeding and the whole cycle starts once again. Adult prawns are basically carnivores, but in their natural environment, they feed on both living and dead material and behave like omnivores.

At each step in its life-history, the shrimp faces hazards and enemies. It has been estimated that out of 50,000 eggs laid, not more than 50 hatchlings reach the adult stage. Man-made engineering works in estuaries and coastal water, pollution of water by different types of toxic and sewage discharge, use of insecticides and pesticides reduce the chances of survival of young prawns even to a lesser degree. Recently the introduction of a fresh-water weed (pest) *Salvinia auriculata*, most probably by accident into the backwater system of Kerala, and its phenomenal growth within a short time, has become another menace and probably restricts the migration of young prawns into the estuary. Another species of weed *Salvinia natans* also occurs particularly in ponds, but in fewer patches. This has smaller fronds. Both these species are pteridophytes and their mode of reproduction is by spores.

With this background information, I shall now attempt to put the subject in a better perspective by providing some more information on the prawn fishery. The total prawn production in the world today is of the order of 7 lakh tonnes, of which India's contribution is over 1 lakh tonnes. This places India as the second largest prawn producing country in the world, the first being the United States of America.

Figure 1 gives the total landings of penaeid and non-penaeid prawns and other crustaceans (lobsters, edible crabs etc.) for a period of 13 years, from 1958 to 1970. As can be seen from this figure, the total catch is dominated by the penaeid prawns. Non-penaeid prawns largely come from the Maharashtra and Gujarat states. The crustacean fishery as a whole showed random fluctuations from 1958 to 1964, between 67 thousand and 1 lakh tonnes, but from 1965 onwards there was a steady increase in the landings of penaeid prawns, reaching the highest figure of about 90 thousand tonnes during 1970, in a total of 1 lakh 26 thousand tonnes for the entire marine crustaceans. Of this, non-penaeid prawns contributed about 26 thousand tonnes and the lobsters and edible crabs about 10 thousand tonnes (see Fig. 1).

Figure 2 gives the prawn landings in Kerala for the last 15 years. It is clear from the figure that in Kerala the prawn fishery has been of a fluctuating nature. Some years were bad while others good. Of the past 10 years, 1965 was the poorest year. From 1966 to 1970 a certain amount of consistency in the catches was maintained. In 1969 and 1970, the contribution of Kerala in the total prawn production of India was of the order of 36%, which would place Kerala, from any standard, as one of the biggest prawn producing areas in the world, contributing nearly 6% of the world's total prawn production—an achievement really to be proud of by the Government of Kerala, which has given economic incentives of all types to those who are involved in prawn fishery.

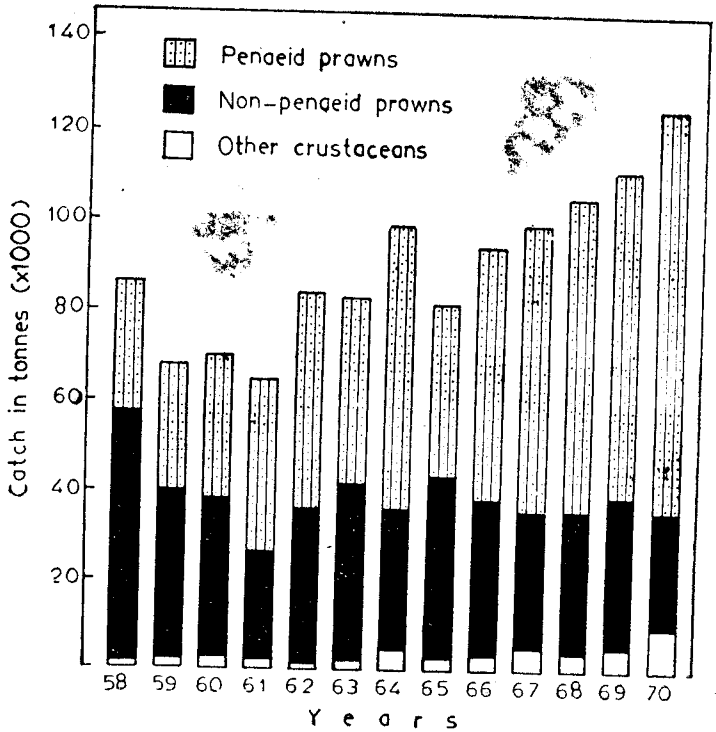


FIG. 1 – *Total landings of marine crustaceans in India from 1958 to l1970.*

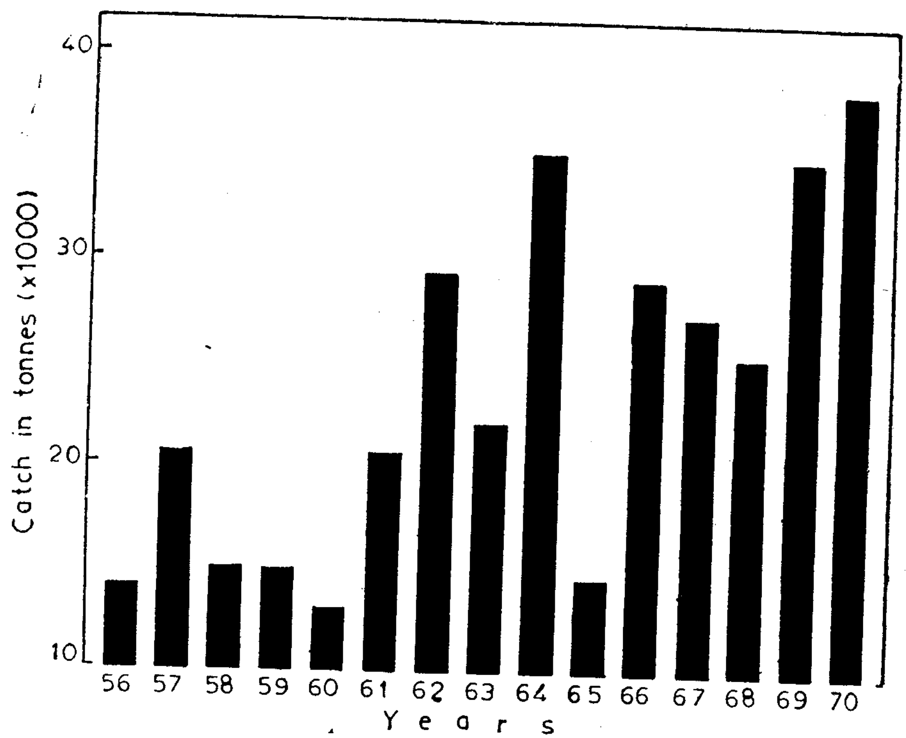


FIG. 2 – *Total landings of marine prawns in Kerala from 1956 to 1970.*

The prawn fishery of India is a multi-species fishery. Among the penaeid prawns alone, the following 5 species largely contribute to the catch: (1) *Penaeus indicus*, (2) *Parapenaeopsis stylifera*, (3) *Metapenaeus monoceros*, (4) *Metapenaeus dobsoni* and (5) *Metapenaeus affinis*.

Figure 3 gives the total prawn catches from the mechanised vessels at Cochin for 6 fishing seasons. The figure also includes the split-up of each year's catch into the 5 species noted above. A close examination of the figure will reveal that the catches of *P. indicus* and *M. monoceros* which are the large-sized prawns have been progressively declining. Instead, the fishery has been largely supported by the medium-sized prawns *P. stylifera*, *M. affinis* and *M. dobsoni*. The purpose of showing the catch statistics for Cochin alone, does not in any way indicate that Cochin is a model or a standard for prawn fishery, but because the most reliable data from the mechanised boats are available only for Cochin. The data indicate a trend in the fishery, largely supported by the three medium-sized prawns, which seems to be of a general nature in Kerala.

The backwaters of Kerala are also well known for their prawn fishery. Figure 4 gives the prawn catches from the backwaters for a period of 5 years (1966 to 1970) From this figure it is evident that good and bad fishery seasons

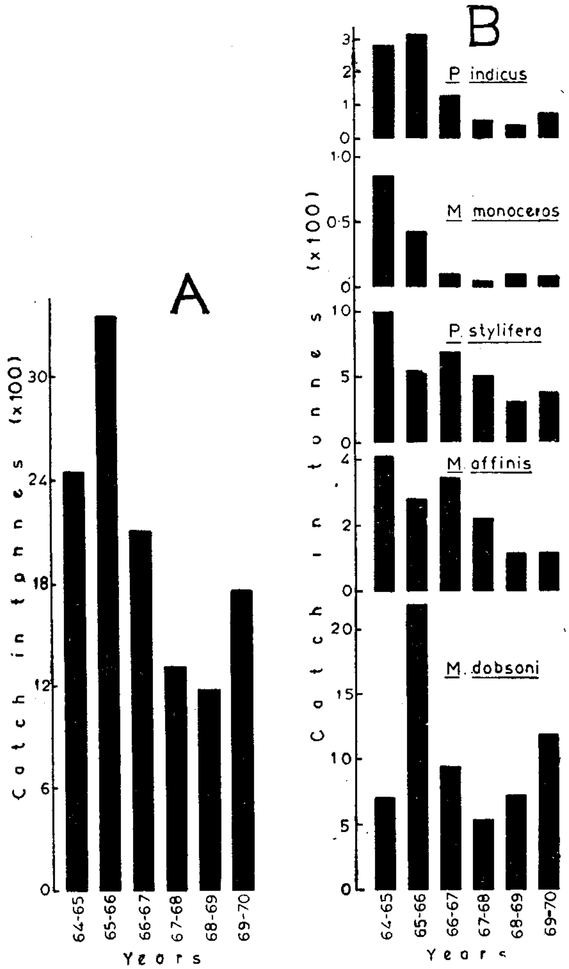


FIG. 3 – *Landings of prawns by the mechanised vessels at Cochin. The A part of the figure shows total landings of shrimps from 1964-65 to 1969-70. The B part of the figure gives a break-up of the catch for each year into 5 different species of penaeid prawns.*

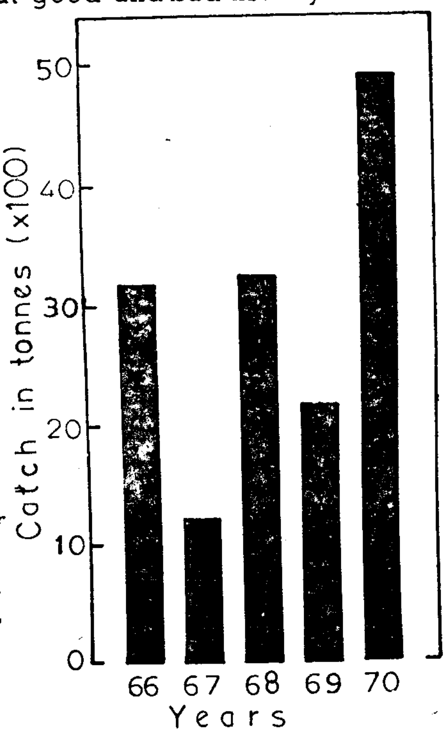


FIG. 4— *Prawn catches from the backwaters of Kerala in different years from 1966 to 1970.*

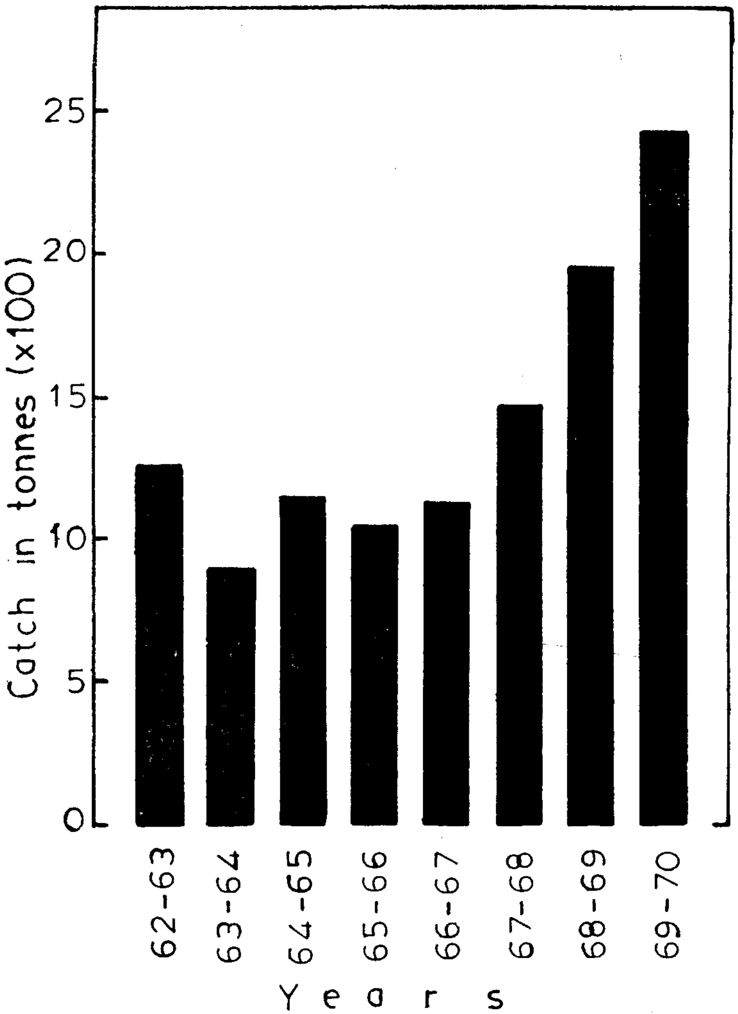


FIG. 5 — *Estimated prawn catches from the Cochin Backwaters by using stake nets during 8 fishing seasons.*

alternate with each other. The year 1970 was the best year with the catch approximately reaching 5,000 tonnes.

Figure 5 gives the prawn catches from the Cochin Backwaters by the stake nets. No decline in the catches by stake nets was recorded from 1965 – '66 season onwards.

The year 1971 is supposed to be a notoriously bad year for prawns, especially for Kerala. Let us first examine the monthly prawn catches for the country as a whole and then for Kerala. Figure 6 gives the catch data for a period of 10 months, January to October 1971. As can be seen from this figure, the total catch of prawns for the period of 10 months in the country is about 1 lakh 22 thousand tonnes, which is slightly greater than the corresponding period of last year which was 1 lakh 7 thousand tonnes. This is largely because of heavy catches of non-penaeid prawns landed in Maharashtra and Gujarat states.

Figure 7 gives the monthly landings of prawns in Kerala from January to October 1971. The total landing for the 10 month period is 24,571 tonnes. For 1970, the total landing for the 10 month period was 27,879 tonnes. Evidently, the figures for this year are lower than those of last year only by about 3,000 tonnes.

Figure 8 (A) gives the total quantities of prawns exported to different countries and their values in Indian rupees. The 'B' part of the figure gives the split-up of the export quantity into three different types — (1) Frozen prawns, (2) Canned prawns and (3) Dried prawns. Two main features emerge from the data presented in Figure 8. Firstly, from 1962 onwards the export of frozen and canned prawns has been constantly on the increase. Secondly, the value of prawns

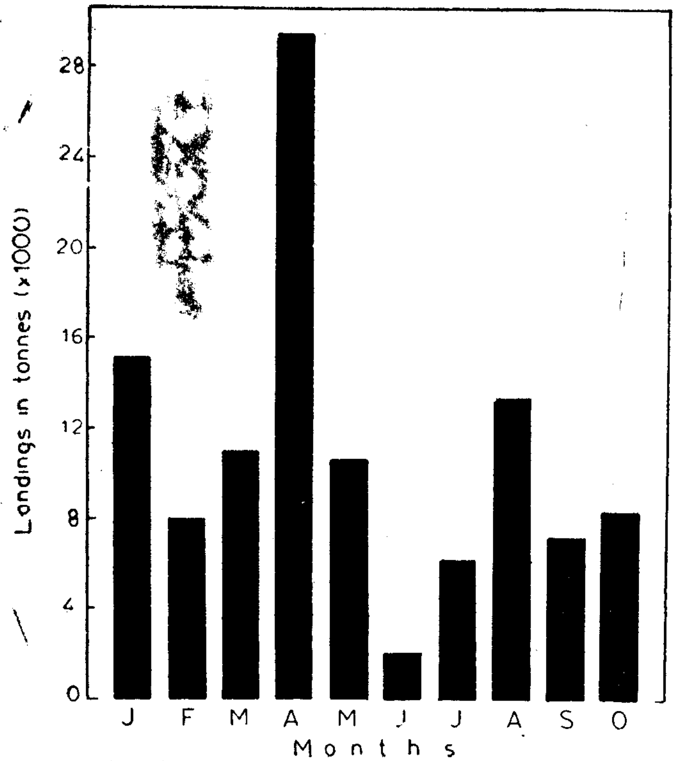


FIG. 6 – *Monthly landings of crustaceans in India from January to October 1971.*

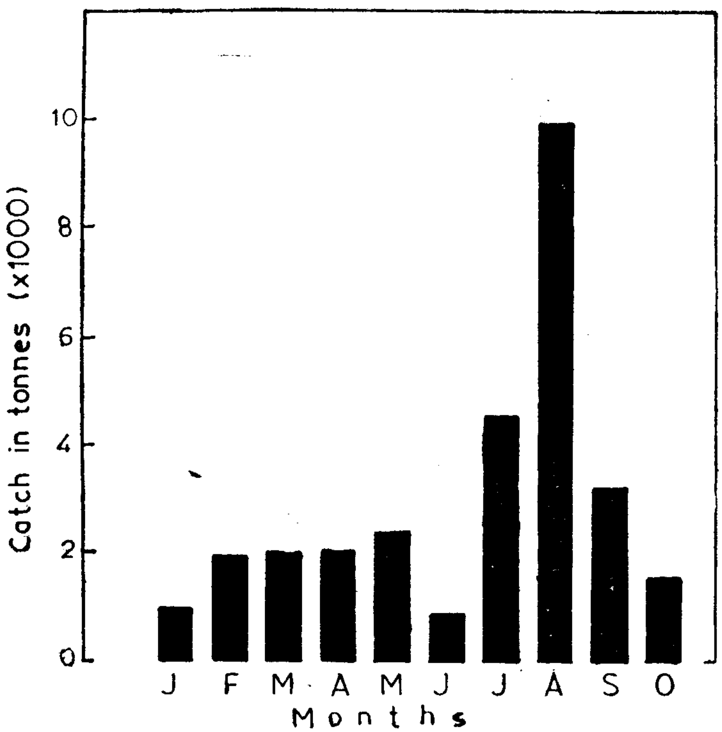
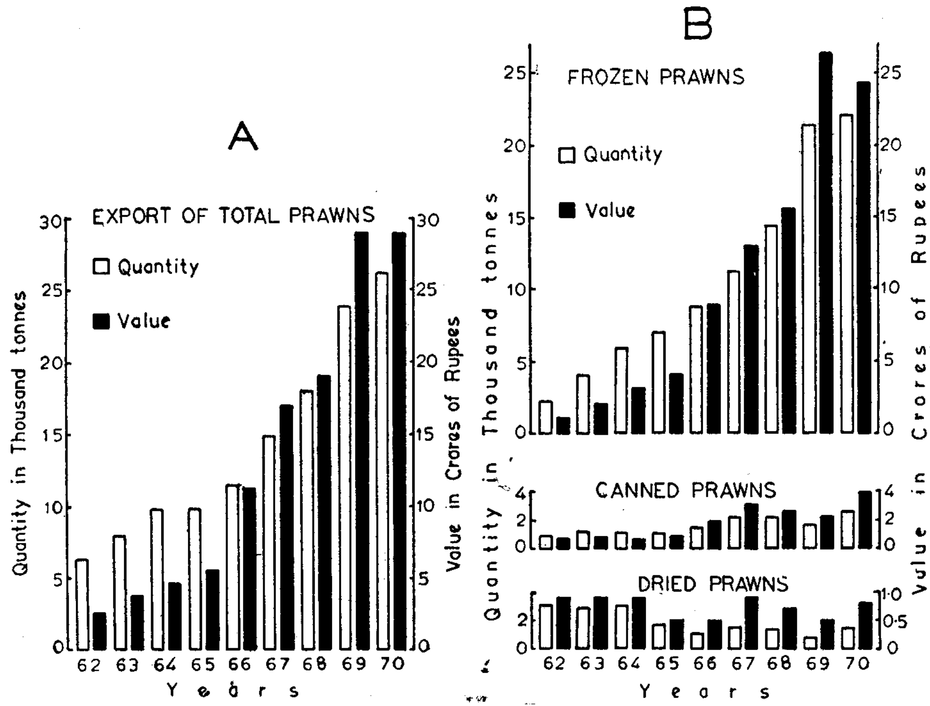
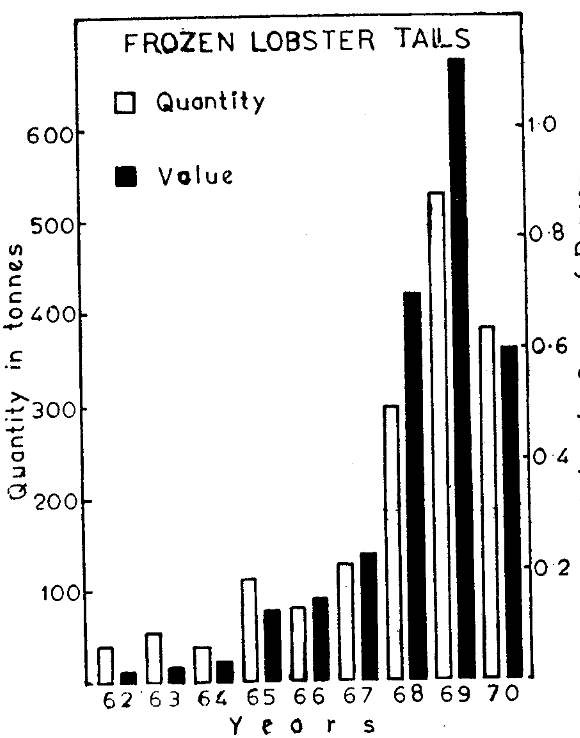


FIG. 7 – *Monthly landings of penaeid prawns in Kerala from January to October 1971.*

FIG. 8 — *Export data of prawns from India. The A part of the figure shows their total quantity and value from 1962 to 1970. The B part of the figure shows the break-up of each year's export into three different categories of prawns and their values.*





in the export market has been rising so sharply that its value since 1962 has increased by at least 4 times.

Figure 9 gives the export of frozen lobster tails. There was a steady increase in the export of lobster tails up to 1969. The value of lobster tails also increased sharply. In 1970, however, the catches of lobster showed a decline and the same year the price of lobster tails in the foreign market fell steeply. This was because, in 1970, Australia made a record export of lobster tails to the United States, resulting in a considerable competition and reduction in price for India. The deep water lobster *Puerulus sewelli* contributed to about 50 tonnes of frozen lobster tails in 1969. Its total

FIG. 9 — *The export figure of frozen lobster tails from India in terms of quantity and value from 1962 to 1970.*

landings were 173 tonnes. In 1970 the total landings of deep water lobster were 77 tonnes. The other lobsters which contributed substantially to the total catch were *Panulirus homarus*, *P. polyphagus*, *P. ornatus*, *P. versicolor* and *P. penicillatus*. These are spiny (rock) lobsters.

It is well known that in fishery yield studies, neither the catch nor the export figures give reliable index of the problems connected with the depletion of resources, because catch is related to effort. If more effort is put in, the catch will continue to increase, until a point is reached when the relation between the two becomes hopelessly lopsided. This is because a boat after putting in 10 hours of fishing will be bringing in as much prawns as it did in 2 hours previously. In other words, 5 boats after fishing for two hours will be bringing in as much catch as one boat did within the same period. As long as the price of the catch goes on increasing, as is evident from Figure 8, even an increase in effort, within limits, will prove to be economical. To understand, however, the situation from the depletion point of view, it is desirable to take into consideration the combined data of catch and effort. Reliable information on these two parameters are available from (1) the medium-sized vessels of the Government of India and (2) the medium-sized vessels of the Indo-Norwegian Project. These boats have been fishing in Kerala waters from 1957 onwards. The data on catch per trawling hour from both these sources have been presented in Table I.

TABLE I

Observed catches of prawns per trawling hour for the medium-sized vessels of the Government of India and the Indo-Norwegian Project from 1957 to 1969.

Year	*Catch per trawling hour, Govt. of India vessels*	*Catch per trawling hour, I.N.P. vessels*
1957	33	70
1958	51	54
1959	27	54
1960	39	45
1961	55	75
1962	37	67
1963	21	23
1964	19	15
1965	16	14
1966	16	14
1967	10	23
1968	6	22
1969	3	23

It can be seen from the table that during the last 13 years, no marked consistency in the catch per unit effort was observed. There was, however, an indication of a decrease in catch per unit effort during the last few years. This would mean that for catching the same quantity of prawns, either more boats, or a greater number of hours of fishing, are required than in previous years. We have no reliable data of catch per unit effort from larger vessels which operate practically throughout the year. However, I would suspect that the larger boats which remain at sea for a number of days fishing for prawns, would get a better catch per unit effort than the smaller boats which spend more time in going and coming for a day's fishing.

The other point which has frequently been mentioned by the industry is the progressive reduction in the size of prawns. This has been attributed to over-exploitation. As has been mentioned earlier, the prawn fishery is a multi-species fishery. The same gear is used for catching the multi-species population from a common fishing ground. The different species caught have a wide range of sizes, so much so that the smallest specimen of a larger species is as big as the biggest specimen of a smaller species. This is in contrast to the prawn fishery of the United States which is largely composed of three species, all these growing to a similar size range.

Figure 10 gives the average size of the commercial species of prawns landed at Cochin by the mechanised vessels.

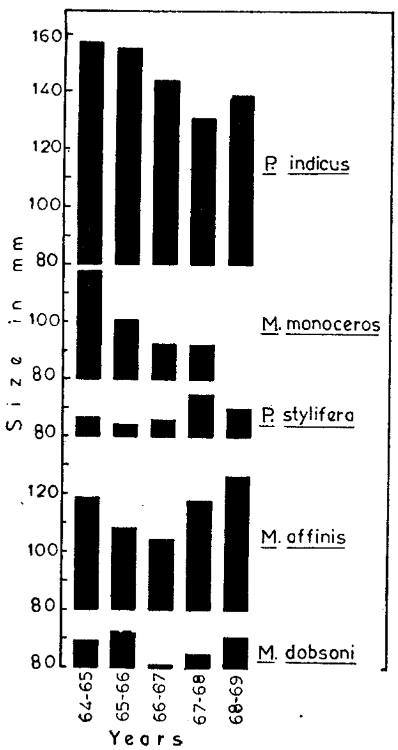


FIG. 10 — *The average size of the 5 commercially important species of prawns in the catches landed by the mechanized vessels at Cochin during 5 fishing seasons.*

Unfortunately the data are not up-to-date. However, from Figure 10 there is an indication of reduction in size from 1964–65 to 1967–68 in *Penaeus indicus*. This is more clearly seen in *M. monoceros* (Fig. 10). In the other three species there are no indications that the size of prawns has decreased as a result of exploitation.

Let us now come back to the original question "Are there enough prawns in the sea?" From the foregoing account it would appear that there are indeed enough prawns to support an industry of the magnitude that exists in India today. It would be totally unrealistic to assume, as has frequently been mentioned, that a stage has reached when most of the industries should close down. Seafood industry, like any other industry, has many other problems, and all these cannot be attributed to one single factor—the natural shortage of prawns. Fluctuations in all types of fisheries are well known the world over. All stocks, including those of the terrestrial plants, which are replaced by a process of natural reproduction, are subjected to annual fluctuations. The yield from an orchard (mango, orange or coconut) does not remain the same year after year, despite the fact that its cultivation can easily be controlled at will. In contrast to the land crops, the fish crop is not normally visible to the human eye, as it remains submerged in water. The amount of uncertainty and risk which the fishery business offers, coupled with a big margin of profit, makes it a most interesting and exciting form of trade.

However, in our own interest, we will be obliged to put a limit to the word "*enough*" fairly soon. It seems likely that what is enough (probably the maximum) has almost been attained with respect to some areas of the sea. Nevertheless, any management policy must be based on clear-cut evidences and hard facts. If the maximum is already attained, then by increasing the effort the annual catch will not increase substantially. In any case, it would be very desirable, without putting the industry out of gear, to specify the target and then provide practical means to achieve it within limits every year. If the industry wishes to have bigger sized prawns, it can either be achieved by reducing the effort or by increasing the mesh size of the nets used at present, so that larger sized prawns are caught. Both these measures are not easy to implement, as these would involve a substantial reduction in the catch every year to which the industry may not agree. Moreover, any mesh regulation would put the multi-species fishery into a state of confusion. The ideal solution, therefore, appears to be to stabilise the exploitation of shrimps in Kerala at its present level. If, however, a considerable increase is our objective, certain principles of husbandry will become inevitable and these will have to be applied to the marine environment. In fact, we should not wait for the traditional methods of fishing to fail before starting culture practices for prawns as an absolute necessity.

Table II gives the estimates for fish and prawn harvest from the fishable areas of the sea, using traditional fishing methods. The table also gives the yield per hectare in areas where culture practices are adopted with certain species. The values will indicate that the difference between the two is enormous. In culture activities, man's deliberate intervention in the environment has led to phenomenal increase in the production of food resources. In Kerala, short-term shrimp culture in paddy fields has been in existence since ancient times. Today about 4,400 hectares of paddy fields are being utilised for prawn cultivation. The culture practice is seasonal and is carried out in those months of the year when the fields are free from rice cultivation. Soon after the single crop of paddy is harvested in September or October, the paddy fields, adjacent to the backwaters, are leased out for prawn culture. The fields are prepared and partitioned with embankment or bunds, which are designed to regulate the flow of water.

TABLE II

Annual yield of different seafoods obtained from various regions

Area	*Seafood*	*Yield in kilograms/ Hectare*
Continental Shelf	Trawl fish	15-75
Continental Shelf	Pelagic fish	375
Continental Shelf	Prawns	28
Kerala	Prawns cultured in paddy fields	1,500
Japan	Prawns (by culture)	6,000
Japan	Oysters (by culture)	57,500*
Spain	Mussels (by culture)	300,000*

* Yield not including weight of shell.

During the high tide the water is allowed to flow into the field and with the flow of water, the juvenile prawns from the backwaters enter the paddy fields. At low tide the water is allowed to flow out of the field through bamboo screens or meshed outlets to prevent the young prawns from escaping. The season generally lasts from November to April, during which period the prawns attain sufficient growth and then they are periodically filtered during the low tide through a hand net placed at the outlet. The fishing operation is carried out when there is either full moon or new moon.

As Table II will indicate the yield from the sea by exploiting natural populations of prawns is of the order of 28 kg/hectare. In paddy fields where prawn culture is undertaken for about 6 months in a year, it is about 1,500 kg/hectare. India has very large natural water resources, which are well suited for prawn farming. Estuaries, backwaters, low-lying areas, swamps and lagoons amount to approximately 7,68,000 hectares. In Kerala alone 16,000 hectares of backwaters, ideally suited for prawn farming, are available. If we are able to get approximately the same yield of prawns as in Japan (6,000 kg/hectare see Table II), or even half of it, the total yield would be unbelievably large.

At the Central Marine Fisheries Research Institute, we have been conducting experiments on the rearing of larval prawns for the last few years. The main purpose of these experiments is to develop a technical know-how and competence in prawn farming. In some species of prawns, considerable success has been achieved in rearing them right through the critical stages of their life-histories. We are now ready to make field trials, and once the whole procedure is worked out, it would be available to the industry for a new venture — "develop your own prawn resources and export as much as you can".

Human population in India is increasing at the rate of 12 million persons per year. For these 12 millions we need 2.5 million tonnes of extra food-grains in the form of rice, wheat, cereals etc., 500,000 tonnes of additional vegetables and fruits and 800,000 tonnes of additional animal food in the form of fish, shrimps, sheep, poultry etc. Today, shrimp is becoming a luxury food item. If the shrimps are going to meet the everincreasing demand, some radical changes are necessary to develop a complex technology in which biologists, oceanographers, marine engineers, technologists, dietitians and economists could work together to increase the prawn production at a substantially lower cost — an achievement at present enjoyed by the poultry industry.