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PRAWN FISHERIES OF INDIA

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PRAWN FISHERIES OF INDIA

by

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The Prawn Fisheries of India rank, from the point of view of production, second only to those of the United States of America (F.A.O. Fisheries Statistics, 1950 to 1953[1]). A number of more or less detailed accounts concerning them have been published (Rai, 1933; Panikkar 1937; Chopra 1939 & 1943 and Naidu 1939). The species of edible crustaceans inhabiting the seas, brackish waters (backwaters), lakes and rivers of India are numerous and practically all of them, excepting the smaller crabs, contribute considerably to subsistence fishing. Those commonly known as prawns (shrimps) are commercially the most important among them, forming as much as 90 per cent of the total landings. In certain areas, especially on the West Coast, the catches of prawns as a group may be more than those of any other single group of fishes. One of such areas is the south-western extremity, comprising the State of Travancore-Cochin and an equally important area is the Bombay Coast, where prawn landings have shown substantial increases in recent years. The statistics of production of prawns from the different sectors of the Indian Coast will help to form an idea of the important position which they occupy in the coastal fisheries. These are given in Tables I to VIII which are self-explanatory.

Fishing Grounds :

Based on the environment in which the prawns are found, it may be convenient to recognize three categories of prawn fisheries, namely, marine fisheries, estuarine and backwater fisheries and freshwater fisheries.

The known fishing grounds in the open sea are seldom situated far away from the shore. Usually fishermen restrict their operations to the shallow areas within the 10-fathom line. During the monsoon months of June to August on the Malabar Coast shoals approach the shore so close as to make it possible for fishermen to use the cast net for catching them. Fishermen of the Bombay Coast do not, as a rule, go beyond 10-12 miles off the home ports, and if large towns are situated within a short distance from such ports, the fishery gains in importance, since the fishermen are able to get better returns.

The Gulf of Kutch area is also an important prawn fishing centre.

The rich prawn fisheries of estuaries and backwaters or saline lakes both along the east and west coasts of the country are probably more important from the point of view of present output than the marine fisheries. Detailed statistics for these are, however, not available. The brackish nature of the water and abundance of food material in the form of animal and plant detritus provide extremely favourable conditions for the growth of young prawns, immense numbers of which migrate into such areas every year. The long chain of lakes commonly called backwaters extending along the coast of Travancore-Cochin and South Malabar and the mouths of numerous hill streams in the Malabar and South Kanara Districts yield large quantities of prawns annually. The Ennore, Pulicat, Collair and Chilka Lakes on the east coast and the Gangetic Delta are also similar prawn fishing areas. Of these the Chilka area is probably the most important in production, but the other areas are potentially important, although often not fully exploited at present.

Various species of fresh water prawns are fished from rivers and other bodies of fresh water throughout the country. Some of them are caught from the brackish-water lakes also in certain months when the salinity is low, since the prawns migrate into them temporarily, chiefly for breeding (Kemp 1915).

Species caught :

The marine prawns fished along the Indian coasts are chiefly members of the Penaeidea. Other families of Decapoda Natantia do not occur in large concentrations and there is no commercial fishery of sea prawns based on families other than the Penaeid group. The most important commercial species are *Penaeus carinatus*, *P. indicus*, *Metapenaeus*

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[1] In 1953 the shrimp production of U.S.A. was 107,000 metric tons, and of Japan 73,400 tons, while the average annual production of marine prawns in India for the past five years is 94,713 metric tons (Vide Table I).

monoceros, M. affinis, M. dobsoni, M. brevicornis and *Parapeneopsis stylifera.*

P. carinatus is the largest, reaching a length of 10-11″ and is brightly coloured. In most places, however, it is not caught in such large numbers as the others.

P. indicus grows to about 9″. This and its abundance, practically along the entire coastline, make it probably the most important commercial species.

Of the 4 species of *Metapenaeus*, the first two grow to about 5″, the other two are smaller. *M. dobsoni*, though rather small, seldom growing over 4-4½″ in length, is caught in enormous numbers, especially from brackish water areas of the backwaters of Travancore-Cochin and the Pulicat and Ennore Lakes.

M. brevicornis is the commonest penaeid of Bengal, large numbers of which are caught from paddy fields in the low lying areas.

Parapenaeopsis stylifera, fished in large numbers along the south-west coast during the warmer months of the year is peculiar, since it does not migrate into brackish water as the other species.

Among non-penaeid prawns species of Leander, especially *L. styliferus*, contributes substantially to the catches in the Gangetic Delta and on the Bombay coast. In Bombay it forms a sea fishery whereas it is an estuarine fishery in Bengal.

Shrimps, seldom exceeding an inch in length, belonging to various species of the genus, *Acetes*, occur in vast shoals along the coast in certain months. They are then caught along with other prawns and fish and are marketed when other crustaceans are rare. In the Mandapam area, it contributes to a summer fishery.

The species caught from estuaries and backwaters are the same, excepting *Parapenaeopsis stylifera*, which rarely occurs in such localities. One important characteristic of the catches from these areas deserves to be emphasized, namely, that the vast majority of the prawns are young and immature, the fully grown mature ones being caught only from the sea.

The prawns caught from fresh water are species of *Palaemon*. They occur practically all over the country. Among them *P. carcinus* is the largest, fully grown specimens reaching about a foot in length. It is caught in appreciable numbers from the backwaters of Travancore-Cochin during the months of September, October and November. *P. idae* is similarly common in these waters from September to December. Several species of *Palaemon* along with penaeids form a very important fishery in the Collair Lake (in Andhra State) on the East Coast of India. It is a characteristic feature of such coastal lakes that they have a predominant *Palaemon* fishery during the rainy season when the water is fresh or nearly fresh, with Penaeids increasing in numbers during the following months when the salinity rises. Later, in the summer months the yield consists entirely of Penaeids. The species of importance in the Collair Lake are as follows :—

Prawns of Collair Lake

Species	*Remarks*
Penaeus indicus	Mainly salt water species found in Upputeru and further down
Penaeus carinatus	Mainly in salt water—occasionally in fresh water regions of the lake
Metapenaeus monoceros	In fresh and salt water
Palaemon carcinus	Mainly fresh water species tolerating brackish water
Palaemon malcolmsoni	Do. do.
Palaemon scabriculus	Only in fresh water
Palaemon rudis	Occasionally in brackish water

A similar distribution of species is also found in Pulicat and Chilka Lakes and other smaller coastal lakes on the East Coast of India.

Fishing Methods :

The boat seine is one of the commonest types of nets used for commercial prawn fishing in the sea along both the south-west and south-east coasts. Fishermen seldom go beyond a depth of about 10 fathoms. The net may vary to some extent from region to region in respect of minor details ; but it usually has a bag-like part and a couple of wings projecting forwards. Two canoes of the dugout type with about 8-10 men are engaged in operating it on the south-west coast. On the east coast catamarans replace canoes. Besides prawns, various species of small fish are also usually caught by the same gear.

Another type very extensively used in estuaries and backwaters, creeks and shallow inlets of the sea etc. is a conical net with floats above and weights to anchor it or supported on pairs of stakes driven into the mud. Its size is variable, some of the largest in use along the coast of Bombay being 500-700 ft. in length with a mouth of 200-300 ft. in circumference. They are usually set against the tide, which sweeps the prawns into them, and are hauled up at the turn of the tide. Fishing with such stake nets is carried on throughout the year in the backwaters of Travancore-Cochin, wherever the tides are not too feeble.

Several variants of this method are in existence in different parts of India, but it may be emphasized that even small operating units give good yields and revenue to the State. For example, stake nets are a common feature of canal systems near the coasts. In the canals intersecting the Vypeen Island in Travancore-Cochin (Narakkal is a village in the island), the net is fixed at the end of two bamboo fences converging towards the middle from either bank of the canal. The right of prawn fishing in these canals is yearly auctioned by the Department of Fisheries of the State. The two main canals in Narakkal village, Bandar, and Appangad Canals which are auctioned together, are, according to the Department's estimate, expected to give an annual yield of about 110 cwts. of processed prawns (dry meat). The fishing rights are auctioned; the amounts realized in the auctions during the last three years are given below :—

1952-53	Rs. 12,000
1953-54	11,300
1954-55	9,100

The Chinese Dip nets, which are so conspicuous along the shores of the chain of lakes in Travancore-Cochin, also catch considerable amounts of prawns, particularly from the backwaters, practically all the year round (Panikkar, 1937).

The cast net, the drag net, a variety of wall net etc., are some other types of nets commonly used in various parts of the country to capture prawns.

The extensive paddy fields adjoining the backwaters and canals of the northern part of Travancore-Cochin form rich prawn fishing grounds, with an annual production at a modest estimate of about 4,000 tons of prawns. The estimate is based on the figures collected by the Central Marine Fisheries Research Station. The method adopted and data relating to various aspects of the fishery were given in the paper read at the last meeting of the Council (Menon, 1954). The high degree of efficiency reached in this type of fishery can be realized by the average yield per acre per annum which frequently exceeds a thousand pounds.

Mention may also be made of certain ingenious devices employed in some regions. In the Chilka Lake the Oriya fishermen construct long fences of about 50′ in length, with a ring of traps at the inner end of each in shallow water about 3′ deep. The habit of the prawns moving along the shore at night is taken advantage of in this method. The fence guides them into the enclosure and thence into the traps themselves at day-break.

In the shallow stretches of the brackish water lakes of Travancore-Cochin and connected canals two canoes connected by two short bamboo poles (fore and aft) with a heavy iron chain fastened by its two ends to the bows of the canoes are used. When the canoes are poled along, the chain moves over the mud at the bottom, scaring the prawns. They jump out of the water and almost always fall into the canoes where they are trapped. Gopinath (1953) has given a detailed description of it recently under the name ' prawn junkhar or pachil ' and has pointed out that it is similar in principle to the prawn ' seriat ' of the Malay Archipelago and Burma and to the ' Rua Kread ' of Thailand.

Craft :

The craft used are generally the same as are commonly used for fishing in each area.

Seasonal Variations :

Though a few prawns may be caught throughout the year at various points along the coast, the marine fishery is largely seasonal. On the west coast the season generally coincides with the monsoon period, June to September, so far as the southern region is concerned. In other months, particularly from October to April, few fishermen go for prawns and small species of fish, since they find it more profitable to go for sardines and mackerel, these months forming the season for their fisheries. Investigations conducted at the West Hill Sub-Station of the Central Marine Fisheries Research Station, have shown that prawns are not absent in the coastal waters, though they may not be quite so abundant as in the other months.

August to October are the best months in the Bombay area and July to September, extending in places to December, the season in Saurashtra. The season starts soon after the North East monsoon on the east coast and may last till about April; but in the Collair Lake, it extends from May to December.

The backwaters of Travancore-Cochin provide an exception to this, since the stake nets and Chinese nets catch appreciable quantities of prawns throughout the year although the peak of the fishery is in the months October or November to April.

Management and Regulation :

The only regulation now in existence is in respect of the paddy field fishery which is allowed to operate from about the middle of November to the middle of April. This is done not so much in the interest of the fishery as in that of rice cultivation.

The methods of fishing now in vogue do not involve the destruction on any appreciable scale of prawn fry and leave sufficient numbers of breeding females to replenish the stock. The fear of depletion has not therefore arisen anywhere and thus no serious problem in management, requiring regulation of the fishery, has confronted the Governments of the various States.

II. Technology and Marketing :

Prawns which are intended for local consumption are taken to the markets as soon as possible after being landed. Hawkers carrying baskets of prawns (fish also) for door to door sale are a common sight in the coastal villages of Malabar and Travancore-Cochin. Those intended for despatch in the fresh state to inland towns are packed between layers of ice either entire or after removing the chephalothorax. Small quantities of prawns are sent by rail packed in ice from Chilka Lake to the Calcutta markets. Recently increasing consignments of West Coast prawns have been reaching the Madras markets. Prawns are also sent by rail to nearby towns from the Railway Stations adjoining the Collair and Pulicat Lakes. The quantity of prawns consumed by fishermen on the basis of subsistence operations appears to be fairly large in India.

Freezing.—During the last few years a small freezing plant has been working at Cochin. Only prawns are frozen at present. The capacity of the plant is one ton per day and the time taken for the freezing to be complete is about 24 hours. Prawns up to a size weighing 30-35 to the pound are frozen directly, after removal of cephalothorax, in blocks weighing about 5 lbs. Smaller ones weighing upto 60 to the pound are also frozen after being boiled and shelled. The chief market for the product is the United States of America. The present output is of the order of 500 cases per month, each case containing 50 lbs. Development plans of some of the States include setting up of new Prawn Freezing Plants.

Drying.—Several methods are in vogue for curing prawns. One of the simplest is spreading them out in the sun for drying. They are then marketed as such or after they are shelled.

An improved method adopted extensively is to boil the prawns before drying. Boiling is done in metal containers (even kerosene oil tins in some places) with just enough water to cover them. Extra salt is sometimes added. After drying for 2-3 days they are put into gunny bags and 'threshed' with sticks or by beating the bags themselves on wooden blocks. The shell pieces are removed and the dry meat packed in bags mostly for export. The dried prawns thus made are of fairly good quality in the Cochin area. In some places, notably in the Kutch area, the curing is done in a very crude manner so that the final product happens to be very poor in quality and unattractive in appearance. Prawns processed in this manner have only a limited market in India, the bulk being exported to other countries.

Smoking of fresh prawns for about 4 hours is done in the Collair Lake area. The smoked product has not yet become popular with Indian consumers.

Semi-drying, a process popularized by the Madras State Fisheries Department, has certain advantages over the other methods, inasmuch as the product does not deteriorate even if kept for months, and when soaked again in water, tastes like fresh prawns (Naidu, 1939). In this method prawns are first boiled in 6% brine for about 2 minutes and then removed and shelled. They are then immersed in saturated salt solution for 15-30 minutes. Drying is done in the sun or by artificial driers, but the flesh is not allowed to become quite hard. An account of this process with recent developments is given by Venkataraman, Sreenivasan and Vasavan (1953).

Pickling of boiled and shelled prawns in vinegar or weak toddy with condiments and spices is carried on in Malabar as a cottage industry (Chacko, 1944). Home pickling of prawn is also popular in Malabar.

Marketing and Distribution.—It may generally be stated that marketing is seldom done by the fishermen themselves, except by a few who are fortunate enough to own their own fishing implements. Usually the catches pass into the hands of middlemen, to whom the former are bound to deliver the catches, because of prior commitments, and it is these men who usually undertake the responsibility of marketing.

In Saurashtra (Government Publication, 1953) a few merchants buy dried prawns wholesale from the fishermen, who would have taken advances from them, and are therefore bound to sell their products at fixed prices, usually quite low. These merchants are only agents of business interests in Bombay, who are well informed about the outside markets, and who are therefore in a position to make the maximum profit from the transaction.

In the Travancore-Cochin area a good portion of the catches of fishermen is bought by merchants who process them. The paddy field fishery is mostly in the hands of men who are able to invest the capital required for obtaining the land on lease and for meeting other initial expenses, very few fishermen being in a position to command it. They do the fishing and processing themselves by engaging hired labour when needed. The product is usually sold to wholesale dealers at Cochin, who export it to Burma and other eastern countries, where it finds a ready market. The price paid to the producers is never so low as in Saurashtra, but is generally in accordance with the prevailing market rates. It has varied from Rs. 500-1,000 per candy (a candy = approximately 6-1/3 cwts.) this year. Despite this, their margin of profit at present is not large, because of the high rents they are forced to pay to the land owners. The Department of Fisheries of the Madras Government has its own agency for distributing the semi-dried prawns processed under its auspices, to merchants and consumers. Exports of dried prawns* from Travancore-Cochin during the past three years are as follows :—

1952-53	..	.. 3,991 tons
1953-54	..	.. 5,322 tons
1954-55	..	.. 4,368 tons

The approximate value of the 1954-55 exports would be of the order of Rs. 14,600,000. Owing to the cancellation of the Open General Licence for importing dried prawns into Burma there is a recent crisis in the industry, as large stocks have accumulated with the dried prawn merchants, who are therefore interested in developing new markets for this product.

III. Biology :

Much remains to be known of the biology of Indian prawns. The Prawn Research Unit of the Central Marine Fisheries Research Station has been mainly engaged in biological investigations relating to the penaeid species common along the south-west coast and has succeeded in collecting a considerable amount of data on several aspects. Along with these general investigations, more detailed studies were also undertaken on individual species. *M. dobsoni*, one of the most important southern species, was the first to be selected for such a study and this work has been followed by work on *P. stylifera* and *P. indicus* (Menon 1951, 1953 and 1954).

Spawning and Maturation.—So far as is known, all species spawn only in the sea. *M. dobsoni* and *P. stylifera* (Menon, 1951 and 1953) liberate their eggs mostly in coastal waters not more than 10-12 fathoms in depth. *P. indicus*, however, seems to prefer deeper water, its eggs or larvae having been seldom obtained along with those of the former. The breeding period is fairly long and continuous in regard to the two smaller species : November-March (*M. dobsoni*) and October-December (*P. stylifera*). In the case of the larger species *P. indicus* a certain amount of evidence has been collected indicating the existence of two such periods October-November and May-June. Both of the first two become mature in the first year of life, the males of *M. dobsoni* maturing in backwaters also.

Early Life History.—The life history of only *M. dobsoni* has been completely followed and it agrees closely with those of other species, several of which have been studied by various scientists. Eggs hatch out in the form of nauplii, which undergo three moults to pass into the Protozoea stage. The latter again moults thrice before becoming the Zoea or Mysis. The Mysis also sheds its skin the same number of times and becomes a post larva. It gradually acquires most of the adult characters in a succession of moults, generally twelve in number. Compared to the larvae of *P. japonicus*, *M. monoceros* and *M. affinis* (Hudinaga 1942) the only notable difference which the Indian species shows is in respect of the number of moults of the nauplius, it being six in the Japanese species.

Growth and Longevity.—Rearing experiments and statistical analysis of length measurements (length frequency curves from month to month) have made it possible to arrive at certain conclusions regarding the growth of *M. dobsoni* during the first three years of its life.

	First	*Second*	*Third*
Male	about 70 mm.	90-95 mm.	110 mm.
Female	,, 75-80 mm.	100-105 mm.	120 mm.

These figures also bring out the fact that growth rate of females is higher than that of males and that it becomes apparent even in the first year of life. The maximum size attained by the two sexes consequently shows some difference.

Length frequency studies carried out in regard

* Dried prawns with shells constitute about 33% of the fresh weight and shelled dried prawns constitute 16% of the fresh weight.

to *P. stylifera* have led to the inference that this species grows in the course of a year to 90-100 mm. in length. Evidence is also available which tend to show that after maturity females grow faster than males.

The data presented above indicate that *M. dobsoni* lives for about 3 years. It is not possible at present to state definitely if the maximum length of life is only 3 years. What can be safely concluded is that during the course of our observations extending over 4 years, the catches, both commercial and departmental, did not contain prawns that were recognizably older. Similarly *P. stylifera* has been noted to live for 2 years. Data collected so far do not permit of definite conclusions in regard to the other species. Srivatsa (1953) is inclined to believe that the life span of prawns of the Gulf of Kutch is from 12-14 months and that they probably die after spawning.

All penaeid prawns studied here, with the exception of *P. stylifera,* migrate into estuaries and backwaters quite early in life in the post-larval phase. A large proportion of the post-larvae of *M. dobsoni* and *P. indicus* collected from such localities measured less than 6 mm. and 10 mm. respectively. Immense numbers of such fry pass into these brackish water areas almost continuously throughout the breeding period, as evidenced by the collections made by the Unit from the Main Canal of Narakkal. They grow for some months in such environments and then go back into the sea, where further growth and attainment of sexual maturity take place. The seaward migration seems to be largely a passive process, since they are usually carried by the large influx of rainwater flowing into the sea during the monsoon period.

Food and Habitat.—It is now well-known that the food of prawns consists of the detritus, both animal and plant, that accumulate at the bottom of their habitat and that they prefer areas with a muddy bottom. Along with this detritus they naturally take in large quantities of sand and mud. Examination of the stomach contents of numerous individuals has revealed the presence of plenty of diatoms, particularly when they are abundant in the plankton. Both *M. dobsoni* and *P. indicus* seem to consume large quantities of algal matter when available, some of the stomachs examined having been practically full of it. *P. stylifera* is apparently an exception to this habit since, excepting diatoms, plant matter was rarely noticed in the stomach contents. Small living creatures like Molluscs and worms, etc. living at the bottom may also be taken in.

Mud Banks.—On the South West Coast of India large concentrations of Penaeid prawns are usually found in the mud banks of the Malabar Coast. These mud banks are a characteristic feature of this coast and is probably the result of intense churning of the sea bottom during the heavy South West Monsoon, resulting in fine silt being suspended in definite patches along the coast and this is also probably connected with certain special geological features which are not yet fully understood. There is usually a heavy accumulation of nutrients (Phosphates and nitrates) in the mud banks (Seshappa, 1953). Prawn fishermen of the Travancore-Cochin Coast are well aware that in the *Chakara* or the mud banks the prawns are found in large numbers and they invariably carry out fishing operations in the placid waters of the banks.

Physiology of Prawns.—From the physiological point of view the prawns belonging to the families Palaemonidae and Penaidae are of great interest. The marine Palaemonids of Europe, i.e. *Leander serratus* (Common Prawn) and *Leander squilla* and the brackish water *Palaemonetes varians* are hypotonic to their surroundings when in sea water attaining isotonicity only in sea water of salinities 25, 25 and 22 parts per mille respectively (Panikkar 1940 & 1941). This behaviour is unusual for marine invertebrates and is associated only with certain groups of Crustacea in the coastal environment. It is not found in the Pandalidae or other true marine families of prawns. The Penaeid prawns on the Indian Coast have an osmotic behaviour similar to marine Palaemonids and the hypoosmotic regulation is associated with powers of regulating the chloride content of the blood when the prawns are in media of different salinities (Panikkar & Visawanathan, 1947). Recent work on ionic regulation has confirmed these findings on Palaemonids (Parry 1955). The ability of the Indian marine Penaeid prawns to migrate easily into coastal lakes and estuaries is correlated with their homoiosmotic behaviour and forms, like *Leander styliferus* at Bombay, have a habitat similar to *Leander serratus* in Europe, while it is mainly an estuarine prawn in the Gangetic Delta. The higher salt content in the blood of freshwater Palaemonids as compared with other freshwater invertebrates enables them to migrate more easily to brackish water even up to salinities not tolerated by several true freshwater species. Among the Penaeids the species most tolerant to changes in salinity is *Metapenaeus monoceros* which occurs in sea water, brackish water and in water that is nearly fresh. Even this species is not known to breed in brackish water, although this species or a close relative is known to breed in such waters in Australia.

Both in Penaeids and Palaemonids the sexually mature forms are less resistant to salinity changes than the juveniles. The migratory movements are probably connected also with the optimal salinity requirements of sexually mature prawns and of egg-bearing females in the case of Palaemonids.

Taxonomy

Order	*Decapoda*
Sub-order	*Natantia*
Tribe	*Penaeidea*

Family : 1. *Penaeidae :* Last 2 pairs of legs well developed—gills many.

Sub-family : *Penaeinae.* Exopodites on all maxillipeds and usually some legs. Arthrobranchs in double series. A leaflike appendage on inner side of 1st antenna.

Genera :

I. Rostrum serrated on both edges ; a pleurobranch on the last thoracic somite (14) ; exopodites on all or all but the last pair of legs.

1. First pair of Chelipeds short and slender in both sexes .. *Penaeus*

II. Rostrum serrated on its dorsal edge only.

1. A pleurobranch on somite 13, but not on somite 14.
   i. Exopodites on all or all but the last pair of thoracic legs .. *Metapenaeus*
2. No pleurobranchs on somites 13 × 14. All the thoracic legs with expodites.
   i. Epipodites absent from at least the last 3 pairs of thoracic legs *Parapenaeopsis*

Species :

Penaeus *P. carinatus ; P. indicus*

Metapenaeus *M. monoceros; M. affinis; M. dobsoni ; M. brevicornis*

Parapenaeopsis *P. stylifera*

Family 2. *Sergestidae :* Last one or two pairs of legs reduced or lost. Gills few or wanting.

Sub-family : *Sergestinae.* Head not greatly *elongated*—Gills present.

Genus : *Acetes*

(From Alcock, 1906)

(Vide also Key for Identification, Appendix)

Future Prospects of Prawn Fisheries of India :

In connection with the future development of the prawn fisheries of India, problems relating to the improvement or modernisation of methods of catching, processing and marketing should first claim our attention. These are indeed common problems concerning Indian Fisheries in general. The possibility of effecting improvements in the present catches of prawns and ways and means of achieving it are briefly discussed hereunder, particularly in the light of the facts brought out by the investigations of the Prawn Research Unit.

The bulk of the catches from the sea and practically the entire catch from other environments consist of young and immature prawns. This is especially true of the larger species like *P. carinatus*, *P. indicus* and *M. affinis.* It is now known that older prawns pass into comparatively deeper regions of the sea, and since the marine fishery is at present confined almost exclusively to the shallow coastal waters usually not exceeding 10 fathoms in depth, such prawns would naturally escape being caught. The rise of the Shrimp fishery in Central and North America and the information on the habits of the Penaeids of the Gulf of Mexico give every reason to think that there are large unexploited stocks of adult prawns in the Arabian Sea. Each species may have its own pattern of vertical distribution as shown by Hildebrand (1954) for the Gulf of Mexico. It is, therefore, very necessary to undertake exploratory fishing, trawling preferably, up to a depth of 30-40 fathoms, in order to discover if exploitable concentrations of prawns exist at such depths along our coasts. Such shoals, when discovered, may have to be judiciously exploited for commercial purposes, for the reason that most of the prawns would be mature and therefore potential breeders, and if their stock is depleted by excessive fishing in any place, where there is a flourishing and highly lucrative backwater fishery as in Travancore-Cochin, the effect on the latter may be harmful since the annual recruitment of fry to the stock in such waters may be considerably reduced.

Another possible line in which efforts at development may be directed is prawn farming. This has been pointed out formerly (Panikkar 1952), and prawn farming is already practised in some countries of East Asia. Rao (1949) has remarked that on a rough computation there are approximately 2,000 square miles of ' culturable ' but at present barren waters, lying scattered along the entire coastline of India in the form of tidal estuaries, backwaters and swamps. If even a portion of this vast area could be put to use for prawn farming, the total production is likely to be augmented substantially. The availability of prawn fry in abundance in the neighbourhood and the possibility of allowing water to flow in and out by tidal action are the two factors that would naturally determine the suitability of any such areas for prawn farming. In an experiment conducted by the Unit at Narakkal it has been shown that a minimum of 800 lbs of prawns could be harvested annually from every acre (Menon 1954). If fish is also cultured in the off-season another 300-350 lbs of fish can also be caught. The total amount compares very favourably with the yield from some of the best tambaks in East Java, where six test ponds produced in 1940-41, 330, 380, 470, 830, 230 and 250 lbs of prawns per acre, besides a normal yield of chanos (Schuster 1952). In the Philippines a hectare of fish pond produces on the average about 350 Kg (315 lbs per acre per annum) of marketable sugpo (*Penaeus monodon*) of about 10″ in length (Villadolid and Villaluz, 1950). The experiment therefore has yielded quite promising results which would warrant its repetition on an extended scale.

The possibility of expanding the rice-field fishery to similarly situated land both in and outside the State also seems well worth investigating.

Programmes of Research and Development.—The fishery development plans of the States and Central Governments in India include exploitation of off-shore prawn fisheries on an extended scale by the use of modern shrimp trawlers and seines and some trials have already been made in certain parts of India. Corresponding with this increase in fishing operations, it is also proposed substantially to augment the research programmes dealing with prawns so that the conservational aspect of this valuable marine resource is fully borne in mind while the fishing facilities are expanded.

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APPENDIX

In the accompanying Tables (I to VIII), the landings of prawns and crustaceans during the years 1950-54 have been given. The figures are based on sample surveys conducted by the Central Marine Fisheries Research Station. For the purpose of Fisheries Survey, the entire coastline of India has been divided into 12 more or less homogeneous zones which represent the following areas.

Zone 1. West Bengal and Orissa.

Zone 2. Andhra Coast, from south of Gopalpur to north of Visakhapatnam.

Zone 3. Andhra Coast, from Visakhapatnam to Masulipatnam.

Zone 4. Andhra Coast, from south of Masulipatnam to North of Pulicat Lake.

Zone 5. Coromandel Coast, from Pulicat Lake to Cuddalore.

Zone 6. Coromandel Coast, from south of Cuddalore to Devipatnam.

Zone 7. Palk Bay & Gulf of Mannar, from south of Devipatnam to north of Cape Comorin.

Zone 8. Travancore, Cochin and South Malabar, from Cape Comorin to Ponnani River.

Zone 9. Malabar and South Kanara, from north of Ponnani River to Mangalore.

Zone 10. Kanara and Konkan Coast, from north of Mangalore to South of Ratnagiri.

Zone 11. Bombay and Gujarat, from Ratnagiri to Broach.

Zone 12. Kathiawar Coast.

Table I

Total Production of Marine Fish and Marine Prawns & Crustaceans.

	(Figures in tons. 1 ton = 2,240 lb.)					Average for 5 years
	1950	1951	1952	1953	1954	
Total catch of marine fish	570,860	525,482	520,002	572,278	578,966	553,518
Total catch of prawns and other crustaceans	73,694	75,584	75,785	89,254	151,789	93,221
Percentage of prawns and other crustaceans to the total catch ..	12.91	14.38	14.57	15.60	26.22	16.84

Note :—The other crustaceans included in the above figures form only a negligible fraction of the total prawns and crustacean catch. These figures also do not include prawns caught in brackish water and fresh water.

Table I(a)

Zone wise production of Marine Prawns & Crustaceans

Zones	(Landings in tons)					Average for 5 years
	1950	1951	1952	1953	1954	
1	168	47	148	70	545	196
2	589	334	448	339	169	376
3	6,660	4,575	3,867	5,283	234	4,124
4	65	65	65	65	2,036	459
5	—	382	419	1,539	960	660
6	—	—	10	157	151	64
7	—	—	12	—	7	4
8	958	3,751	5,254	740	3,144	2,769
9	7,334	7,252	3,656	1,868	3,394	4,701
10	362	1922	891	329	177	736
11	57,558	57,256	61,015	76,550	140,972	78,670
12	—	—	—	2,314	—	463
Total ..	73,694	75,584	75,785	89,254	151,789	93,221

Note :—Kathiawar areas have been included in the table only where sample survey figures have been available. Total production of prawns in Saurashtra according to published official reports average about 4,000 tons per annum.

Table II

Landings of Prawns & Crustaceans—1950 (*in tons*)

Zones	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	—	—	117.98	—	10.74	0.82	0.29	2.96	5.01	1.39	14.00	14.81	168
2	—	119.96	43.51	9.39	110.23	125.66	66.92	53.44	34.88	13.76	11.23	—	589
3	538.13	955.24	1673.53	541.89	343.21	282.06 (19.66)	601.41 (40.70)	707.15	237.32 (5.52)	130.65	356.14	222.54	6589 (71)
4	2.89	—	—	—	1.88	5.43	17.47	5.87	4.84	9.81	16.83	—	65
5	—	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—
8	753.85	—	—	—	—	43.09	—	4.54	—	—	— (15.46)	141.02	943 (15)
9	1235.77	324.50	154.25	148.81 (0.53)	125.72 (7.50)	3218.20 (17.23)	13.29	46.11	—	317.56	1197.13	527.44	7309 (25)
10	0.38 (27.73)	— (140.81)	— (15.23)	0.54 (10.47)	9.46	12.38 (7.71)	5.98 (5.18)	11.95 (1.51)	111.46	1.23	—	—	153 (209)
11	3259.92	4177.70	7498.98	9907.78	13001.82	—	—	—	—	5166.38	5450.76	9094.50	57558
Total	5818.67	5718.21	9503.48	10619.41	13610.56	3732.24	751.24	833.53	399.03	5645.59	7061.55	10000.31	73694

Note I.—Fig. within brackets are the landings of crustaceans, which form 0.43% of the total prawns and crustacean catch of 1950.
Note II.—The sign "—" indicates nil catch.

Table III

Landings of Prawns & Crustaceans—1951 (*in tons*)

Zones	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	0.50	16.57	6.26	0.34	5.80	0.80	2.66	2.11	2.40	1.93	3.50	4.13	47
2	—	—	51.95	17.70	2.89	18.58	30.02	148.83	34.84	24.51	1.92	2.76	334
3	102.40 (3.91)	121.44	357.15	26.75 (78.14)	263.91 (0.74)	378.18 (7.56)	280.52 (274.80)	276.70 (228.27)	511.95 (181.00)	220.97 (112.63)	229.47 (204.74)	463.22 (250.13)	3233 (1342)
4													65
5	10.06	28.27	—	—	44.74 (26.09)	3.56 (1.90)	—	—	128.39	122.61	—	16.37	354
6	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—	—
8	—	19.75 (46.50)	222.40 (49.01)	465.87	761.37	60.41	421.37	1234.75 (416.47)	—	—	53.02	—	3239 (512)
9	—	75.32 (84.00)	239.46	204.68	973.93	1602.31	1811.69	2170.37	90.23	—	—	—	7168 (84)
10	5.29 (26.88)	17.92 (154.99)	— (145.81)	175.09 (208.59)	1.43 (15.34)	—	19.11 (22.73)	973.91 (0.67)	23.25 (20.09)	— (24.98)	— (37.51)	— (48.39)	1216 (706)
11	11884.70	5221.34	5897.17	6202.33	13137.87	—	—	—	2370.08	976.70	1168.49	10396.97	57256
12	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	12033.74	5786.10	6969.21	7379.49	15234.11	2073.30	2862.90	5452.08	3362.23	1484.33	1698.65	11181.97	75584

Note I.—Fig. within brackets indicate landings of crustaceans, which form about 3.54% of the total prawns and crustacean catch of 1951.
Note II.—The sign "—" indicates nil catch, and the gaps denote no data available.
Note III.—The estimate for Zone 4 is the estimate of 1950.

Table IV

Landings of Prawns & Crustaceans—1952 (*in tons*)

Zones	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	12.42	4.82	—		5.39 (0.07)	2.46	9.48	27.09	14.41	3.96	32.01	35.94	148
2	6.19	4.64	10.33	15.16	30.28	56.89	109.65	77.53	39.48	90.03	7.82	—	448
3	170.17 (238.25)	85.19 (403.44)	177.09 (162.44)	356.78 (59.78)	191.34 (7.48)	117.00 (36.50)	107.03 (119.96)	175.18 (104.00)	101.36 (53.74)	121.04	169.45 (420.39)	77.37 (412.02)	1849 (2018)
4													65
5	18.07	—	—	—	4.23	36.66	42.60 (1.56)	72.61 (0.14)	85.67 (1.30)	36.39	62.29	57.48	416 3)
6	0.85	—	—	—	—	—	9.15	—	—	—	—	—	10
7	—				1.96	0.45 (0.08)	2.89 (0.04)	1.48 (0.33)	4.77	—	—	—	12
8	—	—	22.44	8.82 (243.67)	478.64	—	103.80	733.91	223.26 (3372.33)	67.13	—	—	1638 (3616)
9	—	273.49	569.48	494.02	378.17	100.66	531.06	363.31	172.40	22.78	338.21	412.42	3656
10	(23.42)	(298.04)	(11.54)	(117.04)	(128.28)		145.16 (20.63)	125.84 (21.05)	—	—	—	—	271 (620)
11	9406.19	2664.96	9533.80	8775.91	18435.32	—	—	—	387.78	2587.38	4623.63	4600.03	61015
12	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	9875.56	3734.58	10487.12	10071.18	19661.16	350.70	1203.01	1702.47	4456.50	2928.71	5653.80	5595.26	75785

Note I.—Figures within brackets indicate landings of crustaceans which form about 8.26% of the total prawns & crustacean catch of 1952.
Note II.—The sign "—" indicates nil catch, and the gaps denote no data available.
Note III.—The estimate for zone 4 is the estimate of 1950.

Table V

Landings of Prawns & Crustaceans—1953 (*in tons*)

Zones	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	—	—	41.60	—	—	—	0.99	6.82	5.46	13.73	1.40	—	70
2	—	62.72	3.35	—	24.24	33.11	87.58	52.22	52.63 (2.00)	20.79	0.36	—	337 (2)
3	70.04 (410.64)												5283
4													65
5	139.52	316.07	86.05	151.36 56.00)	98.11	132.72	221.15	229.61	63.11	6.98	17.75	20.57	1483 (56)
6	—	—	100.23	—	13.16	41.93	1.68	—	—	—	—	—	157
7	—	—	—	—	—	—	—	—	—	—	—	—	
8	—	—	—	—	—	—	—	307.02	399.98 (28.36)	(4.64)	—	—	707 (33)
9	—	616.60	228.67 (4.72)	13.01 (5.46)	44.46 (5.03)	84.62 (0.79)	101.25	259.32	172.00	1.65	218.57	111.85	1852 (16)
10	(6.01)	(23.32)	(19.69)	0.21 (3.85)	1.58 (39.41)		2.91 (0.39)	95.60	117.66 (1.28)	0.04 (17.05)	—	—	218 (111)
11	11235.48	11474.73	4401.42	8747.88	13548.23	1229.87	—	—	4298.71	2642.44	7173.89	11797.35	76550
12													2314
Total	11861.69	12493.44	4885.73	8977.77	13774.22	1523.04	415.75	950.59	5141.19	2707.32	7411.97	11929.77	89254

Note I.—Figures within brackets indicate landings of crustaceans, which form about 0.24% of the total prawns & crustacean catch.
Note II.—The sign "—" means nil catch; the gaps denote no data available.
Note III.—The estimate of zone 4 is that of 1950.

TABLE VI

Landings of Prawns & Crustaceans—1954 *(in tons)*

Zones	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1	—	—	—	—	—	0.72	4.97	3.43	5.30	0.49	93.80	436.28	545
2	12.96	1.52 (0.13)	2.69	0.52	7.12	18.83	31.64	17.93	13.66	42.83	8.68	10.51	169
3									19.51	—	57.87	—	234
4									—	49.00	—	17.86	2036
5	52.76	76.84	65.64 (1.93)	57.78 (0.87)	57.55 (6.89)	122.44 (11.41)	196.30	155.88	84.87	30.06	23.03	14.71 (1.00)	938 (22)
6	—	—	93.97	4.18	—	—	—	—	—	6.15	1.28	45.42	151
7	—	—	—	—	—	—	—	—	—	—	7.00	—	7
8	10.06 (5.30)	— (17.12)	32.01 (5.77)	58.56 (5.97)	61.94	20.93	213.11	2414.71	190.59	25.25	71.19	11.36	3110 (34)
9	93.23	68.45	120.76 (1.55)	77.37 (3.61)	66.63 (3.57)	307.86	2428.21	141.05	—	5.53	14.83	61.24	3385 (9)
10	— (1.60)	0.17 (0.41)	— (1.12)	0.05 (28.24)	10.83 (63.49)	5.34 (18.80)	12.59 (5.40)	18.04 (2.97)	— (2.20)	0.13 (3.89)	— (1.70)	—	47 (130)
11	4293.99	5727.66	6327.68	34637.69	46281.40	—	—	15.51	597.84	24086.04	12978.28	6026.30	140972
12	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	4469.90	5892.30	6653.12	34874.84	46559.42	506.33	2892.22	2769.52	913.97	24249.37	13257.66	6624.68	151789

Note I.—Figures within brackets denote the landings of crustaceans which form about 0.13% of the total landings of marine prawns and crustaceans in India.

Note II.—The sign "—" indicates 'nil' catch, and the gaps denote no data available.

Note III.—The total estimates of zones 3 and 4 are based on last 4 months' observations.

Table VII

1953—*Landings of Prawns and other shell-fish (lbs) at important centres.*

Centres	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Gopalpur	Nil	Nil	—	—	Nil	Nil	122	959	6033	876	90	Nil
Lawson's Bay	Nil	9824	558 (P)	Nil	3983 (P) 1317 (S)	4666 (P) 2233 (S)	9600 (P) 8617 (S)	6273 (P) 5720 (S)	9752	3061 (P)	36 (P)	Nil
Kakinada	3034 (S) 626 (P)	—	—	—	—	—	—	—	—	—	—	—
Triplicane	4404 (M) 1487 (A)	9389 (M) 218 (A)	3364 (M) 343 (A)	4820 (A) 2674 (M) 292	2990 (M) 2431 (A)	3180 (M) 725 (A)	4031 (M)	4308 (M) 667 (A)	2079 (M)	337 (M)	858 (M) 523 (A)	1083 (A) 281 (M)
Adiram-patnam	Nil	Nil	11657 (P)	Nil	1051 (P)	2761 (P)	Nil	Nil	Nil	Nil	Nil	Nil
Tuticorin	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Vizhingam	Nil	Nil	Nil	Nil	Nil	Nil	Nil	29519 (P)	35583 (P) 1473 (A)	Nil	Nil	Nil
Calicut	Nil	56892 (M) 2728 (P)	21429 (M) 899 (P) 702 (Pp)	1266 (Pp.) 984 (M) 164 (P)	4109 (P) 2643 (M)	4399 (M)	6846 (M) 3315 (Pp.)	35136 (M) 691 (Pp.)	30232 (S & Pr.)	202 (M)	26954 (Pp.) 657 (A)	13108 (M) 360 (Pp.)
Karwar	Nil	Nil	Nil	7 (P) 1 (M)	27 (P) 4 (M)	—	178 (P)	3702 (P) 24 (M)	6707 (P)	1 (P)	Nil	Nil
Versova	1305963 759178 (S)	1712343 (S & Pr.)	625675 (S & Pr.)	1323021 (S & Pr.)	2105893 (S & Pr.)	174559 (S & Pr.)	Nil	Nil	767199 (S & Pr.)	318402 (S & Pr.)	1463439 (S & Pr.)	1479722 (S & Pr.)

Explanations to Abbreviations:

— No data collected or available
M. *Metapenaeus* spp.
P. *Penaeus* spp.
A. *Acetes* spp.

S. Shrimps.
Pr. Prawns.
Pp. *Parapenaeopsis*.
Where no symbols are placed after a figure, it indicates that the total catch is comprised of prawns, shrimps and other crustaceans.

Table VIII

1954—Landings of Prawns and other Shell-fish (lbs) at important centres

Centres	January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Gopalpur ..	Nil	Nil	Nil	Nil	Nil	70 (M) 20 (P)	463 (M) 214 (P)	535	461 (Pr. & Cr.)	33 (Pr. & L)	Nil	Nil
Lawson's Bay ..	1961 (P)	253 (P)	473 (P)	104 (P)	1033(M) 621 (P)	4169	7007	4383	1213 (P) 616 (M)	652 (P) 128 (M)	197 (P) 134 (S)	Nil
Kakinada ..	—	—	—	—	—	—	—	—	599 (M) 102 (S)	Nil	1150 (M) 920 (P)	Nil
Triplicane ..	1905 (M) 215 (A)	2796 (M) 212 (A)	1730 (M) 964 (A)	2005 (M) 828 (A)	1945 (M) 1092 (A)	2876 (M) 571 (A)	3412 (M)	3226 (M)	2254 (M)	2694 (M) 241 (A)	1829 (M) 901 (A) 159 (Cr.)	1747 (M) 114 (Cr.)
Adirampatnam ..	Nil	Nil	6197 (P)	582 (P)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Tuticorin ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Vizhingam ..	Nil	Nil	Nil	Nil	Nil	3702 (P)	9771 (A) 4476 (P)	211792 (P) 40532 (A)	2850 (Ct.)	Nil	Nil	Nil
Narakkal ..	1093	Nil	3239	7264	6653	4426	8273	7543	Nil	Nil	14397 (Pr.)	Nil
Calicut ..	5876 (M) 4114 (Pp. 1240 (P)	3274 (P) 2966 (Pp.) 412 (M)	8115 (P) 2310 (Pp.) 1815 (M)	13132 (Pp.) 1342 (P)	8866 (Pp.) 983 (M) 346 (P)	12701 (M) 3053 (Pp.) 364 (P)	238353 (M) 5738 (P) 1047 (Pp.)	15523 (M) 3750 (P) 316 (Pp.)	Nil	1335 (P)	3623 (Pp.)	13289 (M) 1221 (Pp.)
Karwar ..	Nil	25 (P)	Nil	2 (P)	222 (M) 4 (P)	345 (P)	785 (P)	751 (P)	285 (Cr.)	262 (Cr.) 17 (P) 197 (Ll.)	Nil	13 (Cr.)
Versova ..	929327	1008978	1061440	6181206	8488109	Nil	Nil	2598	48025 (Pr.)	824480(Pr.)	3011504 (Pr.) 76349 (S)	774193 (Pr.) 227966 (S)
Veraval ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Explanation to Abbreviations:
— No data collected or available. Pr. Prawns Cr. Crabs. P. *Penaeus.* M. *Metapenaeus* S. Shrimps.
A. *Acetes* Ct. Cuttlefish Pp. *Parapenaeopsis.* Ll. *Loligo.*
Where no symbols are placed after the figures, it indicates that the total catch is comprised of prawns, shrimps and other crustaceans.