

Souvenir



ISSUED ON THE OCCASION OF
THE INAUGURATION OF THE PERMANENT BUILDING
FOR THE HEADQUARTERS OF
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

COCHIN - 682031

MARCH 1, 1986

SOUVENIR



Issued on the occasion of
the inauguration of the Permanent Building
for the Headquarters of
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
COCHIN-682 031

March 1, 1986

Published by:
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Research Institute
Cochin 682031



OUR FORMER DIRECTORS



Dr. H. SRINIVASA RAO
1947-1951



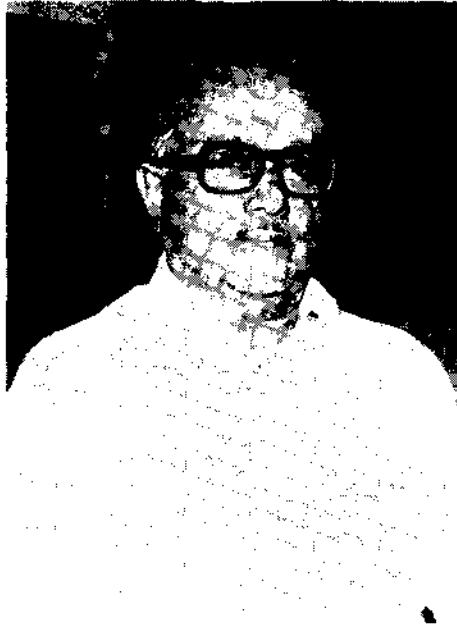
Dr. N. K. PANIKKAR
1951-1957



Dr. S. JONES
19-4-1957 to 26-2-1970



Dr. S. Z. QASIM
7-12-1970 to 4-1-1974



Dr. E. G. SILAS
25-6-1975 to 24-6-1985

Dr. R. V. NAIR Officiated as Director from 27-2-1970 to 6-12-1970 and
from 5-1-1974 to 24-6-1975

Dr. A. V. S. MURTY Officiated as Director from 25-6-1985 to 2-9-1985

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE —
A RETROSPECTION

S. JONES

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On being invited to contribute an article for the Souvenir to be issued in connection with the formal opening of the new building at Cochin to house permanently the headquarters of the Central Marine Fisheries Research Institute, my thoughts go back to 1944 when Dr. Bains Prasad, the first Fishery Development Adviser to the Government of India, was initiating steps for the establishment of a fishery research Institute in the country and enquired of me if I could serve as one of the heads of divisions in the proposed institute. In the course of the next two to three years the original concept of a single Institute for fisheries research for the whole country had to undergo change in favour of two, one for marine fisheries and the other for the inland (freshwater and brackishwater) fisheries, apart from one for fisheries technology. As the only individual surviving who had occasion to serve in senior positions in both the Institutes in their formative years and as one who was responsible for the shifting of the headquarters of the Central Marine Fisheries Research Institute from Mandapam Camp to Cochin, it is felt that information on its historical background will be more appropriate than a narration of its achievements and programme of work as it is presumed that these aspects would be adequately dealt with elsewhere by others in the Souvenir.

The pre-independent Government of India evinced no direct interest in the fisheries of the country which remained a deferred subject until the forties of this century except for the enactment of the Indian Fisheries Act of 1897. Before the integration that took place after Independence, India was a conglomeration of territories under the overall suzerainty of Britain, divided mainly into British India and Native States with their own systems of rules and regulations regarding fisheries, which were essentially revenue oriented. What little work was done on fishes in general in the country till the close of the 19th century was confined mainly to the observations recorded by some of the officers of the erstwhile East India Company, beginning with Russel and Francis Buchanan (Hamilton Buchanan) and followed by several others. In the mean-

Dr. S. Jones was the Director of Central Marine Fisheries Research Institute from 1957 to 1970.

while, collections of fishes from India and adjacent countries made by those interested in natural history belonging to the colonial powers which were over-running the region were described and deposited by ichthyologists in the various museums in Britain and the continent. The latter half of the 19th century saw the emergence of Francis Day, a veterinary surgeon in the British Army stationed in South India, who subsequently rose to the position of the Inspector-General of Fisheries in India and Burma. His contributions on Indian fishes and fisheries yet remain unparalleled and his monumental publication entitled the "Fishes of India" still holds the field as the major work of reference on fishes of the Indian Region even after the lapse of over a century.

Towards the close of the 19th century and the beginning of the 20th century, studies on fishes and other aquatic fauna were carried out by the officers of the Marine Survey of India and the Zoological Survey of India and by research scholars in some of the universities. The credit for highlighting the need for organised work on fisheries and for the establishment of full-fledged fisheries departments in the major provinces and states was stressed by Sir Frederick Nicholson, an Indianised Britisher in the Civil Service, who will ever be remembered as the father of fisheries in India. His frank and forthright views that India should look to Japan and not to Britain for the development of fisheries gave vent to scathing criticism against him by the Anglophiles of those days which he withstood with courage of conviction and organised the fisheries department in Madras, the first of its kind in India. However, fisheries continued to remain as a deferred subject which served as severe constraint for its development.

The recommendations of the Report of the Industrial Commission of 1916-1918 stipulated that the Central Government should promote studies on fisheries by strengthening the scientific staff of the Zoological Survey of India. About quarter of a century passed with hardly any change in the situation, the great economic depression of the late twenties and the thirties imposing severe constraints on the expansion of any research activities.

An idea of the state of our knowledge on Indian fishes till the late thirties could be had from the following statement of Dr. Stanley Kemp, a former Director of the Zoological Survey of India and the then Director of the Marine Biological Laboratory at Plymouth, in the course of an address at Cambridge to the Zoological Section (D) of the British Association for the Advancement of Science. "It is no exaggeration to say that in Africa and almost throughout the stretch of the Indo-Pacific region, there is scarcely a fish whose life history is fully known and whose various stages from egg to adult can be recognised. Of such matters as age, rate of growth, spawning periods, food and migration, we are equally ignorant, nothing is known of the incidence of fluctuations and nothing in seasonal and other changes in the environment." In

fact by then the picture had begun to change owing to the investigations initiated by several Indian scientists, particularly belonging to the University Zoological Laboratory at Madras and the Madras Fisheries Department.

The entry of Japan as an ally of the then fascist powers brought South East Asia within the orbit of the war zone and India, on account of its vital position and vast man power, became the main base for the Allied Forces in this region. This brought in its wake the problem of supply of adequate quantities of fish, particularly for the very large number of army personnel, and this served as a pointer to those in power to the woefully backward organisational set up of the fisheries in the country. The British Administration poignantly began to realise the absence of a central co-ordinating authority regarding fisheries in general in the country and in 1943 Dr. Bains Prashad, who was then Director of the Zoological Survey of India, in his historical Memorandum entitled "Post-war Development of Indian Fisheries" rightly stated that he is "definitely of the opinion that it would be best if a central Research Department of Fisheries of the Government of India is constituted instead of tagging it on to the Zoological Survey of India and that "it would not be in the best interest of fishery research in India to make it a subsidiary of the activities of the Zoological Survey of India." In the opening paragraph he stated as follows:

"I recommend that a Central Fishery Research Institute be established by the Government of India on lines similar to those of the Agricultural Research Institute at New Delhi, the Veterinary Research Institute at Mukteswar and Izatnagar, and the Forest Research Institute at Dehra Dun. Agriculture including veterinary work, and forestry are, like fisheries, transferred subjects; but the Government of India are maintaining fully equipped and well staffed research institutes for the study of problems connected with these subjects, and there seems to be no reason why the development of Indian fisheries, which in their importance are second only to agriculture and animal husbandry, should not be taken up along similar lines".

The above recommendation helped to pave the way for considering favourably the establishment of a Central Fisheries Research Institute and this was endorsed among other aspects of fishery development in the country in the "Report of the Fish Sub Committee of Policy Committee No. 5 on Agriculture, Forestry and Fisheries" dated 18th January 1945 prepared by Dr. Bains Prashad in his capacity as its Member-Secretary who by 1944 had become the Fishery Development Adviser to the Government of India, thereby bringing fisheries within the orbit of concurrent subjects. To begin with, grants were provided for some projects to a few states through the ICAR. For making specific recommendations regarding the establishment of the proposed Central Marine Fisheries Research Institute Lt. Col. Dr. Seymour Sewell who was formerly Surgeon Naturalist to the Marine Survey of India and Director of the Zoological Survey

was invited to India in 1946.* We have to bear in mind that India was undivided then and regarding Marine fisheries research the entire coastal area from the Makran Coast of Baluchistan in the west to Chittagong Coast in Bengal in the east had to be considered. He made visits to most of the potential centres considered suitable for the different types of fisheries research establishments contemplated then and gave his recommendation in his "Memorandum on the Proposed Fisheries Research Institute" (1946). Herein on page 4 under "The organisation of the proposed Central Fishery Research Institute" he stated as follows:

"The work of such an Institute will be of primary importance in the whole of India including all the various Provinces and States. While a number of problems and the research necessary for their elucidation will be common to the whole country, others will be purely local; hence any organisation for Research and for the scientific development of the fisheries must be so designed as to cover not only all the various Divisions of the country but also the various kinds of Fisheries that are carried out, namely:—

Marine Fisheries
 Estuarine Fisheries, and
 Fresh Water Fisheries

and two of these three main branches are still further sub-divided into Sections. Thus we have

Marine Fisheries	a. In-shore Fisheries
	b. Off-shore and deep-water fisheries
Estuarine Fisheries	
Fresh Water Fisheries	a. Pond, tank and lake fisheries
	b. River Fisheries

Since there are no political boundaries to these different branches, the direction and co-ordination of Fishery Research must be carried out by the Central Government though these problems that are of purely local importance and interest should be studied by the Fishery Department of the Provincial or State Governments that may be concerned".

* I recall the visit of Dr. Seymour Sewell, who was 68 years old then, to Mandapam in 1946 accompanied by Dr. Bains Prasad. They were received by the officers of the Madras State Fisheries Dept and all of us visited in a Royal Indian Navy boat the Marine Biological Station in Krusadi Island and subsequently the abandoned Naval Hospital buildings at Mandapam.

The marine fisheries research set up envisaged by Dr. Seymour Sewell in his Memorandum was for the whole of undivided India. Regarding the essential requirements for the location of a marine fisheries research station, he stated as follows:

1. That it shall be in a place that is easy of access; as Prof. A. V. Hill F.R.S. has pointed out, "A Central station should be established at a place where large numbers of people could be attracted and where it would create a public interest. The staff of the Zoology Departments of Universities and lecturers and research workers should come to work at the station.
2. It should be at or near an important fishing port, on which a fishing fleet is based and where large catches can be landed. In this connection, as the use of power craft for fishing increases, these craft will, of necessity, have to be based on a relatively few home ports, where all engineering facilities and supplies of fuel and oil etc. are readily available.
3. It must have good harbour facilities, with workshops, slip-ways, dry docks etc.
4. It should be reasonably near to good fishing grounds; other requirements are
5. A good fresh water supply
6. Supply of electricity for power and light
7. Suitable land for building
8. Good road and rail communication
9. Good cold-storage and refrigeration facilities, ice-factories etc".

He pointed out that although about 75% of the Marine fish catches are from the West Coast, "with the further development of power driven crafts it is quite possible that very valuable and extensive fisheries will be developed on the East Coast also". He recommended Karachi for the West Coast and Mandapam for the East Coast. Adjacent to the Quarantine camp established by the Ceylon Government at Mandapam, was a huge sprawling Naval Hospital Complex in an area of about 90 acres which was lying in an abandoned condition overgrown with thorny jungles and this was to be acquired to accommodate the proposed marine fishery research institute for the East Coast section of the country.

Pending renovation and reconstruction to make the place habitable, the Central Marine Fisheries Research Station* started functioning in the Zoology

* "Station" changed to "Institute" and "Chief Research Officer" into Director subsequently.

Laboratory of the Madras University from February 3, 1947, with Dr. H. Srinivasa Rao, formerly of the Zoological Survey of India and till then Deputy Fishery Development Adviser, Government of India as the Chief Research Officer. During the same year the country passed through the trauma of partition bringing in its wake several problems which were resolved by our leaders. It took about two years for renovations and reconstructions to make the buildings at Mandapam Camp habitable and they were occupied in 1949. The research activities of the Institute began to increase and correspondingly a number of substations and research centres were established in places of fisheries importance. Gradually living facilities also began to improve as at the beginning only rail connection existed between Ramanathapuram, the nearest town with banking and marketing facilities, and Mandapam Camp, a distance of about 35 km. Towards the end of 1950, Dr. Rao retired and was succeeded by Dr. N. K. Panikkar. An area of over 100 acres consisting mainly of sandy lagoon lying on the Palk Bay side was added to the Research Station for conversion into a fish farm. Steps were initiated by the mid-fifties for the construction of permanent quarters for the staff. My advent to the Central Marine Fisheries Research Station was in early 1954 as head of the Fishery Biology Division, after seven years as head of the Estuarine Biology Division of the Central Inland Fisheries Research Station, the overall charge of which I had held for nearly a year.

Seven years of fisheries research appeared to have made every one involved in it wiser than ever before. Most of the scientific members of the staff were in their twenties and thirties, a few of the oldest being in their forties. Practical experience had given them a good picture of the distribution pattern of the major marine fisheries in the country and the rather pitiful unsuitability of Mandapam Camp to serve as headquarters of the Research Institute. Except for a few of the local staff, there was hardly any one who had any inclination to live in this place for any length of time. This was realised by every one from the lowest to the highest in the Institute but nobody had the courage to voice the truth openly. Those who could manage to get out of the place did so quietly one by one. Some of the luckier ones who continued in the Institute had opportunities to get themselves posted in its substations and centres where living facilities were better. The major handicaps were the lack of schooling, medical and marketing facilities apart from a sense of perpetual isolation from the so-called "civilized society". Even the Marine Biological Station of the State Fisheries Department in Krusadai, considered as a "paradise" for marine biologists and a place of "pilgrimage" for college students from all over India, was suffering for long from the same fate as it could hardly attract any experienced scientists to remain in charge of it for any appreciable length of time. One could see the silent sense of frustration writ large on most of the staff. In the meanwhile permanent quarters were being built which instead of giving to the scientific staff relief, created only despair and depression under the

feeling that they are condemned to live there for the rest of their official career. Most of them were resigned to their fate and any thought or mention of change of the headquarters from Mandapam Camp was considered a sacrilege.

It was under those circumstances that I took charge in 1957 from Dr. Panikkar as head of the institution. Thanks to the co-operation of my colleagues and the research scholars working under me it was possible to maintain the steady growth of the Institute into one of the foremost of its kind in South East Asia. The tempo of scientific activities was maintained at a high level by organising field trips and cruises and founding the Marine Biological Association of India and holding international symposia and bringing out a journal and other publications under its auspices. The Institute was recognised as a centre for research by quite a large number of universities in India and served as a base for scientists from various parts of the world during the International Indian Ocean Expedition in the early sixties. Several scientists from within this country and outside used to come and spend short periods for research. Investigations were carried out by research scholars supported by the University Grants Commission in marine biological subjects including fish and fisheries. This helped to produce several specialists who are now foremost in their respective fields in the world.

However it was evident that if the Institute had to grow and fulfil its purpose, the headquarters should be shifted to a more suitable place. Strangely, efforts made to acquire a plot of land for years either in Madras or Tuticorin in the hope that the same could be developed and strengthened did not meet with success. It almost looked as if some were intent on pinning down the headquarters of the Institute to its existing place for ever though none of them could ever think of staying in such a place for any length of time. In the meanwhile, subtle attempts made in certain quarters, to have it eventually shifted to Bombay by stationing initially all the senior officers there, were effectively thwarted by speedily posting them to Cochin which by that time had grown into the most important centre for fisheries activities in the entire Indian Region. In 1967, the Estimates Committee of the Parliament visited the Institute at Mandapam Camp and it was possible to present before them very forcibly the need for shifting the headquarters of the Institute to a better place, so that it could work with better efficiency and grow to its fullness. It goes to the eternal credit of the elected representatives of our people that they were convinced of the justification for the same and recommended the move in unequivocal terms. By 1967, the transfer of the Institute from the Ministry of Food and Agriculture to the Indian Council of Agricultural Research took place and it was rightly decided subsequently that my successor should take over charge as Director at Cochin. Fortunately attempt made in some quarters to thwart the same turned futile and it is best that those sordid events are forgotten. In 1970, I was succeeded by Dr. S. Z. Qasim who in turn was succeeded by Dr. E. G. Silas

in 1975 followed by Dr. P. S. B. R. James in 1985, all scientists of a very high order, the last a product of the Institute itself.

Retrospectively speaking at the fag end of my life, I feel happy at the steady growth that the Institute had been maintaining from its very inception and take the liberty of expressing my satisfaction at the significant role that I had the privilege of playing in it for a period of over 16 years. For me the completion of the new building for the headquarters of the Institute is like a dream coming through. It is now on the threshold of a new era in its history and it is my earnest hope and wish that it would continue to blaze its trail as the premier institution of its kind in the entire Indian Ocean region. My good wishes and blessings go with it.

SOME PROJECTIONS OF MARINE LIVING RESOURCES IN THE YEAR 2000 A.D.

S. Z. QASIM

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In India, sea fish largely comes from the capture of natural fish populations from the coastal waters. In 1947, the marine fish production in India was 0.4 million tonnes and today it has reached 1.5 million tonnes. Although the increase has been significant, it has not really reached a spectacular figure. This is because our fishing effort has largely been confined to a narrow coastal zone. The estimates of potential fish yield from the Indian Ocean vary from 7 million to 17 million tonnes. Of this potential, India's contribution is expected to be 5-9 million tonnes. From the Indian Exclusive Economic Zone, the fish production is expected to be about 3 million tonnes. The projected fish requirements of India's population by the 2000 A.D. is expected to be 11.4 million tonnes. Of this, nearly 7 million tonnes is expected to come from the sea and the rest from fresh water resources. Is it conceivable that our technology of fishing i.e. the development of mechanized boats (crafts and gears), including the methodology of fish finding, will reach a level within the next 15 years to achieve the expected target? The answer is that it is very unlikely that the 7 million mark can be achieved from mechanized fishing alone.

The next alternative, therefore, is to generate extra resources of seafood by sea farming or aquaculture. At present the total production of fish and prawns from aquaculture practices is about 10000 tonnes. This is because out of the total potential areas of wetland available for culture, only a small fraction is being utilized for cultivation. If the unused areas of wetland (coastal and brackish waters) are utilized effectively, a substantial increase would indeed be possible. Intensive efforts are being made by several South East Asian countries to generate more and more resources by culture practices. The potential in this sector appears to be very high.

Seaweeds form another important living resource and these are being used as food, animal feed, fertilizers and as raw materials for chemicals and pharmaceutical products. Today the seaweed production in India is about 20000 tonnes. This is not enough even to keep several seaweed-based industries in

Dr. S. Z. Qasim is a former Director of Central Marine Fisheries Research Institute

India going. The result is that many industries had to be closed down. The natural regeneration of seaweeds in beds is not fast enough to meet the growing demands and hence the only way to generate extra resources is by their cultivation on ropes and wooden frames. Projections indicate that the production of seaweeds by cultivation will increase substantially within the next two decades.

The other living resources which unfortunately have been used "unwisely", or it would be more correct to say "misused", are the mangroves and coral reefs. During the last two decades, mangroves have been severely depleted because these have been used as a source of timber and charcoal. It is only in recent years that mangroves have been recognized as ecologically vital plants for the protection of shoreline from erosion.

Similar has been the fate of coral reefs. Due to population pressure along the coast, most of the coral reefs in coastal areas (fringing type), once known for their lush vegetation and a multitude of fauna, have become dead. This is largely due to pollution and industrial development along the coast. The forecast is that by the year 2000 A.D., the reefs which would probably survive would be on the atolls of Lakshadweep and on some of the islands of Andaman and Nicobar.

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE:
MY REMINISCENCES AND IMPRESSIONS

R. V. NAIR

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I am glad to be associated with the souvenir which is being released on the auspicious occasion of the inauguration of the new headquarters building of the Central Marine Fisheries Research Institute at Cochin. In this context, it may not be out of place to recall here the simple 'inauguration' of the Institute itself about four decades back, i.e., in 1947, in a single room accommodation given by the University of Madras in the Zoological Research Laboratory at Chepauk, where I was working as a Research Assistant at that time. In the absence of Dr. C. P. Gnanamuthu, the Director of the Laboratory, I had the rare privilege of receiving the distinguished scientists, Dr. H. Srinivasa Rao, Chief Research Officer and Dr. N. Kesava Panikkar, Special Officer, and giving them the necessary facilities. Dr. Rao was empowered with the wide powers of direct recruitment and I was offered the first gazetted post of Sardine Research Officer on a higher start, which I accepted after relinquishing my post in the Laboratory, in charge of a fisheries research scheme financed by the Imperial Council of Agricultural Research. I was associated with the Institute in different capacities, from its inception till my voluntary retirement as Director about ten years back. I can look back with satisfaction that I have contributed in no small measure to the growth of the Institute, during my service spanning about three decades.

Fisheries research is the main responsibility of the Union Government and accordingly the Institute's objectives were to estimate the resources and rate of exploitation, to carry out research on the major commercial fisheries, to study the possibility of increasing fish production and to formulate measures for conservation of the fishery resources, if found necessary. In accordance with these policies, I was assigned the oil sardine research programme and transferred to Calicut to organise the sub-Station and also to carry out investigations on the oil sardine fishery which is the most important commercial fishery of the west coast. I was the principal investigator of this project for several years and the research work carried out by me on the oil sardine and other allied fishes was

Dr. R. V. Nair is a former Director of Central Marine Fisheries Research Institute.

consolidated and published as a monograph. Subsequently several persons have been working on the sardine research programme and valuable data have been collected about this fishery. In my opinion high priority should be given to studies on egg and larval surveys for elucidating the factors responsible for the wide fluctuations encountered in the fishery in view of the importance of this fishery in the overall fish production of the country.

I was also the Head of the Fishery Survey Division for a number of years and the main function of the Division was the estimation of marine fish production in the country. A multistage sampling system was devised for this purpose and valuable data extending over several years have been collected. In recent years, the industry has introduced several innovations for augmenting fish production, but the effect of these is not properly reflected in the catch statistics which show only marginal increase in production. Of late, the different maritime States have also evolved their own machinery for independent collection of landing data and in view of the wide differences in these figures for some States, reconciliation of the data collected by the different States with estimates made by the Institute has become a regular feature. In the context of these differences it is desirable that the entire sampling system is reassessed and remedial steps taken to overcome the shortcomings. In fact, the time has come to relegate the function of collection of fish landing data to the different maritime States and concentrate on specific subjects like stock assessment, etc.

Mariculture was attempted at Mandapam Camp from the inception of the Institute and a series of experimental fish ponds were constructed for this purpose, the sea water in the ponds being replenished by tidal influence. Unfortunately, several impediments hampered the operation of these fish ponds, particularly in the renewal of the sea water caused by the low tidal amplitude. Perhaps, a wind-mill type of pump would have served the purpose better, since strong winds blow in the region throughout the year. The cyclonic tidal wave which hit the region in 1964 washed away all the fish ponds and the field laboratory and thus ending that phase in the initial maricultural activity of the Institute.

During my tenure as the Director of the Institute, several schemes on mariculture were implemented which yielded very interesting results. The elvers which abound the south east coastal regions, and which have considerable export potential, were reared under laboratory conditions and the growth rate was found to be much better than that of the Japanese elvers, and consequently the Japanese eel culturists evinced interest in importing Indian elvers. The occurrence of pearl oyster spats, observed accidentally at Vizhinjam, was utilised for the production of cultured pearls. All the commercially important sea-weeds occurring in the neighbourhood of Mandapam Camp were cultivated in special rafts, in the shallow inshore waters and excellent results were obtained. Even

salt-pan fish culture undertaken at Tuticorin yielded very good production figures exceeding those obtained in the fish farm at Mandapam Camp. Based on these highly encouraging results, several pilot projects were prepared jointly with the respective States and submitted to the NRDC for approval.

I have made an analysis of the fish catch during the early plan periods and the landing trends of the major fisheries have shown a declining tendency, barring the oil sardine fishery. Biological studies carried out subsequently on Bombay-duck have also confirmed this finding. It is desirable that this study is continued especially in view of the very low increase in annual fish production. Practically no work has been undertaken by the Institute on the destructive fisheries prevalent in some parts of the country. The post-larval fishery known as "nonnavu" is a very good example of highly destructive fishery carried out along the southern stretch of the Kerala coast. One of my Ph.D. students observed more than 90 species of post-larval fishes involved in the "nonnavu" fishery during a three year study conducted at only one centre, namely, Sanghumugom of Trivandrum city. The colossal waste of potential fishery resources can easily be judged by the fact that, on a moderate estimate, about 180 metric tonnes of post-larvae are landed in a single day from the "nonnavu" fishery zone. It is desirable that the Institute make a survey of such destructive fisheries and study their impact on the fishery resources for adopting suitable remedial measures.

The scope for publishing the scientific papers produced by the staff of the Institute should be adequately increased to cope up with the multifaceted activities. At present, the Institute publishes the well established and widely circulated *Indian Journal of Fisheries* and the *Journal of the Marine Biological Association of India*. The Bulletin of the Institute was converted by me into treatises on specified subjects and these Bulletins were in great demand and I get requests for them even now. The Institute has recently started *Marine Fisheries Information Service*. I feel that this publication should be replaced by a suitable Journal like *Nature* intended for small papers and notes prepared in conformity with the standard format adopted for scientific papers.

It is very fortunate that the next one decade of the Institute's activities will be guided by Dr. James, who is a product of the Institute and one of the best fishery scientists of the country. His varied experience as a Fishery Scientist, Professor of Fishery Biology and Asst. Director General (Fisheries) in ICAR will be highly beneficial in the formulation and implementation of schemes of national importance. I have great pleasure in wishing him and the scientists of the Institute every success.

THE TASK BEFORE THE CENTRAL MARINE FISHERIES RESEARCH OF INDIA

G. N. MITRA

Fishery Consultant and Adviser, Professor Para, Cuttack 753003

The Central Marine Fisheries Research Institute has, after decades of valuable research and investigation on marine fishes and fisheries, been able to upgrade its technology with recently acquired vessels and equipment.

With its own building and more facilities, it is hoped that it will be able to adopt advanced technology to solve the main problem of the Industry which in a nut-shell is 'Economic fishing on a sustained basis in the Maritime zone of India and beyond'.

The present position is that India's production hovering around 1.6 million tonnes a year is contributed 60% by traditional fishing, 39% by Mechanised boats and 1% by Deep Sea fishing. There were 86 Nos. of deep sea vessels in 1984-85 including Chartered vessels.

There have been comments that there has been no real progress in deep sea fishing with only about 16 vessels at present against a reduced target of 250 in the Sixth Plan period.

There is conflict in almost every maritime fishing country among the fishermen using different sizes of craft and gear. This has started in India and controversies in some cases are taking an ugly turn.

Revision of Charter rules in April 1984 specifying revised zones as indicated in August 1982 by the Government of India has sharply reduced the number of such vessels even though the period of licence has not expired in some cases.

Depletion of shrimp in certain areas is suspected as indicated in the reduction in the catch per unit effort. This is true in case of shrimp trawlers operating off Paradip where data is available for a number of years. But for a cyclone which rendered 50% of the craft in-operative the fishing by all the boats

Shri G. N. Mitra is a former Fisheries Development Adviser in the Ministry of Agriculture, Government of India.

would have been uneconomic. A situation similar to this is also being faced in Kerala.

To add to the problem, important fisheries of the lagoons are sustained economically by migratory fish from the sea. The stock of these fish in the sea has relationship with the lagoon fisheries. We have very little information regarding the limitation of these stocks in the sea. The same applies to estuaries.

Until the complicated inter-relationship of the different stocks of species is studied in a co-ordinated manner, a rational policy of fishing cannot be enunciated.

While the concerned Ministry is responsible for rational development as a whole, it evolves on the Marine Fisheries Research Institute to guide the fishing policy by providing a sound technological base.

Buildings do not make research but men and equipment do. The Fishery Survey of India conducted surveys of about 71000 sq. kms. of sea area in 1984/85. Some surveys of the EEZ have also been made. The results together with the data available to this Consultant from some Private Industries bring out some interesting points. Fishing is economic in some areas in certain seasons only. These are the well defined fishing Banks like the Wadge Bank and the Kori Great Bank. The catch rate in the fishing season is almost doubled. The reason for this, as is well known, is mainly migration of some commercial species but little is known about the details.

The important data of Fishery Survey of India is not correlated with factors governing abundance.

Breeding grounds of few commercial fishes are known, so also their behaviour to different gear.

It is obvious that the Central Marine Fisheries Research Institute, which had at one time laid down and monitored the programmes of the Fishery Survey of India should now be in charge and important exploratory cruises will include studies on environment.

Sustained investigations to know the limitations of the stocks and their migratory pattern in space and time should be undertaken on a national scale, also inviting international co-operation where required. There have been sporadic efforts to study migration of some fishes in the West Coast of India and in the Chilka Lake. For want of sustained effort, the results have only been indicative.

Distribution of the important commercial species in space and time must be determined as early as possible to enable the concerned Ministry to determine its policy and take suitable measures for regulating and financing the

Industry. The present *ad hoc* measures are leading to a lot of wastage in effort and money.

The Deep Sea Co-ordination Committee of the Ministry of Agriculture of the Govt. of India recommended that data of fishing by commercial fishing vessels should be sent to CMFRI in a prescribed proforma. The proforma is already prescribed on an international scale which is the standard log book of the fishing vessel. For enabling the CMFRI to arrive at conclusions it should be made obligatory for commercial vessels and selected mechanised boats with educated skippers to supply a copy of the log book to CMFRI. A suitable incentive may be given.

A very important factor is to create a batch of scientists with a love of the sea, good sea legs and ability to work under gruelling conditions.

The techniques of studying population dynamics are well developed. Determination of the priority areas of work, obtaining equipment and training men in their use, and rapid analysis of the data with a suitable computer will enable the CMFRI to advise the Ministry in an objective manner to make fruitful legislation in promoting and regulating fisheries.

These will be the tasks before the CMFRI which is a National Institute to provide a sound technological base for optimum development of India's marine fisheries.

PRIORITIES IN MARINE FISHERIES RESEARCH, DEVELOPMENT & MANAGEMENT

P. C. GEORGE*

Marine fisheries research programmes did undergo gradual changes during the last four decades, ever since the establishment of the Central Marine Fisheries Research Institute. The ship board research and data support provided by the Fishery Survey of India, Integrated Fisheries Project and the National Institute of Oceanography has also been too significant to be left aside. The changes that took place can be grouped under two categories. The first was a gradual shift from ichthyological studies to one of quantitative fishery resource research although the former was necessary for a meaningful approach for the latter. The second was to broad base the investigations from near shore areas to the off-shore and oceanic zones and to connect the two wherever necessary to get a full picture of the nature and extent of availability of the living resources in time and space.

However, these investigations were masked to a considerable extent by the so called "cultural revolution" that took place in the Central Marine Fisheries Research Institute. The development of improved technology in coastal aquaculture with a strong bias to shrimp culture became so pronounced an activity in the Institute in the last decade (with all its publicity and support from the marine export industry) that scientists and techno-administrators began to express fears of a possible shift in emphasis taking place in the priorities of activities, although the contribution by the Institute in culture techniques was quite significant to be proud of. This has also called for steps to put back the programme in their proper perspective.

In the meanwhile, as many as more than a hundred coastal countries, noting the emerging trends of the 3rd UN Conference on the Law of Seas, declared a two hundred mile exclusive economic zone (EEZ) reserving sovereign economic rights to explore, exploit, conserve and manage the living and non living resources in this area including safeguards for marine protection and

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pollution control. The immediate impact of this was that more than sixty percent of the known resources came under exclusive jurisdiction of coastal states, practically depriving the distant water fishing nations free entry into conventional fishing grounds not far away from coasts. While the convention conferred rights of exploitation to the coastal states, most of which were actually developing states, they did not have the necessary technology, management expertise or financial backing to organise optimum utilisation of the resources. They also lacked the necessary information base on the resources that suddenly came under their exclusive jurisdiction. However, the Food and Agriculture Organisation and other Co-operating agencies, initiated programmes of technical support to coastal states although the main responsibility to develop and manage resources rests on the national agencies themselves. In this context, national institutions engaged in living resource development and management and similar organisations carrying out marine science studies started stepping up efforts to achieve national self sufficiency in expertise and information base. In other words, research, development and management of living resources of the EEZ sprang into the fore-front of priorities for practically all the marine living resource study programmes. India cannot be an exception nor it can lag behind in any such programme because of its vast coastline of more than five thousand kilometres and an EEZ of over two million square kilometres.

Although the coastal zone is by and large more rich in nutrients and consequently supports the major share of marine catches, a better knowledge of the off-shore environment helps to improve management information particularly for those fish stocks that are migratory in habits. In addition, off-shore fisheries, both demersal and pelagic, supplement the catches of the conventional varieties. Oceanic varieties of fish that move in and out of the Economic Zone and those that move into and move away from the EEZ of one state to another also require careful study and monitoring for rational exploitation and sound management. The conventional fishing grounds identified and charted during periods of early exploitation a few decades ago can undergo changes as pressure of fishing increases. It has also been found that in several areas of the oceans, feeding and breeding grounds also undergo changes in quality and quantity due to environmental changes and due to pollution and environment damage. Migratory varieties are also subjected to pressures of diversion of flowing waters and artificial barriers and are often found to adjust to changes and restrict their sojourn to lower reaches of estuaries or become endemic and all these changes call for detailed investigations for developing management options.

The situation mentioned above is not unknown to fishery scientists and marine ecologists. However, these are seldom taken into consideration when progress is reviewed and new priorities identified. As far as the EEZ of India is concerned, there is more or less sufficient information on the resources of the

coastal zone, say upto the forty fathom limit. The resource availability data beyond that is fragmentary and do not provide adequate and reliable information for detailed planning and for investment. Hence, one of the main priorities in Marine Fisheries Research and Survey Programmes is to complete and consolidate the information base on resource availability. Another area of priority research is to scientifically assess the impact of fishing pressure on such stocks as the marine shrimp which is much sought after by the private industry. In addition, the drastic reduction in the breeding stock of marine shrimp may have an adverse effect on regular availability of "wild shrimp fry" for culture. A continuous monitoring of what is happening in the shrimp ground due to pressure of fishing, has to be a standing programme of work to be undertaken pooling all the resources at the disposal of the marine research agencies. Environmental damage, as is well known, can be remedied if detected early.

The mid water and the pelagic resources have to be reassessed periodically in view of the large fluctuations in their availability year after year and also because of the large variations in the estimates provided by various organisations and agencies. Unfortunately these resources which do not fetch an attractive price in the international market, are not getting the attention they deserve although they still offer us the main source of fish protein particularly for the vulnerable section of the coastal population. In practice, the "lab to land" programme which is claiming success in the agricultural extension set up should be a model for a "lab to sea" programme. In other words, there appears to be urgency to devote more time to stock assessment and management and in monitoring of mid water and pelagic resources and to assess commercial possibilities through analysis of commercial catch data and confirmatory surveys.

It is well known that marine fishery resources from open waters cannot be raised to substantial levels through adoption of any technology. All that we can do is to carry out intensive studies of the parameters that contribute to the fluctuations in the availability and to use this information for short and long term forecasting and thereby render technical advice to the industry for optimum harvest of the resources with an eye on conservation. In other words, Marine Fisheries Research Scientists will have to remain vigilant on the changes that takes place in the marine environment due to natural or man-made cause in order to keep the resource as truly renewable. Although this is being done with a certain degree of regularity in all institutions, there is need for allotment of top priority for such research programmes to reap full benefits from the Exclusive Economic Zone.

INDIAN FISHERIES PERSPECTIVE

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With 2.02 million sq. km. of sea in its EEZ, more than 27,000 km of rivers, about 1,13,000 km of canals, 1.75 million ha. of identified water spread in the form of reservoirs, over a million ha. in the form of tanks and ponds and approximately 0.6 million ha. of stagnant derelict water-spread, India portends with considerable scope for development of fisheries, both capture and culture. There are about one and a half million fishermen, actively engaged in fishing who support about 6 million people of fishermen community for their livelihood. With the present fish production of 2.80 million tonnes (1984) India contributes to a little over 3% of the world fish production of about 76 million tonnes. India's contribution is highest in the Indian Ocean fishery. The annual growth of fish production has been in the order of 7% during the last couple of years as against 3.1% during the base of the last plan. The per capita consumption of fish in India is about 3.6 kg|annum while the world average figure is about 12.5 kg|annum. The level recommended by the Nutrition Advisory Committee on Human Nutrition stands at 31 kg|annum.

Fish production in India has been fluctuating from 2.4 to 2.6 million tonnes until 1983. For the first time, the production level crossed this barrier and reached 2.80 million tonnes in 1984. This has been an increase of 12% over the previous year's production.

Against the Sixth Plan target of 220 crores of fish seed production, the actual production has reached 542 crores, 2½ times of the target set. Another achievement has been that the area brought under organised fish culture has increased by more than 200% over the previous year.

By its 3% contribution to the world fish production of about 76 million tonnes, India ranks 7th among fish producing countries of the world. By 2000 AD the world fish production is expected to be around 100 million tonnes of which it should be possible for India to contribute to the order of 5 to 6%. For increasing the per capita consumption the target of fish production by the turn of the century is envisaged at 5 million tonnes comprising about 3 million tonnes from the sea and 2 million tonnes from the inland sector. Similarly the export earning from marine products envisaged for 2000 AD is about Rs. 1000 crores as against the present value of Rs. 386 crores.

The fish production increased from 23.40 lakhs tonnes in 1979-80 to 28.59 lakhs tonnes by 1985 showing a growth rate of 3.1% per annum during the 6th Plan. During the same period the inland fish production has increased from 8.48 lakh tonnes to over 11 lakh tonnes by 1985. Similarly the marine fish production has gone up from 14.92 lakh tonnes during the same period to about 18 lakh tonnes. At present we are harvesting about one-third of our EEZ potential. Even this quantity comes largely from coastal waters extending to about 70 m depth. About 99% of our total marine catch is confined to 15-20% of our EEZ. Much of the future additional landings would necessarily come from off-shore and deep sea areas. Non-exploitation of these perishable resources in deep sea areas would result in a complete loss to the country.

The number of Fish Farmers Development Agencies (FFDA) in the country with central assistance stood at 147 nos. at the end of 1984-85. Eighteen new districts were covered under the scheme during 1984-85. About 1.30 lakh hectares of water area had been brought under production through FFDA's by the end of Sixth Plan. The number of fish farmers trained under the scheme is about 51,000 at the end of last plan. The productivity has also reached the level of 800 kg/hectare through this scheme. India is one of those fortunate countries to have fabulous brackish-water resources. The prime marine species of prawn is highly suitable for brackishwater farming. Brackishwater fish farming to a considerable scale is being carried out only in few States such as West Bengal, Kerala, Karnataka and Goa. Brackish water fishery potential is expedient not only to project the curve of national fish production upwards but also to meet the demands of high exchange export market of shrimps.

The main thrust in the marine sector will be an extended exploitation of EEZ by promotion of investment in deep sea fishing. By and large the resources beyond the 40 fathom depth remain unexploited. The new fishing grounds and new resources which have been discovered during the recent past by the Fishery Survey of India in the deeper waters are expected to be intensively harvested by the deep sea fishing sector. The potentially rich grounds for deep sea lobster and deep sea prawn, squids and cuttle fishes, perches, baracudas, mackerel etc. have been located through survey by the Fishery Survey of India (FSI) along the West Coast, South Coast, Gulf of Mannar and East Coast. Potentially rich resources for yellowfin tuna within the EEZ have also been located off Karnataka coast and along the East Coast from September to March. For encouraging deep sea fishing in the country, the Department has recommended a total loan of Rs. 56.21 crores for acquisition of fishing vessels and a subsidy of Rs. 15.19 crores to the indigenous shipyards during the year 1985. The target for the 7th Plan is 300 deep sea fishing trawlers.

In the traditional sector which is the mainstay of the marine sector, it is planned to mechanise 12,500 craft with outboard (DBH) engine during the 7th Plan. This would enable the traditional fishermen to expand the range of

operation and to diversify the fishing methods and thereby increasing the catch besides easing physical strain on them. In addition to this, introduction of organised scheme under the self-financing arrangement, bank financing facility etc. would continue. By the end of the 7th Plan, it is expected that there would be more than 30,000 mechanised craft as against the present 20,000. Realising the need for providing appropriate landing and berthing facilities the Department of Agriculture and Cooperation has sanctioned a total of 131 fishing harbour schemes consisting of 5 major and 26 minor harbours and 100 small landing centres since the 4th Five Year Plan period. The majority of these harbours and landing centres are in full working condition.

One area which received the focal attention during the current plan is the welfare of fishermen. The Government have introduced a Group Accident Insurance Scheme for active fishermen which covers both the inland and marine sectors. More than 5 lakh fishermen have been covered under the scheme during the year. To mitigate the plight of the poor fishermen a Fund known as the National Welfare Fund for the Fishermen was established during 1984-85. The Fund is expected to play a key role in promoting housing scheme, protected water supply, in the area of health, hygiene, recreation, education etc. in selected fishermen villages of the States besides providing old age pension to the elderly and widows.

The targeted fish production by 2000 AD and beyond is planned to be achieved by scientific utilisation and exploitation of the capture and culture fishery resources in the inland sector. Bulk of the production is to be raised from intensive culture fisheries operation in tanks, ponds, reservoirs, brackish water farms. This calls for a number of measures such as proper land use policy, relaxation of land ceilings in suitable areas, introduction of high technology in selected areas, introduction of appropriate post harvest technology including intensive marketing. It is perhaps possible that a sizeable portion of the domestic fish requirement could be met from fresh water fish production especially in the land locked provinces. Inclusion of biotechnology such as use of bacteria for cleaning of effluents, algal culture in oxidation ponds, composting of domestic waste through biogas technology for use in aquaculture for manure and feed, recycling and land and water management would open avenues for low input high productivity oriented aquaculture technologies. The scope to modernise fisheries sector through support of the country's plastic industries, engineering and electronic sector including remote sensing technology through satellite, use of refrigeration system and effective co-ordination with the related sectors such as agriculture, irrigation, power, meteorology etc. would be attended to.

RESEARCH SUPPORT FOR SEAFOOD EXPORT PRODUCTION

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Marine capture fisheries contributed nearly 60-65% of the total fish production during the past decade. Out of the total marine landing of 1.4 million metric tonnes comprising a variety of items, only a few selected species found their way into the export market. During the 1981-85 period, the volume of processed marine products exported from India was in the range of 70,000 to 92,000 tonnes per annum. Among the export items one single item, namely, frozen shrimp constituted the bulk, amounting to more than 60% by volume and 85% by value. The demand for different fishery items already in the export markets and several new items for which India has potential for production is on the increase in the international markets. Mainly on account of production constraints we have however been unable to fully avail ourselves of the favourable market opportunities.

A perusal of the export data reveals that several of the items that have no domestic demand as food or otherwise are in good demand in the international markets. The possibilities of augmenting production and export of some of the items for which resource potential in our waters has been fairly well established are briefly discussed in this paper.

Till the technology of freezing and canning was adopted for marine products, exports from India were largely confined to dried items to neighbouring countries like Sri Lanka, Burma, Singapore, etc. The advent of quick transport facility for frozen cargo opened the sophisticated affluent markets of Japan, USA and other European countries to Indian exporters of marine products. Over the years India emerged as the largest supplier of frozen shrimps to Japan and a major supplier to the USA, next only to Mexico and Ecuador. However, the near total reliance on a single commodity, viz., shrimps, that too only to one or two countries is not quite a healthy trend for a country like India. Efforts have, therefore, to be made for diversifying the markets and products. The Marine Products Export Development Authority after conducting several market surveys has identified the following items which have export potential:

1. Tuna and allied fishes
2. Ribbon Fishes
3. Silver Pomfrets
4. Anchovies
5. Cat Fishes
6. Perches
7. Shark
8. Sardine
9. Mackerel
10. Scianoids
11. Polynemids
12. Threadfin Bream
13. Aquarium Fishes
14. Squids
15. Cuttle Fishes
16. Clams and Mussels

These items already figure in our exports but in very insignificant quantities. Except for tuna, squids, cuttle fish, clams and mussels, the consumer demand for these items within the country itself is very high and their international market prices are not very attractive.

According to one study, the projected marine fish requirement of India by the year 1984-85 was 2.88 million tonnes. Of this, 1.9 million tonnes were for human consumption, 0.59 million tonnes for industrial uses such as production of fish meal|fish manure|poultry feed and the remaining 0.39 million tonnes for exports. Against the demand the estimated production during the year 1984-85 was hardly adequate to meet the internal demand for human consumption. Unless the internal demand is met and sufficient surplus is generated fish export may not be an economically viable proposition. However, considering the gap between the potential resources and the actual exploitation, there is considerable scope for increasing production. The prime food fishes such as pomfret, perches, sardines, mackerel, etc., have good demand from importing countries but the scarcity of supply in the internal market does not permit large scale export of these items:

The marine products items which have not much demand in the national market are tuna and allied fishes, cuttlefish and squids. These items are also the poorly exploited ones at present, though the identified potential is quite

vast. Against the estimated potential of 0.180 million tonnes of cephalopods, the quantity being exploited is around 16,000 tonnes (less than 9%). Squids and cuttlefish are only incidental catches in the exploitation of shrimps and fishes and the effort put in to exploit these resources through specialised fishing is next to nil.

One way of increasing marine production is by increasing the effort of exploitation and another is by extending the operations into under exploited|un-exploited areas. The essential data with regard to the fish population abundance, area of concentration and the impact of fishing effort over given area has to be compiled on the basis of research and investigation and provided to the industry. More thrust is necessary in this area in order to increase fish production.

From records it may be observed that the near shore area upto 50 meter depth is well exploited and production is showing trends of stagnation. On account of large scale demand for shrimp for export, intensive fishing operation have already lead to economic, if not biological, overfishing. Therefore, it is time that fishing operations moved offshore. The lack of reliable, useable information about the types of catch, location of fishing grounds and suitable fishing technology in the offshore have been identified to be some of the major reasons for the poor effort put in for the exploitation of offshore fisheries resources. Studies on the size of the stocks of different species, their rate of mortality and recruitment, the inter-relationship among species, and the inter-relationship between a stock and its environment in the distant sea within the EEZ are essential. The collection of data and its analysis and proper interpretation on a continuing basis are absolutely necessary to have clear understanding of the resources and to plan proper exploitation strategies.

PROSPECTS OF AQUACULTURE

Several species of fish and shell fishes are now successfully cultivated in marine farms of different descriptions. The lead taken by the Central Marine Fisheries Research Institute in India on this aspect is commendable. However, production programmes have not taken off the ground for various reasons. There is no doubt that the export of shrimp can be increased considerably by augmenting production through farming. Scientific management technology has to be introduced in the traditional prawn culture practised in about 30,000 ha. in the country. With the potential area available in the country estimated to be well over 1.4 million hectares, it should not be difficult to bring an additional 50,000 ha. under brackishwater prawn farming. Absence of clear policies on land use, lack of adequate quantity of prawn seed for stocking, lack of technically trained manpower to handle the multi-disciplinary functions connected with prawn hatchery and farms, etc. have been identified to be major constraints on the growth of prawn farming in the country. The level of production

of prawns through culture is quite poor in the country in comparison with many South East Asian countries. Therefore, intensive research is required to develop technology, viable under Indian conditions, to optimise production from the existing fields and new farms are to be brought under prawn culture. The technology developed has to be effectively disseminated to the field level and for that training and demonstration programmes have to be organised.

The backwaters, brackishwater lakes and in-shore sea in India are ideally suited for the purpose of pen culture and restocking to improve natural population and other management techniques to increase production. And it is high time we moved into the open waters with modern tools of management to sustain and improve production. Our research programmes have to be oriented to this if we have to achieve the targeted production. The Central Marine Fisheries Research Institute being the nodal organisation collecting data on marine fisheries resources, the institute should also effectively disseminate knowledge and information to the end users namely, the fishing industry. While it is gratifying to note that the Institute has attached considerable importance to extension activities and included them as integral parts of its research and development programmes there is considerable scope for intensifying the extension services and making them more result oriented. On the one hand resource data and such other technical information should be passed on effectively to the end users and on the other research projects should be so designed and oriented as to be of direct practical relevance to the fishing industry.

For sustaining the large momentum of the export-led growth of the fishery industry which was witnessed in the 60s and the 70s it is absolutely essential that adequate research, training and extension back-up is provided by institutions like the CMFRI.

THE CENTRAL MARINE FISHERIES RESEARCH INSTITUTE —
PERSPECTIVES AND NEW DIMENSIONS

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The Central Marine Fisheries Research Institute, Cochin, under the ICAR is the premier Institute which engages itself primarily in all aspects of research in marine fisheries and marine life, their ecology and biology. Starting after India's independence in the sprawling sea side campus at Mandapam, Tamilnadu, the CMFRI has now become a major fisheries Institute with about 253 Scientists and a total manpower of 1193 persons.

The Institute has 12 Research Centres and 28 field stations situated all along the Indian coastline extending from Gujarat to Kerala on the West Coast and from Tamilnadu to West Bengal on the east coast. They provide network and research infrastructure to cover the Indian Coastline.

The mention of marine fisheries reminds of millions of undernourished fishermen who live in poverty and misery in small improvised huts in coastal villages all along the Indian Coast. They use local craft and gear made of hemp and cotton for the exploitation of the fisheries resources of the inshore waters. Over decades from one generation to the next, they had fished the inshore seas, enjoyed the bounties of good fishing seasons with plenty of fish in certain periods and had also faced the periods of adverse and very poor catches. They were silent spectators, to the events of good and bad fishing seasons. They use indigenous craft and the primitive gear to fish in coastal waters upto a distance of about 15 km from the shoreline. In the past, on the socio-economic front, marine fisheries in India was a backward profession, in which the poor earned their livelihood from the sea surrounding the Indian Coast, about which we had very little knowledge. Since independence, this picture has changed, gradually. Today, India has a strong coastal fishing fleet and trained manpower for the operation of the fleet. Trained Manpower skilled in fish handling and processing, and marketing has also contributed to the country's economic progress and export trade. A large number of fish processing factories has also come up particularly for the export trade. However, the potential is enormous and much needs to be done. The lack of information about the Indian Ocean was to some extent overcome with the launching of the International Indian Ocean Expedition which was organised by UNESCO during 1960s. This resulted in

more information about the seas around India and a greater appreciation of the fisheries resources by the Indian Government and the people.

During this period the CMFRI has made original and valuable contributions, and as a first task, established a nationwide system of collecting and interpreting data on the marine fish landings in India. This system has now become an important tool for the acquisition and processing of the data on marine fisheries of India, which forms the basis for realistic evaluation and planning and development of marine fisheries in the country. In the recent past, with the declaration of the EEZ, the task has become more difficult. It requires collection of real time data from distant waters and high seas and involves shipboard research. It has posed a new and a difficult task which requires that the Scientists spend most of their working time on shipboard research. This has now become an important and a continuous task to understand the fluctuations in the abundance of commercially important fish stocks in coastal, nearshore and distant waters. It also involves prolonged shipboard research to conduct fish operations in different parts of the ocean and evaluate their economics so as to provide real time data which should become the basis for large scale investments in marine fisheries. Resource information has shown geographical and seasonal variations due to variations in oceanographic parameters. In order to understand these changes, the CMFRI has started studies on stock assessment of commercially important marine fisheries. These studies supplemented with the dynamics of the lesser known mesopelagic and pelagic fishes, including of tuna and the tuna-like fishes have become one of the major thrusts of the Institute.

The ever changing marine environment is very challenging and influences the migrations, breeding, survival and abundance of fish stocks. Related marine life particularly the abundance of plankton and the benthos which form the food of fishes are also influenced. The other important factors which need extensive studies include the distribution of nutrients, temperature, currents and other physico-chemical factors which essentially influence and govern the marine productivity.

The problems of marine fisheries have become more complicated due to the extensive uses of the oceans for navigation and transport and for the exploration and exploitation of oil and other minerals. The major economic activities in many parts of the oceans have also resulted in extensive pollution. Disastrous accidents of oil tankers, like the "Torry Canyon" off the UK Coast and oil well blowouts off the California Coast in the USA, are becoming common in the Indian Ocean also. The oil tanker accident off Gujarat Coast, Oil-well fire at the Bombay High and the blowout of an oil well in Gujarat indicate that India is also getting increasingly exposed to the dangers of pollution due to oil. The threat of pollution from sewage and industrial pollution to coastal

fisheries is increasing every day near our large cities like Ahmedabad, Baroda, Bombay, Mangalore, Cochin, Madras, Vishakhapatnam and Calcutta. Thus, one of the major emerging disciplines of study in marine sciences is pollution and its abatement with special reference to coastal fisheries. Coastal fisheries play an important role in our economy, because this sector still contributes about 65% of our fish catch and almost 90% of the Indian fishermen depend on the Coastal seas for their livelihood.

India has a long tradition of marine research. The Zoological Survey of India and the Universities situated in the coastal regions have made valuable contributions on the taxonomy and biology of different species of marine fishes. The old tradition was started with Sir Francis Day (1875) who had written on Indian Marine Fishes and the CMFRI has developed this tradition into a productive area of research through important contributions on various aspects of fisheries including marine biology and oceanography. These have contributed new knowledge and have become the basis for further studies and research. Research at CMFRI has also led to the generation of large manpower in the field of marine fisheries. Distinguished contributions have also been made on marine flora and fauna which have been recognised both at the national and international levels. The Institute has a band of highly educated and well trained young Scientists who are constantly endeavouring to study and understand marine life and continue to make research contributions of high order.

The study of the interaction between the marine environment and capture fisheries has gradually led to the development of new technologies of mariculture. Amongst these, pearl culture, prawn culture, culture of sea weeds and culture of marine fishes are important for the future of mankind. Mariculture is now emerging as an important field and it is necessary to organise information inflow for the development and refinement of mariculture technologies.

The contribution of the CMFRI for the development of a system for the survey of marine flora and fauna, monitoring of coastal and near shore fisheries, developing new aquaculture technologies and building a cadre of scientific manpower etc. are some of the distinguished services rendered by this Institute. With the construction of the new building and with the new vessels that the Institute has acquired, the CMFRI is entering a new era where marine fisheries Scientists will concentrate more on ship-based research to understand and predict the commercially important stocks of marine fisheries, which will help India to develop its marine fisheries and make optimum use of EEZ. It is necessary to protect the marine environment so that the coastal villages, cities and the fishermen continue to enjoy the bounties of nature. The CMFRI has new challenges of the 21st Century. They have to develop new management practices and new technologies to meet the increasing demand for the valuable marine food which can become a support of health and wealth for people living along the coast line.

FISHERY TECHNOLOGICAL RESEARCH AND EXTENSION IN INDIA

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The Central Institute of Fisheries Technology was set up by the Government of India according to the recommendations of a high power Fisheries Research Committee headed by Dr. B. N. Chopra so as to undertake research on Craft and Gear, and Byproducts technology. The Institute had started with Fishing Craft and Gear wing in 1957 and in the following year Processing Wing was added to carry out research on handling preservation, Quality Control and Inspection and to conduct fishery technology extension services. Since then the country has achieved commendable progress in her fishing and fish processing industries. Ranking sixth in the world in magnitude of production, landing 2.4 million metric tonnes of fish, India's export of processed marine products reached an all time record of Rs. 3850 million per annum.

Some of the important achievements of the fishery technological research and extension work carried out in the country so far are briefly enumerated in the following paragraphs.

FISHING CRAFTS

The crafts most widely employed for fishing in the early years when mechanisation was thought of in the country were wooden dug-out canoes. The first mechanised boat to be introduced in the country by the Indo-Norwegian Project was of 7.5 m OAL Pablo type. The problem of designing of mechanised fishing boats suitable for the Indian coast was taken up by the Central Institute of Fisheries Technology even from its early years of existence. Twelve standard designs varying in OAL between 7.67 m (25 ft) and 15.35 m (50 ft) perfected by the Institute were readily adopted by the State Fishery Departments and private fishery interests and a majority of the 19,000 and odd mechanised boats operating in the country at present are of CIFT design. Designs for boats for fishing in rivers and reservoirs varying in length from 6.14 m (20 ft) to 9.21 m (30 ft), an 11.66 m (38 ft) boat for pole and line fishing, an 18.42 m (60 ft) trawler-cum-carrier vessel and a 17.5 m (57.4 ft) steel trawler-cum-purse seiner were also developed.

Seasoned and preservative-treated secondary species of timber like haldu (*Adina cardifolia*) and mango (*Mangifera indica*) wood were proved to be

cheaper but efficient substitutes for the conventionally used costlier timbers like teak (*Tectona grandis*) and aini (*Artocarpus hirsuta*) for construction of wooden boats. Toxin-incorporated wood plastic composites were developed by treating secondary species of timber with monomers such as acrylonitrile, polyester etc. together with toxicants such as tributyl tin oxide and creosote followed by irradiation.

Arsenical and copper creosotes were developed and standardised for treatment of wood intended for marine applications. Spheroidal grain austenitic cast iron was proved to be highly suitable for marine propellers instead of costlier bronze, resulting in 25 to 30% savings in their costs. Marine antifouling paints incorporating tributyl tin oxide and cuprous oxide were developed and produced on pilot plant scale for protection of wooden boat hulls. Anticorrosive paints using zinc dust, sodium silicate and modified cashewnut shell liquid developed by the Institute were found effective in providing cathodic protection to steel and aluminium. A method for sheathing wooden hulls of fishing boats with fibreglass reinforced plastic was developed with a view to protecting them against fouling.

FISHING GEAR

During the early years of the fishing industry in India, the materials that went into the production of gear and accessories were of natural origin like cotton yarns, imported hemp yarns, ropes like coir and manila and indigenous floating materials. The Institute standardised construction of ropes and twines for different gears, developed methods for their preservation to get better service life and efficiency and found out indigenous substitutes for Italian sun hemp used for ghol-dara gill nets along the north-west coast. With the introduction of synthetic floats and sophisticated sinkers in the early sixties and their acceptance by both the artisanal and mechanised sectors, these were standardised and knotless webbings fabricated and popularised. The Institute also actively associated with the Indian Standards Institution in formulating national standards for the above materials. Suitable gear and accessories were designed for the mechanised fishing sector, particularly different concepts of trawl designs for shrimping in various areas of the Indian coastline. Several new designs of gears were developed both for the marine and inland areas like different types of high opening trawls, midwater|pelagic trawls, purse seines, trolling for seer, tunny etc., long lines for sharks and traps for lobster and fishes. Methods for shrimping from medium and large vessels were worked out. Double rig trawls, bulged belly trawls, separator trawls for the separation of shrimp and fish and six-seam four panel large-mesh high opening trawls for the capture of bottom and column fishes were some of the sophisticated types of gear evolved. Bottom trawling and long lining for eradication of predatory and uneconomic varieties of fishes from reservoirs, standardisation of

a tickler chain for more efficient shrimping resulting in 35% increase in catches and development of different types of otter boards like rectangular flat, horizontal curved, oval and 'V' shaped for bottom trawling and vertical curved, hydrofoil and four board system for midwater trawling were some of the other fields of investigations taken up by the Gear Division of the Institute.

INSTRUMENTATION IN FISHING

Several instruments for fishery hydrographical investigations like Bathy Thermometer, Salinity-Temperature-Depth meter, direct reading digital current meter and ocean tele lab were developed. Electronic instruments for behaviour studies of marine animals like fish activity recorder, barnacle cirri beatings counter and oyster shell movement counter were fabricated.

Deck equipments such as collapsible gallows and pulley systems for using in purse seining, hydraulic winch for hauling up trawl nets, equipments for fishing squids with the aid of light attraction and a totally enclosed power take-off clutch suitable for small fishing boats were some of the accessories developed by the Institute for efficient fishing operations.

Portable electronic warp load meter, ship-installed warp load meter, trawl depth meter, speed and distance log and catch indicator were some of the important gadgets developed for use in fishing. Electronic instruments for fishing gear testing like Bollard pull monitor, Mesh distortion meter, Net flow meter, Under water tension meter, Board tilt meter, Angle of attack meter, Marine temperature alarm, Rudder angle indicator, Bilge water alarm and Multi signal data acquisition system were also developed successfully.

BIOCHEMISTRY

Knowledge of the fundamental biochemical compositions of fresh fish muscle and the changes they undergo during handling and processing is very essential for evolving methods for their long term preservation. In this context, fatty acid compositions of oil sardine, mackerel, seer, pomfret, lactarius, anchovy, prawns, tilapia, barbus, ophicephalus, caranx, sole, tuna, mullet etc., and a comparative study of the lipids of skin, muscle and viscera of our important food fishes and their seasonal changes were studied in detail. A systematic study of the changes in 5'-nucleotides, the important flavour-bearing constituents in fresh fish and the changes they undergo during iced and frozen storage in prawns and oil sardines was made. Changes in the major protein fractions of all commercially important fishes during storage in ice and in frozen condition and during thermal denaturation were studied in detail.

Detailed studies of the proteolytic enzymes in fish and shell fish like prawns, sardines, mackerel, perch, jew fish, sole, ribbon fish, catla, tilapia and

ophicephalus were made. Hepato-pancreas of oil sardine had high concentrations of lipase enzymes. Phosphorylase enzymes were isolated from tilapia, lactarius and jew fish and their activities studied.

Animal feeding experiments showed that fish oils rich in poly-unsaturated fatty acids could bring down blood cholesterol levels considerably.

FISH MICROBIOLOGY

Seasonal variations in the qualitative and quantitative distribution of the bacterial flora of commercially important marine fishes like oil sardine, mackerel etc. and changes occurring in them during ice storage, freezing and frozen storage were studied extensively. During ice storage, the heterogeneous flora underwent significant changes giving place to one or two genera at advanced stages of spoilage viz. *Pseudomonas* in the case of fish and *Pseudomonas-Acinetobacter-Moraxella* in the case of prawns. During freezing there was a reduction of 40 to 90% in the number of bacteria and after 3 to 6 months of frozen storage, the residual flora consisted mainly of *Micrococcus* and *Bacillus* genera. There was complete arrest of bacterial activity during frozen storage at -18 to -20°C .

Detailed investigations were carried out on the bacterial profile of brackish water fishes like pearl spot and milk fish, fresh water fishes like tilapia and shell fishes like clams, mussels and oysters.

Chlorotetracycline dips and CTC-incorporated ice considerably suppressed bacterial spoilage in sardine and mackerel; but chemical spoilage progressed unhindered.

A systematic study of the occurrence of *Clostridium* group of bacteria in fish, fishery products and fish processing environs on the west coast upto Mangalore showed the presence of *C. perfringens* in one of the factory environs and guts of some prawns. Investigations on other food poisoning organisms like *Salmonella*, *Vibrio parahaemolyticus*, *V. cholerae* and *Staphylococcus aureus* were also carried out.

PROCESSING AND PACKAGING

Marine, brackish water and fresh water fishes could be successfully transported in iced as well as frozen condition by rail in plywood boxes insulated with expanded polystyrene slabs over distances involving journeys of 3 to 4 days. A chemical sanitizer was developed for cleaning, deodorisation and disinfection of fish boxes, railway wagons and trucks used for transporting iced fish.

Quick frozen tuna and seer in the form of chunks kept in better condition in frozen storage than in the form of fillets. Wrapping in polythene film increased their storage life. Oil sardine with fat contents of 10 to 25% (DWB)

kept well for 12 to 16 weeks at -18°C , while those with 25 to 40% fat had a shelf life of only 10 weeks when frozen individually. Absolutely fresh oil sardine having a fat content of 20% (DWB), when block frozen with heavy glaze, remained in good condition for 6 to 8 months at -18°C . Sardine and jew fish could be frozen in 30 to 40 minutes by immersion in 15% brine containing 20% glucose at -9 to -10°C . Cat fish, kalawa and jew fish could be filleted manually, frozen and stored for long periods.

Processes were standardised for canning of oil sardine and mackerel in oil, brine, tomato sauce etc. Methods were also perfected for canning of smoked oil sardine and froglegs in brine and tomato sauce, crab meat in brine, tuna in oil and brine, mussel and clam meat in oil, brine and tomato sauce and edible oyster meat and anchovies in brine.

Methods were worked out for preparing several diversified products like soup powder, flakes, hydrolysates, fish protein concentrate, bacteriological peptone, pet food, fish fingers, poultry feed, fish ensilage etc. from cheap varieties of fish. Acceptable products like fish curry, fish pickles and smoked fish shavings were developed from trash fish. Nonpenaeid prawn powder from Jawla prawns and salted, smoked and dried doma were some of the other products developed.

Instruments developed for use in quality control and automation in processing factories included Brine concentration meter, Freezer temperature monitor and alarm, Automatic brine dispenser and Moisture meter. Several mechanical devices for fish processing were developed, some of the more important ones being a Rotary drum dryer for fish meal and prawns, single and multi deck tunnel dryers for salted fish, an Electrothermal smoke kiln, Pilot plants for fish protein concentrate and chitosan, a Solar dryer for salted fish and a Refrigerated sea water plant for preserving fresh fish.

A survey of the packaging materials used in the fish processing industry showed that the packagings require considerable improvements in their properties. Hygienic packaging materials were developed for cured fishery products.

Considerable work has been done towards improvements in quality of exportable products. Blackening/blueing of canned prawn/crab meat was prevented by maintaining the titratable acidity in the fill brine at or above 0.06% and addition of disodium salt of EDTA.

A method worked out to prevent drip loss from frozen prawns was commercially applied on 50,000 tonnes of prawns in 1970-75, effecting a saving of raw material to the tune of 5000 tonnes valued at Rs. 7.5 crores. A method was successfully worked out for preparing frozen froglegs completely free from *Salmonella*. Separation of frogleg processing from prawn processing units, stoppage of hut peeling and avoidance of backwater and fresh water prawns for

freezing in raw condition have been recommended for exclusion of *Salmonella* from frozen prawn products. A method for assessing the hygienic conditions in processing plants for introducing inprocess quality control and the requirements for a laboratory for implementing the same were drawn up for assisting the industry. A reagent-impregnated filter paper was developed for determining chlorine levels upto 500 ppm in water used in processing plants, the chemicals employed being potassium iodide, acetic acid and starch.

Methods were worked out for preparing several industrial products from sardine oil. Some of the important products developed were factice (artificial rubber), printing ink and lubricating oil. Procedures were also developed for extracting rays from shark fins and chitosan from prawn shell waste.

National standards were worked out for all important fishes and processed fishery products in association with the Indian Standards Institution.

EXTENSION

Considerable amount of work has been done for popularising the research results for the overall development of fishery industry in the country, gathering feed back information from fishermen, fisheries departments and fishery industry as a whole, organising short term refresher training courses for the benefit of technical personnel from fisheries departments and industry, studying the extent of adoption of new and improved technologies already worked out and conducting statistical investigations on the technological problems involved in fishery technology.

These were achieved through promptly answering all technical queries received from fishing and fish processing units all over the country, State Fisheries Departments, other fishery organisations as well as new entrepreneurs in the field.

Refresher training courses were conducted for giving advanced training to fishermen, fisherwomen, fish processors and new entrepreneurs in the fields of gear fabrication, fishing, fish processing, production of diversified products and byproducts, quality control and bacteriological analysis of seafoods.

Testing of different kinds of samples, products, water and raw materials received from numerous processors and different types of marine engines manufactured in the country was undertaken and reports furnished. Exhibitions and open houses were conducted in order to create awareness and interest in fisheries development among the public. Frequent film shows were conducted in several fishing villages and fish processing factories which helped immensely in imparting general education to the fishermen community and processors on the modern ways of harvest and post-harvest technology.

Radio talks made by the scientists of the Institute over the AIR were of great help in creating awareness of the new developments in fishery technology among fishermen, fish processors and others engaged in or associated with fisheries. Several booklets, folders, pamphlets and leaflets (nearly 120 in number) published by the Institute contributed significantly to its activities. The Institute receives foreign trainees sponsored by FAO and International Agencies and Government of India from several countries like Philippines, Burma, Sudan, Tanzania, Guyana, Yemen, and Nigeria in the disciplines of both harvest and post harvest technology of fish for durations varying from one week to 12 months.

CONCLUSION

India has made rapid strides in the field of Fishery Technological Research and Extension in the past two and a half decades. In terms of quality and quantity, the contributions made by the country so far in this area are second to none in the world. The country can legitimately feel proud that in the matter of research and extension in harvest and post harvest technologies of fish, she is now on a par with any of the developed countries of the world.

HISTORY, GROWTH AND ACHIEVEMENTS OF CMFRI

DR. P. S. B. R. JAMES

Director, Central Marine Fisheries Research Institute, Cochin-682018.

HISTORY

The proposal for the establishment of a Central Fisheries Research Institute in India was first made in 1943 by the late Dr. Bains Prashad, who was, at that time, the Director of the Zoological Survey of India. In his Memorandum on the "Post-war Development of Indian Fisheries" he recommended that a "Central Fishery Research Institute be established by the Government of India on lines similar to those of the Agricultural Research Institute, New Delhi, the Veterinary Research Institute at Mukteswar and Izatnagar and the Forest Research Institute at Dehra Dun". This recommendation was endorsed by the Fish Sub-Committee of the Policy Committee on Agriculture and Fisheries and thus, in their Report of 1945, the need for the establishment of Central Marine Fisheries Research Institute was proposed. The Government of India again sought the advice of the Late Lt. Col. Dr. R. B. Seymour Sewell, who had previously been the Director of the Zoological Survey of India, regarding the proposal of the establishment of the Institute. In 1946, Dr. Sewell submitted his "Memorandum on the proposed Fishery Research Institute". Based on his report, the Central Marine Fisheries Research Station (as it was known then) came into existence on 3rd February 1947.

In the beginning, three divisions, namely, Fishery Survey and Statistics, Fishery Biology and Marine Biology and Oceanography were established. The Central Marine Fisheries Research Station had, besides the Headquarters, sub-stations, Units and Survey Centres to handle research on regional basis, zonal basis and collect data on marine fish landings respectively.

The head of the Station was Chief Research Officer. First Chief Research Officer was Dr. H. Srinivasa Rao, who was succeeded on his retirement by Dr. N. K. Panikkar towards the end of 1950. On the appointment of Dr. Panikkar as Fisheries Development Adviser to the Government of India in April 1957, Dr. Jones took over as the Chief Research Officer. In 1961 the designation was changed to Director and simultaneously the term "Station" was changed to "Institute". Dr. Jones was succeeded by Dr. S. Z. Qasim in 1970, by Dr. R. V. Nair in 1974 and by Dr. E. G. Silas in 1975. Dr. P. S. B. R. James took over as Director in 1985.

OBJECTIVES

The main objectives of the Institute were:

- (i) to estimate the catches of the marine fishes and other animals from the seas around India throughout the year by different types of vessels and gears,
- (ii) to conduct research on marine fisheries resources in order to step up their production to the maximum possible extent,
- (iii) to locate new fishing grounds; to conduct environmental studies in relation to fisheries, and to generate additional resources by mariculture, and
- (iv) to recommend measures for the rational exploitation of the various resources.

INITIAL ORGANISATIONAL FRAMEWORK

The Fishery Survey and Statistics Division at the Headquarters was responsible for planning, execution and processing of the data on fish landings and fishing effort, and the estimates of the state-wise, region-wise and species-wise production of marine fish. The Division also attended to the work of stock assessment and estimation of potential yields of fish populations.

The Fishery Biology Division coordinated the work on fishery biology, which includes studies on food and feeding habits, maturity, spawning and life history studies, age and growth, size and age composition of catches, mortality and migration. A careful watch was maintained by the Division on the changes in marine fish stocks. Cochin being one of the important centres for prawn fisheries in the country, a substantial part of the effort was devoted to investigations on the valuable prawn resources. Studies on the culture of prawns have also been started here. The study of the lobster grounds, including those of the deep-sea lobster *Puerulus sewelli*, and the assessment of fishery potential of the crabs, *Portunus pelagicus* and *Scylla serrata*, were undertaken here.

The Headquarters also handled work on the two most important pelagic fisheries, namely, the oil sardine and mackerel. Particular attention was paid to tagging of these two fishes and their shoaling in the grounds beyond the inshore areas. An evaluation of the offshore demersal fisheries resources off the southwest coast was in collaboration with the other fishery institutions, namely, the Indo-Norwegian Project and the Offshore Fishing Station.

The Headquarters was also the main centre for marine biological and oceanographic researches. It co-ordinated the investigations carried out in these fields at the other establishments. Specific projects included studies on food

chain, energy flow in selected ecosystem, determination of standing crops of phytoplankton and biomass of zooplankton with reference to individual groups which are of particular interest to fisheries, the Deep Scattering Layer (DSL) and its biological constituents with reference to their importance as forage for other fishes; seasonal distribution and abundance of fish eggs and larvae, with a view to determining the spawning seasons and spawning grounds of commercially important fishes; and marine environmental damage due to pollution, engineering works and other man-made changes. Special emphasis was laid on problems of regional importance such as the formation of mud banks along the Kerala Coast and their influence on fishery.

After shifting the headquarters from Mandapam Camp to Cochin, the Institute has a Regional Centre at Mandapam Camp and 11 Research Centres: at Veraval, Bombay, Karwar, Mangalore, Calicut, Vizhinjam, Tuticorin, Madras, Kakinada, Waltair and Minicoy. Smaller establishments known as Field Centres are located at 29 centres along the coasts of India.

The Research Centres at Bombay, Calicut, Madras and Waltair were proposed to be upgraded as Regional Centres.

The Institute also established field experimental laboratories at Narakkal (near Cochin), Kovalam (near Madras) and Veppalodai (near Tuticorin).

INFRASTRUCTURAL FACILITIES

The Institute's headquarters at Cochin will now have its own permanent building for accommodating the offices, laboratories, stores, library and class rooms and laboratories for post-graduate students in mariculture. In addition, the Institute has rented accommodation at the Fishing Harbour premises for wet laboratory work, storing and sorting of fish and other samples for analysis and for recording and monitoring of day to day fish catches landed at the harbour. The headquarters of the Institute has facilities for transport for field and other official work and mechanised boats for coastal research.

The Regional Centre of the Institute at Mandapam Camp has provision for various laboratories and residential accommodation for the staff. It has also facilities for guest scientists from the country and abroad and is the most popular resort for visiting students and scientists from several parts of the country. The museum, the laboratories and the aquarium are well equipped and serve the visiting scientists and the public.

The museum at the Regional Centre has a reference collection containing a number of new species described by the scientists of the Institute as well as collections made from different parts of the country including the Andaman and Nicobar Islands and the Lakshadweep. The type material of the new species has been transferred to the Indian Museum in Calcutta recently for being taken care

of by the Zoological Survey of India. The museum also contains models of different types of craft and gear.

The library at the Regional Centre is the finest in the country for literature on marine sciences and allied subjects and one of the best in Asia. It includes a vast collection of books, journals, reprints, cruise|expedition reports, micro-films and micro cards. The library receives many journals and publications and reports free of charge as well as on exchange basis. The library has documentation, photocopying and other facilities. Other research centres also maintain libraries on a small scale.

The Regional Centre has an aquarium with facilities for circulating seawater for 24 hours. The facilities are mainly used for keeping experimental animals. Many species of fishes, shrimps, lobsters, turtles and dugongs have been kept in captivity for a number of years in the past. However, since the building, the tanks and other facilities have come of age, renovation and reorganisation of the aquarium is now being attempted. The aquarium attracts a number of visitors almost round the year.

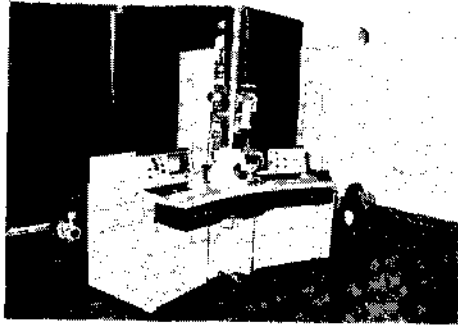
The Centre has a guest house, vehicles and mechanised boats for inshore fisheries research work.

The Research Centre of the Institute at Calicut is located in a permanent building with facilities for a museum and transport. The Research Centre at Karwar is located in the Institute's own building and has facilities for transport and a boat for coastal work. The Research Centre at Tuticorin has recently developed its own facilities for laboratories and hatcheries for oysters and pearl oyster. The Centre has also got transport and boat facilities in addition to a small salt water fish farm. The Research Centre at Madras has two field laboratories at Muthucad and Kovalam, the former attached to a salt water lagoon where earthen ponds have been constructed for experimental work. The field station in Kovalam is located in a temporary building for conducting experiments on marine organisms such as prawns, lobsters, turtles and seaweeds. The Centre has also facilities of transport and boat for coastal work.

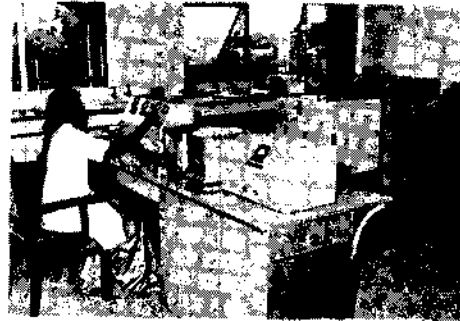
The Research Centres at Waltair, Veraval, Kakinada and Minicoy are expected to develop their own facilities for laboratory and residential accommodation very shortly. All the other research centres have limited transport and boat facilities.

RESEARCH VESSELS

During sixties and seventies, scientists of the Institute were wholly depending upon the mechanised vessels particularly *R. V. Kalava* and *R. V. Varuna* of the Integrated Fishery Project (formerly the Indo-Norwegian Project)



Electron microscope at the Headquarters laboratory, Cochin



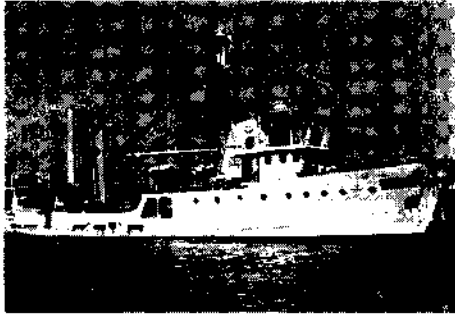
Marine pollution laboratory



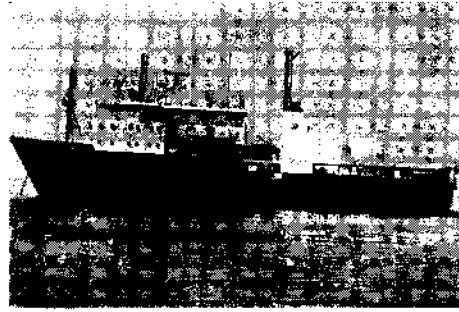
A classroom at the CAS in Mariculture



Laboratory building of Calicut Research Centre



Research Vessel SKIPJACK



Fishery and Oceanographic
Research Vessel
SAGAR SAMPADA
of the Department of Ocean
Development



Research Vessel CADALMIN
for coastal research



Mobile laboratory for survey
and monitoring of biological
and environmental parameters of
coastal farms

at Cochin and other fishing vessels of then Exploratory Fishery Project and Offshore Fishing Station (presently named as Fishery Survey of India) of the Government of India for their research cruises and biological and oceanographical investigations in the Indian seas.

Now the Institute owns nine 43' long *Cadalmin* series of vessels, mostly equipped for inshore fisheries research work, deployed at different centres of the Institute. In addition, the Institute had acquired R. V. *Skipjack* (33 metres long) in 1982 for undertaking offshore fisheries research both along the east and west coasts of India. Quite recently, the Department of Ocean Development, Government of India, placed the Fishery and Oceanographic Research Vessel *Sagar Sampada* at the disposal of Indian Council of Agricultural Research, as a national facility to be used by various Institutes and Universities and other organisations involved in marine sciences research work. The CMFRI has been identified as the nodal Institute for coordinating the technical programme of the vessel. The vessel will be run by the Shipping Corporation of India. The expenditure is borne by the Department of Ocean Development. FORV *Sagar Sampada* is equipped with sophisticated instruments and gadgets and other facilities for undertaking fisheries resources, oceanographic and meteorological work on board the vessel. The vessel has already completed 11 cruises by January 1986 along both east and west coasts of India and the scientists of the Institute have been able to contribute to a good deal of new information regarding marine fisheries resources. It is foreseen that the vessel will contribute greatly to achieve the immediate objective of providing data on the underexploited and unexploited marine fisheries resources in relation to oceanographic conditions in the offshore and oceanic areas of the EEZ of the country.

REORGANISED DIVISIONAL FRAMEWORK AND RESPONSIBILITIES

Several changes have taken place in the fishing industry during the late fifties and sixties due mainly to the introduction of mechanised fishing and improvements to fishing craft and gear. The fishing grounds have been extended and new resources on the outer shelf and the slope began to be exploited. All these developments necessitated that the objectives of the Institute be changed to meet the demands of the industry. Accordingly, in the late seventies, the objectives of the Institute have been modified as follows:

To conduct short-term and long-term multidisciplinary researches on the marine capture and culture fisheries of the country in order to provide RESEARCH support for the rational exploitation, conservation and management of the marine and brackishwater resources for stepping up production from the coastal water areas and the Exclusive Economic Zone and DEVELOPMENT support for growth with stability of the industrial, artisanal and culture fisheries through transfer of technology, dissemination of information, education, training and extension.

Therefore, during the VI Plan, the original three divisions have been re-organised into nine divisions to handle the increased capture and culture fisheries research programmes.

Fishery Resources Assessment Division

The three major technical programmes of the Division are Fishery Survey, Fishery Statistics and National Marine Living Resources Data Centre (NMLRDC). The Division provides data as total and variety-wise estimates of marine fish production for the country, with seasonal and regional breakup along with the estimates of fishing effort expended to get the production. The Division conducts every 4-5 years National Frame Surveys of the fishermen population, fishing villages, fishing crafts, gears and other infrastructure facilities. This helps to understand the potentialities of the traditional small-scale fishery and changing pattern in the fishing industry. The data on such production means also helps in developing suitable plan programmes. The stock assessment of various exploited resources are made by the Division for proper fishery management.

The NMLRDC is the store-house of all types of fishery data and is responsible for coordinating the work of several agencies collecting various types of data. The centre has laid down precise definition and methods for uniform collection of data and has devised standard proformae and circulated them to various agencies for collecting data. The centre is receiving all types of fishery resources data from the Fishery Survey of India, Integrated Fisheries Project and other private agencies. In addition to these data, the centre is also processing regular survey data collected from various fish landing centres along the coastline of India on the basis of sample survey programme of the Institute. The data are analysed and disseminated to the various end-users in the desired form.

Besides these functions, this Division is involved in training in fishery statistics including population dynamics for research workers engaged in research or teaching in the universities, state and central organisations in the field of marine fisheries. Training on the sampling design of this Institute for the benefit of the personnel of Fisheries Departments of maritime States and Union Territories of India is also conducted by this Division.

The Pelagic Fisheries Division

The Pelagic Fisheries Division was formed during the 6th Five-year plan by the reorganization of the Fishery Biology Division, to implement the project programmes on pelagic fisheries resources. Prior to this, the Institute's programmes on the pelagic fisheries resources, were carried out under the composite Fishery Biology Division. The Division monitors the stocks and population characteristics of major resources as those of oil-sardine, mackerel, Bombay-duck and resources of lesser magnitude and which have higher unit value such as pomfrets, carangids and seerfishes. With research vessel facilities the Division

undertakes extensive surveys of the Exclusive Economic Zone to assess the potential of conventional resources such as tunas and related species and non-conventional resources of mesopelagics to help the growth of an oceanic fishery.

This Division conducts mark-recovery studies on pelagic fishes to understand their growth, migration and other aspects. Fishery forecasting and preparation of fishery atlases are also the important functions of this Division.

Demersal Fisheries Division

The Demersal Fisheries Division was formed in 1982 as a result of the bifurcation of the existing Fishery Biology Division. Fin-fishes make up over 80% of the marine landings and, with the rapid strides in mechanization of the fishing crafts and the greater emphasis laid on culture fisheries, a single Division could not adequately deal with the problems relating to both capture and culture fisheries. Such a functional separation of work transferred to this Division the programmes relating to ground fish resources and the culture of marine fin-fishes.

The research programmes of the Division in capture fisheries include evaluation of the biological and fishery characteristics of the ground fish resources such as silverbellies, threadfin bream, Kalava, Ghol, Koth, Dara, Dhoma, Rawas and Snappers from the presently exploited grounds. This involves close monitoring of the catches from mechanised fishing vessels, exploratory vessels and participation in the fishing cruises. In the coming years the evaluation of the demersal resources will be extended to non-traditional grounds and the Exclusive Economic Zone. Other demersal resources which are investigated include the catfishes, wam, lizardfishes, flatfishes, rays, skates etc.

Similarly the potential non-conventional resources such as that of *Priacanthus*, pufferfish, deepwater butterfish and *Chlorophthalmus* which are available in considerable quantities in the outer continental shelf will be evaluated. Preparation of fishery maps for the demersal resources forms an important function of the Division. The Division is also engaged in the programmes of finfish culture involving different candidate species and culture systems.

Crustacean Fisheries Division

As crustacean fisheries programmes demanded greater attention, this Division was created during the V Five-Year Plan from the composite Division of Fishery Biology. The main thrust of research activities of this Division in capture fisheries is on the monitoring projects for the assessment of resources. Prawns, lobsters and crabs constitute bulk of the exploited crustacean resources and they form the mainstay of the marine products exported from India. The multispecies prawn fishery composed of two major groups namely penaeid and non-penaeid prawns is beset with many problems. Increased fishing effort in

certain regions of the coastline has created situations akin to overexploitation and in some other regions the rate of exploitation seems to have reached the optimum level. The major component of the fishery, the penaeid prawns occupy the marine and estuarine environment in their life history and in many parts of the country they are exploited from both these environments.

The dynamics of the species between the environment and exploitation in such regions make the management of the resource very complex. The Division carried out extensive studies on population characteristics and dynamics of the fishery in order to arrive at suitable management policies. The Division also keeps track of the exploitation of the deep-sea prawn, lobster and crab resources with a view to exercise control in their exploitation. This Division is also responsible for fishery forecasts in prawn fishery of the coastal zones and exploratory surveys of the crustacean resources of the Exclusive Economic Zone.

Culture of crustaceans in the marine environment and development of experimental hatcheries for production of seed of prawns, crabs, etc. form an important activity of the Division.

Molluscan Fisheries Division

Like the Crustacean Fisheries Division, the Molluscan Fisheries Division was created during the V Plan to give greater attention and direction to the molluscan resources and culture. The important research activities of this Division have been monitoring of the marine molluscan resources of the country and conducting resources survey on commercially important molluscs such as cephalopods, pearl oysters, chanks, mussels and clams. With an expertise developed for underwater diving with SCUBA, a team of scientists had already surveyed the extensive pearl and chank beds of the Gulf of Mannar and new batches of personnel are being trained in SCUBA diving.

Future programmes of this Division will include resource surveys for the exploitation of cephalopods in the Exclusive Economic Zone and adjacent waters through vessel-based programmes.

The major function includes culture of molluscs such as edible oyster, mussel, clams and gastropods and pearl culture. Hatchery production of seed has been given considerable importance in the recent years.

Fishery Environment Management Division

This Division is primarily responsible for investigations on fisheries oceanography, primary and secondary production, fish eggs and larvae, seaweeds, ecological energetics, mass culture of plankton organisms, marine pollution and ancillary marine resources.

The future programmes include obtaining synoptic pictures of environmental parameters and preparation of fishery oceanographic atlases; intensification of the studies on marine pollution in relation to protection of living resources; assessing productivity of different ecosystems including mangroves for promoting mariculture, investigation on ancillary resources such as corals, sponges, gorgonids, etc.

The Division collaborates with Indian Space Research Organisation and National Remote Sensing Agency in the use of remote sensing techniques for resources and environmental studies.

The additional functions of the Division include investigations on farm engineering and instrumentation and review of legal aspects pertaining to the conservation and management of marine resources in the context of the Law of the Sea.

Physiology, Nutrition and Pathology Division

This new Division, established in 1982, is intended to investigate various basic problems such as neurosecretory, reproductive, respiratory and osmoregulatory physiology and environmental and biological stress on cultivable organisms. On the nutrition side, studies will relate to nutritional biology, preparation of artificial feeds, food conversion efficiencies and large scale production of cheap and suitable feeds for culture organisms.

This Division will also take up research programmes on cataloguing ecto- and endo parasites of finfishes and shellfishes, life history of parasites, host specificity, commensals, vectors, pathogenic bacterial cancerous growth, histopathology, immunology, etc. Diagnostic and disease control measures will also be developed.

Fishery Economics and Extension Division

In capture fisheries, it must be ensured that both industrial fishery and small scale artisanal fishery have to be developed without detriment to each other. In view of the emphasis on exploration and exploitation of the Exclusive Economic Zone and integrated rural development through coastal aquaculture, a whole range of economics of fishery operations and socio-economic aspects have to be investigated in detail to maximise production and improve the rural economy. Therefore, this new Division concentrates on comprehensive investigations on the above aspects and provide reliable data on fishery economics for planning and implementation of development programme.

The Institute intends to have a massive transfer of technology programme to artisanal and farming communities by deploying sufficient man power to conduct field testing and adoption trials; to prepare and distribute printed exten-

sion materials, to participate in Radio and Television programmes, to organise exhibitions, seminars, farmers day and Kisan Melas and to plan documentary films and news reel on relevant technology. The Division will also provide efficient consultancy service and look after the maintenance of marine museum and aquarium.

Library and Documentation Division

Fishery Science has shown a phenomenal growth in recent years and is expanding rapidly in every component disciplines with increasing research efforts. Thousands of books, periodicals and other documents are published the world over. The CMFRI has built up steadily one of the finest library facilities with a holding of 50,000 books and periodicals. In view of the expanding activities of the Institute and in order to keep abreast with the latest technologies developed in various fields, the Division's main functions will be book|journal procurement, technical processing, circulation, reference assistance to readers, documentation, reprography, printing, binding, etc. Besides catering to the research needs of Institute's own staff the library services will be extended to other institutes, universities and departments.

Centre of Advanced Studies in Mariculture

The Indian Council of Agricultural Research (ICAR) with the assistance of UNDP launched a project in 1971 on Post-graduate Agricultural Education and Research in selected fields of agricultural service with a view to promoting post-graduate education, enhancing the competence of professional staff and undertaking high quality research. One of the disciplines included in the second phase of the project is mariculture.

Mariculture in India has been projected as a sector with great growth potential in consideration of the availability of water and species resources and a technological base. To accelerate the pace of this projected growth, it is felt appropriate that research and training of personnel required to execute and manage the projects should go simultaneously with the development of the sector. On this premise, the Centre of Advanced Studies in Mariculture was started as a sub-project of the UNDP|ICAR project mentioned above in June, 1979 at the Central Marine Fisheries Research Institute, Cochin.

The main objective of the CAS in Mariculture is to promote and catalyse research and post-graduate education in mariculture. To accomplish this objective, the following activities are initiated at the Centre:

1. Strengthening of the research programmes in mariculture and corollary aspects through the investigations carried out by the research scholars;

2. Institution of a post-graduate course, M.Sc. (Mariculture) to develop and create a cadre of personnel to meet the research, managerial and executive level manpower;
3. Equipping of the laboratory facilities to carry out research and conduct the education programme;
4. Arranging advanced training of scientists involved in mariculture research and faculty members engaged in educational activities in the identified priority areas;
5. Arranging Expert consultancies in the subjects in which there is little expertise in the country; and
6. Organising workshops and seminars to facilitate exchange of views and enhance research and instructional capabilities among the scientists and teachers in the field of mariculture.

During the last six years, the Centre has been actively participating in all the above activities. Under the post-graduate research programme, 41 short-term (4-5 months) and 13 long term (3.5-4 yrs.) research projects were completed. Most of these projects dealt with the marine penaeid prawns, particularly *P. indicus*, covering different aspects such as reproductive physiology, ecology, nutrition, pathology and physiology. The on-going research programmes include 17 long-term projects under the Ph.D. programme.

In the M.Sc. (Mariculture) programme, 41 candidates were trained between 1980 and November, 1985 in four batches. 17 candidates, 8 belonging to the fifth batch and 9 to the sixth are now undergoing the third and first semester of the course respectively. In the Ph.D. programme eleven scholars completed the research work and two of them have been awarded the Ph.D. degree by the University of Cochin. The works of other scholars are in advanced stage of completion. Twentyeight research scholars belonging to third, fourth and fifth batches are currently working in the programme.

Under the expert consultancy activity, 12 experts, one each in the field of reproductive physiology, fish and shellfish nutrition, shrimp nutrition, tissue culture, fish genetics, crustacean physiology, culture of live food organisms oyster, biology and culture, water quality management and environmental physiology and two experts in fish pathology visited the Centre. Similarly, between 1980 and 1985, 23 subject-matter areas were covered in the training of faculty members. These programmes greatly helped in enhancing competency of scientists in mariculture R & D and education programmes.

Another important activity of the Centre has been the organisation of workshops in subjects of topical importance in mariculture and on research

methodologies since 1979. The centre organised 13 workshops in subjects such as crustacean biochemistry and physiology, fish nutrition, fish pathology, invertebrate reproduction, fish genetics, endocrinology, environmental physiology, water quality management, culture of live food organisms and marine toxins in bivalves and published 9 manuals on research methodologies.

Considerable efforts were made to strengthen the facilities for research in physiology, nutrition, endocrinology and pathology of cultivable organisms; equipping the laboratories with equipments such as spectrophotometer, feed analysis systems, amino acid analyser, gas chromatograph, osmometers, centrifuges, high power and phase contrast research microscopes and Tran-Scan Electrone microscope.

The project has been extremely useful in organising the mariculture research on an inter-disciplinary basis, strengthening of the infrastructure facilities and providing specialised training. The linkages and interaction with the overseas institutions developed during the visits of the expert consultants and the fellowship training programme have helped to build up a cadre of competent scientists in mariculture. Working in the private and public sector undertakings, the candidates trained at the Centre are now engaged in the development of the sector.

Summer Institutes

Between 1974 and 1985 the Central Marine Fisheries Research Institute conducted four Summer Institutes relating to identified subject areas in mariculture. The first Summer Institute conducted in 1974 was on 'Coastal Aquaculture' and dealt with culture systems for prawn, finfish, mussel, edible oyster, seaweed and pearl culture. With the successful achievement of breeding and rearing of marine prawns under controlled conditions the second summer institute was organised on the subject in 1977 at Cochin. The Third Summer Institute was organised in June, 1980 on the 'Culture of edible molluscs'. With the objective of providing an insight into the various systems of molluscan culture developed in the country. The programme was attended by 16 participants.

The fourth in the series was on 'Hatchery production of prawn seeds and culture of marine prawns' in 1985. This was organised to highlight the potential for prawn culture and adoption of indigenous methodology developed by CMFRI for large scale production of prawn seed.

The Summer Institutes provided an opportunity to participants to learn the new technologies developed in the emerging field of mariculture, and to discuss the problems associated with. The thrust given for field work helped the participants to gain practical knowledge in various aspects of mariculture.

Krishi Vigyan Kendra

The Krishi Vigyan Kendra established in December 1976 at Narakkal under the Central Marine Fisheries Research Institute, Cochin has been engaged in giving intensive practical training of durations ranging from 5 to 30 days in prawn and fish farming to small and marginal farmers, landless labourers, school drop outs and the unemployed youth, in order to transfer the latest low cost technologies developed by the Institute to the end users, generating opportunities for self employment among the rural population of the coastal areas. In addition to the main subject of Fisheries, the Kendra has been conducting short term training courses of 1 to 3 days duration in other subjects such as Agriculture, Animal Husbandry, Home Science, Health and Hygiene, Finance and Financing Agencies etc. with the help of specialists in these fields from other departments and Institutions. So far, the Kendra has trained 4159 persons consisting of 1935 men and 2224 women. Out of these, 1884 persons belonged to Scheduled Caste and 7 persons were from Scheduled Tribe.

The follow up surveys conducted, to assess the impact of the training programmes, have revealed that about 31 to 37% of the ex-trainees have taken up employment directly or indirectly connected with prawn and fish farming out of which 12% were doing Scientific Culture, 13.5% were engaged in prawn seed trade and 2.3% practicing semi-scientific culture.

As part of the extension activities, the Kendra has brought out 12 patrikas and leaflets on various aspects of prawn and fish culture, Lab-to-Land Programme and employment opportunities for youth. Besides, popular articles have been published by the staff of the Kendra on prawn culture in the local dailies and other regional publications. Radio talks are given on various topics on prawn and fish culture, training facilities etc. from time to time over the All India Radio, Trichur Station. Science Camps are arranged for the School children and 10 Schools of the area have been adopted to make the children and staff aware of the latest technologies in farming of marine prawn and fish. Field demonstrations of newly developed technologies were arranged in the fields of ex-trainees in various parts of Ernakulam, Trichur and Alleppey districts for the benefit of the numerous farmers engaged or interested in scientific farming.

Film shows were regularly arranged for the trainees on campus and for the public at different places. The visiting dignitaries as well as students parties were also shown films of mariculture interest. They were given lectures on the scientific prawn and fish culture and the activities of the Kendra in the field of training and extension. The Kendra has actively participated in all the All India Exhibitions conducted by the Corporation of Cochin and other agencies at Cochin and other places.

The great awareness among the traditional farmers about the new scientific prawn farming propagated through the KVK is a clear evidence of the impact of the training given by the Kendra. The 'Velon screen' introduced by the KVK for fixing on the sluice gates to prevent the entry of undesirable species has been accepted by even traditional farmers of the area. The "prawn seed industry" of collecting the prawn seeds and supplying them to the farmers has come to stay only after the KVK started giving special training in the collection, identification and transport of prawn seeds. Our training has triggered the scientific prawn culture in areas like Quilon where it was non-existent.

The staff of the KVK have been actively involved in the first and second phases of the Lab-to-Land programme of the CMFRI in the field. The KVK staff have demonstrated the economic feasibility of the culture in the fields of the Valappu Harijan Society by increasing their annual income many folds from the revenue accrued out of the culture of prawn and fishes and also from the yield of the coconut trees and vegetables cultivated on the bunds of the fields as example of integrated farming system. Consequently, in the third phase of the LLP the KVK has been allotted 100 farm families.

Trainers' Training Centre

The Trainers' Training Centre at Narakkal was sanctioned in October, 1983.

Pending recruitment of regular staff, with the help of the scientific staff of the Institute, two training courses in the Hatchery production of penaeid prawn seed, each for a duration of 3 weeks was organised at the Narakkal Prawn Hatchery Laboratory in January-February 1985 and February-March 1985 for the benefit of the officials of the maritime states. Sixteen senior level officers from the States of West Bengal, Orissa, Andhra Pradesh, Pondicherry and Gujarat attended the training courses. Practical training in all aspects of hatchery management including induced maturation and spawning of prawns in captivity, rearing of larvae on a large scale in hatchery tanks, culture of algal feed for larvae and preparation of artificial feed for post-larvae was imparted to participants.

During the year 1985-86, five training courses on hatchery production of edible oyster seed, farming of edible oysters, seaweed culture, hatchery production of marine prawn seed and prawn farming are proposed to be organised.

DIVISION-WISE ACHIEVEMENTS

Assessment of Fishery Resources

One of the first major tasks of the Institute was to develop a scientific system for the estimation of marine fish landings, both for obtaining production

estimates at the national and State levels and for stock assessment purposes. This was a challenging task considering the artisanal nature of the fishery, with a multiplicity of crafts and gears and landings over the long stretch of 6100 km coastline both during day and night. Based on the initial experience gained, the Institute developed a stratified multistage random sampling design, the stratification being over space and time. The design is currently adopted by this Institute and has been recommended for other countries by the Food and Agriculture Organisation of the United Nations. Resources-wise and region-wise estimates are made available to national and international organisations. Fish catch statistics and related data are collected from 62 zones and 20 single-centre zones covering the entire coastline.

Information on fishermen population, gears, crafts employment details, education standards and infrastructure facilities available in the marine fish landing centres has been collected periodically. The most recent census data were collected in 1980. These results are used by the State and Central agencies for planning and developmental purposes.

Some of the basic data for stock assessment are desired through the sampling scheme. Biological and environmental data are collected concurrently. Some of the commercially important fish stocks such as shrimps, Bombay-duck, oil-sardine, mackerel, catfishes, cephalopods and tunnies have been assessed. The classical stock assessment models require information on age structure of the stocks which are not easily available for tropical fishes. Suitable modifications have been made and length frequency data are used for deriving the levels of effort and mesh size for obtaining maximum sustainable yields. Since tropical fisheries are of multispecies and are operated by multigears, gear-specific and species-specific approach may not be possible in many cases for this purpose. Relative response model, a macro analytic one, was advanced by the Institute for assessing exploited stocks in a progressive fishery where total catches alone are considered. Studies made on shrimps, catfishes, etc. have indicated measures to be taken for management and viable exploitation of these resources.

Realising the importance of marine fish catch statistics in the formulation of fishery development plans and management policies, this Institute has been collecting, processing and disseminating data on exploited marine fishery resources for more than three decades. This task is carried out through the National Marine Living Resources Data Centre (NMLRDC). The existing schedules for collection of data on marine fisheries have recently been modified and improved. A code list has been prepared for commercially important fishes to facilitate computerisation.

For application of stock assessment models and proper interpretation of results, training of personnel engaged in fisheries research and teaching has been taken up. The course is of six weeks duration. Three such courses have so far

been conducted for the benefit of those engaged in R & D programmes in the Central and State organisations and faculty members from the Agricultural Universities. A ten-day training programme on the sampling design of CMFRI is conducted for the benefit of the Fisheries Department personnel of maritime States and Union Territories. So far, two such courses have been conducted and 35 persons have been trained.

Pelagic Fisheries

The extent and pattern of exploitation of the pelagic fish resources of the west and east coasts of India have been studied by monitoring the landings from the artisanal, drift net and purse seine fisheries. Analysis of the data from exploratory cruises undertaken on a limited scale has provided information on the nature and extent of distribution of the pelagic resources beyond the presently fished grounds. These studies have revealed two peak periods of abundance during March-May and October-December; the latter being the primary one for most of the coastal pelagic species.

Intensive studies on the oceanic resources like tunas and related species have highlighted the rich and valuable resources of this group of fishes in the seas around India.

Intensive exploratory surveys conducted during mid seventies off the southwest coast of India from Ratnagiri to Gulf of Mannar have brought to light the high potentials for pelagic fish resources such as oil-sardine, mackerel, anchovies (*Stolephorus* spp.), ribbonfishes and horse-mackerel (*Decapterus* spp. and *Megalaspis* sp.) and for mesopelagics like filefishes (*Odonus* spp.) on the continental shelf and slope.

The pelagic fish resources of the northwest coast were studied based on the data collected during the industrial fishery survey by M. V. MURAENA. These studies besides providing valuable information on the distribution and abundance of pomfrets, have brought to light the existence of horse-mackerel (*Megalaspis cordyla*) and ribbonfish stocks of great potential in depths between 100 and 140 metres.

Stock assessment studies on the exploited resources like oil-sardine, mackerel, tunas, anchovies, Bombay-duck, pomfrets, seerfishes, ribbonfishes and horse mackerel have been made. Studies on the stocks of oil-sardine *Sardinella longiceps* on the west coast of India have indicated an average annual stock size of 400,000 tonnes. The mortality rate of population is found to be about 80% ($M = 1.12$) per year and the exploited resources form only about 39% ($F = 0.54$) of the stock. A part of the stock (41.7%), found beyond the present fishing grounds, is known to consist mainly of larger adult fish. The available data point out that considerable increase in the catches is possible by



Pole-and-line fishing for tuna in
Minicoy



Tuna catch at Cochin

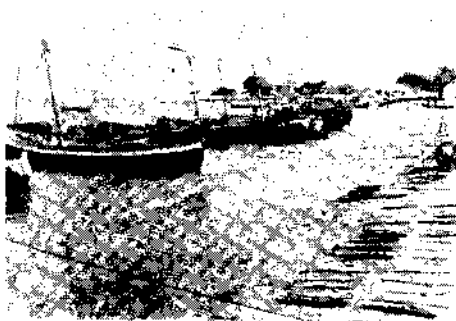


Ribbonfish catch landed at
Neendakara fishing harbour

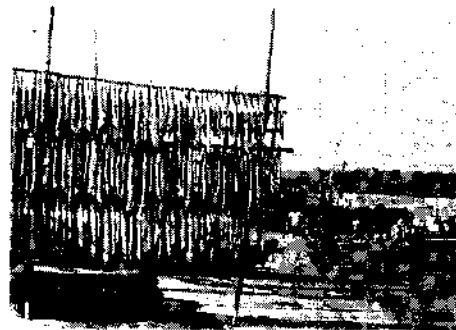


Intensive activities at Cochin
fishing harbour

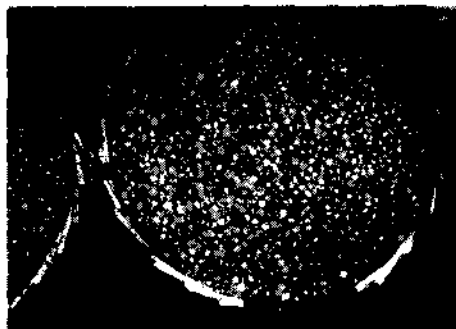
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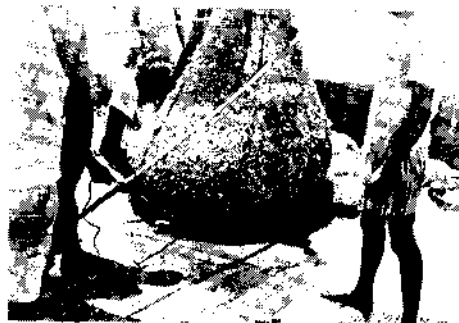
Traditional landing centre at
Tuticorin with seerfish catch



Bombayduck being sun-dried



Catfish eggs from purse-seine
catches at Mangalore



Trawl catch by Research Vessel
CADALMIN

stepping up fishing effort in the offshore grounds employing efficient fishing methods like purse seine. Consequent on the large-scale introduction of the purse seiners in Karnataka and on a limited scale in Kerala, a detailed study was initiated to assess its impact on the stocks and the artisanal fishery. The studies in Kerala have indicated that there is no tangible impact of purse seining on the artisanal fishery for oil-sardine, at the present level of exploitation and availability.

In the case of the Indian mackerel *Rastrelliger kanagurta* stock assessment studies have revealed an average annual stock level of 265,000 tonnes off the south west coast of India (7°-17°N); and considerable portion (32.3%) of the stock is found beyond 25 m depth. The total mortality of the stock in the fishing ground was estimated to be about 90%. Studies on the exploited resources indicate that any further increase in the catches should come from the offshore stocks or by increasing the age at capture (tc) to 8 months in the present fishery (by increasing mesh size).

The estimations on the fished stocks of *Euthynnus affinis* and *Auxis thazard* have indicated that their average annual stock levels were in the order of 206,000 and 7,700 tonnes. The exploitation rate (U) was 0.5 for both the stocks, indicating that the two species are under-exploited and a substantial increase of production is possible by increasing the fishing effort. In the case of the oceanic skipjack (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*), their exploitation rates (U) were estimated at 0.64 and 0.85 and total mortality rates (Z) at 2.07 and 3.17 respectively. In view of the low exploitation rates as compared with the high rates of total mortality, it is emphasized that substantial increase in the production from these stocks is possible by increasing fishing effort.

Studies on the stocks of whitebaits (*Stolephorus* spp.) have shown an estimated yearly average biomass of 479,000 tonnes in the Gulf of Mannar and 267,900 tonnes in the southwest coast (Cape to Ratnagiri). In both the areas the major component species were *S. heterolobus*, *S. bataviensis* and *S. zollengeri* in the order of importance. Major concentrations were located in 20-50 m depth domains in both the sectors. Viewed from the present level of exploitation, vast scope for increased production from these potential stocks exists in both the areas. A critical study of the exploited resources of the anchovies from Indian seas have revealed that species belonging to the genera *Stolephorus*, *Thryssa*, *Coilia*, *Setipinna* and *Thrissina* are the main contributors in the order of abundance. Based on the productivity data and yield equation, a potential yield of 585,000 tonnes of anchovies was estimated for Indian waters. Of the total potential yield, the share of west coast, east coast and Andaman-Nichobar waters is in the order of 403,169 and 13 thousand tonnes respectively. Since the present catch is very meagre compared to the potentials, substantial expansion of the

fishery could be recommended. The expansion of the anchovy fishery will be more rewarding along the coasts of Kerala, Tamilnadu and Andhra Pradesh for *Stolephorus* and *Thryssa*; along northern Maharashtra-Gujarat sector for *Coilia* and along northern Orissa-West Bengal sector for *Satipinna*. Similar possibilities also exist for the increased exploitation of *Stolephorus* and *Thrissina* stocks from Andaman waters.

Studies on the stock assessment of Bombay duck, *Harpodon nehereus* have indicated that at Nowabunder, Saurashtra coast, the present level of exploitation is close to the maximum sustainable yield (MSY) and that any further expansion in the fishery would result only in the over-exploitation of the stocks. By increasing the age at capture higher sustainable yield from the stock is indicated.

The population parameters of the silver pomfret *Pampus argenteus* off Saurashtra Coast were estimated. The growth coefficient (K), the asymptotic length (L_{∞}) and t_0 for the exploited stock were 0.088, 317 mm and - 0.297 month respectively. The species was estimated to grow to an average size of 207 mm, 279 mm and 304 mm at the end of one, two and three years of its life.

The fishery of seerfishes off the Karnataka Coast was mainly supported by the stocks of king seer (*Scomberomorus commerson*), spotted seer (*S. guttatus*) and streaked seer (*S. lineolatus*) of which king seer was the most dominant. The annual mortality rates for the above three species were in the order of 0.6, 0.7 and 0.8 respectively. It follows, therefore, that the seerfishes along the Karnataka Coast were under-exploited and an expansion in the fishery would result in increased production without affecting these stocks.

The resources of horse-mackerel on the southwest coast of India and the Gulf of Mannar have been investigated. The potential resources consisted mainly of *Decapterus* and *Megalaspis*; and an average annual biomass of about 134,400 tonnes was indicated for the whole area. Out of this potential, 16,280 tonnes from the Gulf of Mannar and 118,120 tonnes from the southwest coast (Cape to Ratnagiri) were estimated. The bulk of this biomass was located in 20-75 m depth in the Gulf of Mannar and 50-100 m depth in the southwest coast. Viewed from the present level of exploitation of these stocks, a substantial increase in the catches by the expansion of the fishery is possible.

Studies on the stocks of ribbonfishes (mainly of *Trichiurus lepturus*) of the Andhra-Tamilnadu and Kerala-Karnataka Coast have indicated that these resources were underexploited and greater fishing effort may be applied to get increased yield from the stocks. Increase in the age at capture to 1 year would also substantially increase the production from the existing fishery.

Demersal Fisheries

The early studies have naturally been on coastal ground-fish resources, as the inshore area was the major realm exploited by the artisanal fisheries using the traditional gear and the mechanised fleet of small and medium-sized boats using bottom trawls, bottom-set gill nets or hooks and lines. These provided the information base on the nature of the grounds and the relative richness of the different areas, essential for the development of trawl fishery in the inshore region.

The studies during 1949-55, based on the operations of the trawlers of the Government of India Deep Sea Fishing Station and of the New India Fisheries Co. in the Bombay-Saurashtra waters, marked the first attempt at a scientific analysis of the demersal catch data and the charting of the fishing grounds to provide the distribution pattern of the commercially significant fishes. With the expansion of such exploratory fishing programmes and the setting up of additional bases along the east and west coasts, the analysis of the fishing data and the demarcation of the trawlable areas and productive grounds continued, until nearly all grounds up to 50 m depth were covered. The delineation of the good ground for ghol, dara and Karkara off Kutch, Dwaraka and Porbunder, for eels off Bomay and Cambay, for prawns, nemipterids and perches off the southwest coast, silverbellies off southeast coast and catfishes off north east coast emerged out of these studies.

The areas beyond this inshore commercial belt were also studied, though to a lesser extent, based on exploratory cruises of the Government of India vessels that covered mainly the southwest coast. This brought forth much valuable information on the deepsea prawn and lobster resources near the shelf edge and slope, the perch fishing grounds along the rocky areas at 70-100 m depths and the enormous potential of the bathy pelagic fish complex in the shelf slope and beyond.

With the declaration of the Exclusive Economic Zone the need arose to explore the farther reaches of the shelf in greater detail. The first move in this direction was the comprehensive, year-long Indo-Polish Industrial fishery survey and the detailed analysis of the fishery and environmental data that followed in the late seventies. The study covered the west and northwest zones, from 15° to 24°N and 55 to 360 m depth and indicated the periods and areas of abundance of threadfin-breems at 125-360 m depth, serranids and larger carangids in 90-125 m, and ribbonfishes, pomfrets, horse-mackerel and eels in the 55-90 m depths.

In addition to such over-all studies on the nature and disposition of the demersal fisheries resources, the Institute's work included detailed studies on individual fish species/groups that contributed to major commercial fisheries,

chiefly catfishes, threadfin-brems, silverbellies, sciaenids, perches, eels, flatfishes and lizardfishes. The earlier years were devoted to the essential studies on the biology of the main species. Data on recruitment, feeding and growth, maturation and spawning along with catch data, are required for a proper scientific appraisal of the stocks available for exploitation and for a proper management policy. Such studies on the dynamics of the exploited populations of the main species of catfishes, threadfin-brems and silverbelly have been carried out. The estimations on the fished stocks of the five catfish species *Tachysurus thalassinus*, *T. tenuispinis*, *T. serratus*, *T. dussumieri* and *Osteogeniosus militaris*, have indicated that, except for the last-mentioned, all species are at present under heavy fishing pressure and either the pressure has to be reduced or the size of fish caught increased, if the fisheries are to be sustained. While this is the situation common to all regions, the extent of regulation needed is greater for Waltair and Mandapam and relatively less for Cochin and Veraval.

Studies on the stock of the threadfin-bream *Nemipterus japonicus* have indicated that at Kakinada any increased effort on the present fished stocks at the present size of capture would only result in lesser yield. Greater production from these grounds is possible only by increasing the size of capture (increasing mesh size). At Madras, however, the stock is not fully exploited and greater fishing effort may be applied to get increased yield without adversely affecting the stock.

In the case of silverbellies, studies on *Secutor insidiator* has indicated that, though, theoretically, increased catches can result from a reduction in age at capture, this is not advisable, as the present age is near the age of maturity and a reduction of fishing size would result in the removal of spawners and so adversely affect the stock.

The significance of the exploratory surveys and the demarcation of coastal fishing grounds to the trawl fishing industry needs no reiteration. With the declaration of the EEZ and the availability of vast shelf areas for exploitation, the prime need now is to explore the offshore areas up to the shelf edge and beyond, and a beginning has been made by the Institute's participation in the industrial fishery survey covering the region from Goa to Okha upto a depth of 360 m and the subsequent detailed analysis and charting of the important fishing grounds for the different commercially important fish species/groups.

Studies on the presently exploited demersal resources have shown that, with the rapid development of the mechanised trawl fishery in recent years, many of the inshore fisheries are under heavy fishing pressure and damage to stock can be avoided only with a decrease in fishing effort or increasing the mesh size of gear used. This has great relevance to future development plans on marine resources. Since trawling is the means of exploitation of the shrimp,

which is the most important foreign exchange earner, an increase in mesh size to save some other resources, would be at the expense of the shrimp industry. So, the reduction in fishing effort in the inshore areas would be the practical alternative, and this would necessitate the diversification of fishing to farther and potential grounds, and this is clearly linked to exploratory studies in the EEZ.

With the world trend of marine fish catches levelling off in the face of increasing demand, attention is being turned to culture fisheries to augment production. While, in our country there is still scope for exploitation from off-shore fishing grounds, the building up of an efficient fleet of trawlers and the needed infrastructure, is a highly capital-intensive venture. Hence, the need to turn to culture fisheries would seriously arise and the experiments on fish culture are pre-requisites for any future developmental plans in this direction.

Experimental finfish culture had been part of the Institute's programme from the early years at Mandapam, along with the necessary biological and physiological work on selected species. The culture programme was intensified and extended to other centres in the course of the past decade and a half to Tuticorin, Madras, Calicut and Narakkal, by mono and poly-culture techniques, in ponds, cages and pens. Special attention was paid to development of techniques to make use of waters at present lying unutilized such as the coastal lagoons, low-lying and seasonally inundated areas. Prawns, milkfish, mullets have been reared successfully in ponds and pens, while preliminary studies with species of *Lethrinus*, *Epinephelus* and *Lates* at Mandapam and Tuticorin have yielded promising results.

Crustacean Fisheries

Work on marine crustaceans started in 1947 at the very inception of the Institute at Madras. With the establishment of the Prawn Research Unit at Narakkal in 1951 attention was focussed on the prawns which very soon became the foremost marine fishery resources of great economic and industrial importance.

Research on the biology, life history and fishery of the commercially important prawns on the southwest coast was initiated. The rapid expansion of the export market for frozen prawns, the discovery of new fishing grounds for prawns and the introduction of mechanised boats for trawling gave further impetus to the research on prawn fisheries. With the opening of research centres all along the east and west coast of India a concerted effort was made to study the prawn fisheries on an all India basis. A wealth of information was collected on the distribution and abundance of the prawn species in space and time, their growth, feeding habits, fecundity, sex ratio, and their movements parallel and perpendicular to the coast. Pioneering work on the taxonomy of the Indian prawns was also done throwing new light on the systematic position and geo-

southwest monsoon season. They complete this 380 km journey in 68 days at an average speed of 5.6 km per day. This study also showed that the prawns grew from a size of 110 mm to 149 mm during this period.

Apart from the major research thrust on the prawn resources of the country, the other crustacean resources such as rock lobsters, crab and stomatopods have also been the subject of study. In recent years the lobster landings have increased at Veraval and Bombay. The stomatopods or mantis shrimp which were being discarded in the sea earlier are now being utilized as poultry feed and are a potential source of Chitin which has various industrial uses.

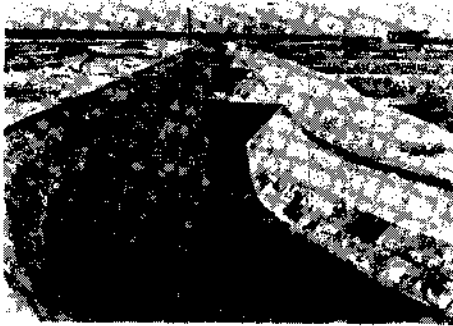
Prawn Culture

During the last decade there has been a tremendous upsurge in the prawn culture activities throughout the world to provide additional material for the burgeoning frozen prawn industry. The Institute took an active interest in prawn culture and established the Marine Prawn Culture Laboratory at Narakkal near Cochin in 1975. Within a year all the commercially important species of penaeid prawns such as *P. indicus*, *P. monodon*, *Metapenaeus dobsoni*, *M. monoceros*, *M. affinis* and *Parapenaeopsis stylifera* have been made to spawn in the laboratory and their larvae reared upto the postlarval stage under controlled conditions. A detailed study of the structure of the larval appendages enabled the scientists to rationalise the larval rearing procedures which were being developed simultaneously. To feed the prawn larvae, indigenous methods for culturing live feed organisms such as diatoms, rotifers and cladocerans on a large scale were developed. The larval rearing technique was improved and simplified over a period of 8 years. By this process of steady improvement, the Institute has now evolved a totally indigenous, low-cost technology for the hatchery production of penaeid prawn seed, specially suited to the Indian conditions.

Intensive work on methods of induced breeding of prawns has resulted in the development of a technique for making farm grown prawns mature and spawn in captivity. Unilaterally eyestalk ablated prawns kept in specially designed maturation pools where the water quality is strictly controlled, mature and spawn within 4-5 days.

Development of reliable techniques of larval rearing and induced maturation has enabled the domestication of *P. indicus* in the Narakkal farm *i.e.* this prawn now completes its entire life cycle in the farm itself and six continuous generations have been maintained.

To enable the interested parties in setting up prawn hatcheries to supply seed to the rapidly expanding prawn culture industry in the country a manual entitled "Hatchery production of penaeid prawn seed" has been published by



Marine fish farm at Mandapam
Regional Centre



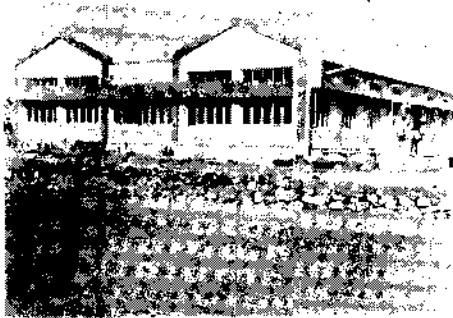
Experimental marine prawn
culture farm at Narakkal



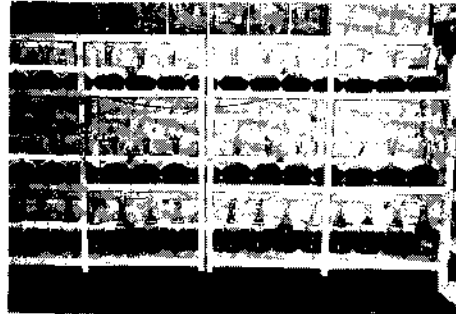
Harvested milkfish from
experimental pen culture at
Mandapam Regional Centre



Coastal fish farm in mangrove
ecosystem at Tuticorin



Experimental molluscan shellfish hatchery at Tuticorin



Microalgal culture facility at the hatchery at Tuticorin



Molluscan spat production system at Tuticorin



Pearl oyster spat produced in hatchery

the Institute giving details about hatchery site selection, hatchery equipment and lay-out, induced breeding techniques, larval rearing techniques, preparation of live and artificial feeds for the larvae and economics of operation of a commercial hatchery.

While the Narakkal Laboratory concentrated on *P. indicus*, the Institute's field station at Kovalam near Madras has been successful in domesticating the Japanese prawn *P. japonicus* and in the hatchery production of *P. monodon* seed. The Karapad Laboratory of the Tuticorin Research Centre of the Institute has achieved similar success with *P. semisulcatus*.

A technique of artificial insemination of *P. indicus* and *P. monodon* has been developed. This is a significant achievement that is basic to all future work on selective breeding of prawns for improving production in culture systems.

A sea ranching programme for producing the seed of *P. semisulcatus* on a large scale and releasing them in the Palk Bay to augment the natural stock of this species which supports a good trawl fishery in the Palk Bay area, has been initiated. The semienclosed nature of this shallow Bay, the sedentary nature of the species and the habit of the young ones of this prawn to cling on to seaweeds which abound in the area, are factors that are favourable for taking up this sea ranching programme, which will benefit the fishermen of the area.

Production of upto 600 kg/ha of marketable size (65 nos. head-on/kg) *P. indicus* has been achieved in a culture period of 50-55 days at the Narakkal farm. The possibility of culturing *P. indicus* in the brackishwater canals of the coconut groves in the Vypeen Island has been demonstrated. A pelletised feed compounded from locally available raw materials such as prawn head waste, mantis-shrimp, fish meal, groundnut-oil cake and tapioca has been developed at the Narakkal farm. It contains 25% protein and gives a conversion ratio of 4.0.

Progress has been made in rearing the larvae of the crabs *Scylla serrata* and *Portunus pelagicus* to the crab stage in the laboratory. Rapid increase in growth rate of cultured lobsters has been achieved by eyestalk ablation.

Molluscan Fisheries

At the time the Central Marine Fisheries Research Institute was established in 1947, the exploitation of molluscan resources in the country was very limited. There was subsistence fishery for the backwater clams in the estuarine regions and mussels in the coastal areas in some pockets. The squid was exploited for local consumption in the Palk Bay. Oysters were collected sporadically for local consumption. The pearl fishery of the Gulf of Mannar and Gulf of Kutch were of intermittent character and, except for the series of 1955-61 in Gulf of Mannar, no worthwhile pearl fishery was conducted. The subsoil deposits of

clam shells were moderately exploited, not for industrial purposes, but mainly for lime-kiln use.

From such a situation of very poor exploitation of the molluscan resources in the forties, the country has advanced to much higher levels of utilization of the molluscs thanks to the resource data provided for development and culture technologies developed at the Institute.

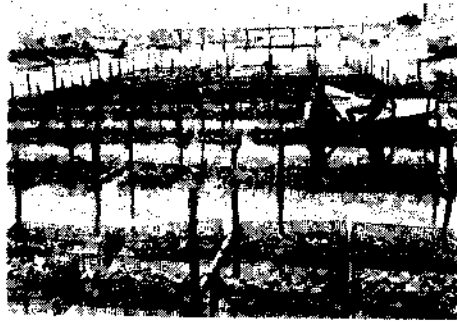
An inventory of the molluscan resources, species composition distribution and levels of exploitation has been made based on surveys conducted from time to time in different regions along the coasts of India, including the Andaman and Nicobar Islands. This forms the base-line data for the development programmes for increasing production and for management of the resources.

The clam resources of the estuaries of Karnataka and Kerala, which form the mainstay of the subsistence fishery along the coastal stretches of these two states, have been investigated in detail. This was done particularly in the context of the recent spurt in export of clams, including the "baby" clams from this region, with a view to providing the resource information for conservation of the resource. The species in question are *Meretrix meretrix*, *M. casta*, *Katelysia opima*, *Paphia* spp. and *Villorita cyprinoides*.

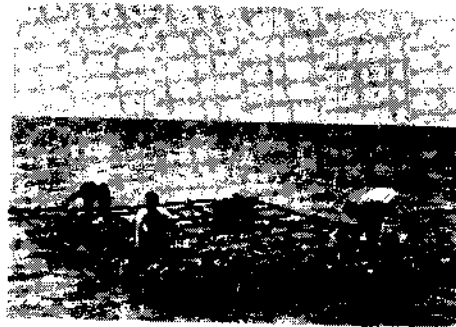
The mussel fishery for the green mussel *Perna viridis* along the Malabar Coast and for the brown mussel *P. indica* along the extreme southwest coast, has been studied and the resource potential and level of exploitation have been indicated. The standing stock of *P. indica* was estimated at 1610 t (1983-84) while the landings were only 556 t along the southwest coast. No estimate of standing stock of *P. viridis* could be made, but the catch was estimated to be 2597 t.

Along the east coast, the molluscan resources of Kakinada Bay, particularly those of the blood clam *Anadara granosa* and windowpane oyster *Placenta placenta*, were surveyed in detail and the potential for further development has been indicated. Estimated molluscan resources of Kakinada Bay (1983) were: *Anadara granosa* - 6895.3 t; *Placenta placenta* - 12418.7 t; *Paphia textile* - 664.7 t; and *Meretrix meretrix* - 1081.6 t.

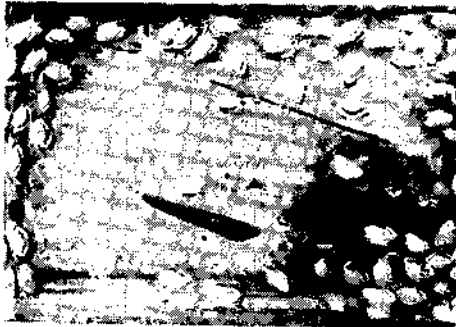
The pearl banks of the Gulf of Mannar were surveyed on a scientific basis by underwater observations using SCUBA and the configuration of the 'paar's, ecology of the grounds and the pearl oyster resources along with the associated fauna and flora, were documented for use. Subsequently periodic surveys have been conducted to understand the resource position from year to year and the composition of *Pinctada fucata* along with the flat pearl oysters, the latter being an incursion during the recent years. Predation by gastropods was observed.



Oyster culture farm at Tuticorin



Pearl oyster farming under
raft culture



Seylla serrata produced in the
crustacean hatchery at Tuticorin



Mussel seeding for raft
culture at Calicut



Seaweed culture on coirnet frame
at Mandapam



Sea turtle hatching programme
at Kovalam, Madras



Underwater investigation on pearl
banks at Tuticorin



CMFRI had participated in the III
Indian Antarctic expedition during
December 1983-March 1984 for
oceanographic and krill investi-
gation: photo shows the Antarctic
krill, *Euphausia superba*

The resources of the sacred chank *Xancus pyrum* have similarly been surveyed in Gulf of Mannar and monitored in other regions of their exploitation such as the coasts of Tamil Nadu and Kerala.

Squids and Cuttlefishes have gained prominence during the last decade as items of export. The cephalopod resources of the inshore waters have been closely monitored and the stocks of *Loligo duvaucelii* and *Sepia pharaonis* have been estimated for some centres.

Stock estimates of cephalopods of inshore waters (1979-80 data):

Average annual stock of <i>Loligo duvaucelii</i> off Madras	.. 104 t
Average annual stock of <i>Loligo duvaucelii</i> off Cochin	.. 250 t
Average annual stock of <i>Sepia aculeata</i> off Madras	.. 168 t
Average annual stock of <i>Sepia pharaonia</i> off Vizhinjam	.. 636 t

Overall estimates (projections based on above data) for all-India cephalopod resources of inshore waters are: *D. duvaucelii* - 18,203 t, *S. aculeata* - 23,536 t and *S. pharaonis* - 15,245 t.

The vast potential resources of oceanic squid *Symplectoteuthis oualaniensis* in the EEZ of India have been indicated based on survey results of Research vessels.

A significant breakthrough was achieved in developing indigenously the techniques of pearl culture. This has led to the establishment of a new pearl culture industry in the country.

Techniques for the culture of edible oyster have been developed. Under rack-tray culture method, the annual production estimate is about 135 t/ha for the shallow coastal region.

Open-sea mussel farming techniques developed at the Institute at different centres yield an average production rate of about 10-15 kg of mussel per metre length of seeded rope per season of 7 months under raft culture. It has also been found feasible to culture mussel in salt-water lagoons of shallow depth.

The blood clam (cockle) of Kakinada Bay has given estimated production rates of 38-42 t/ha/6-7 months under experimental culture.

Another major achievement has been the development of techniques for seed production in hatcheries. Following the initial breakthrough of technology for pearl oyster seed production, the edible oyster seed is also produced on large scale in experimental hatchery. Similarly mussel has been brought under the hatchery technology. The problem of paucity of seed for large-scale culture operations of economically important bivalve molluscs has been solved. Experimental success in clam seed production has also been achieved.

Initial success in rearing the cuttlefish from egg clusters to adults has been achieved in the laboratory.

Basic researches on reproductive physiology of mussel and pearl oyster, larval nutrition of pearl oyster and pearl-sac formation have been undertaken.

Under an inter-institutional project with the Central Institute of Fisheries Technology, product development and quality control of molluscan products were taken up. In another such project with the Vikram Sarabhai Space Centre, FRP floatation blocks for open-sea mariculture have been developed.

The mariculture technologies are linked with developed programmes for increasing production. Specifically, pearl culture has already been adopted by industry, so also pearl oyster hatchery technology. Oyster culture and mussel culture technologies remain to be taken up by industry. In oyster culture, product development and trial marketing has been done by the Integrated Fisheries Project using oyster production from CMFRI experimental farm. A very good potential market in the country for oyster has been indicated. All these technologies have been transferred to interested State Fisheries Department personnel through training programmes in pearl culture, oyster culture, mussel farming and underwater ecological studies. Gujarat has an R & D programme in pearl culture based on CMFRI technology.

Fishery Environment Management

In the early period, the investigations on the fishery environmental conditions were confined mainly to the coastal belt, using country boats or small mechanised boats. Gradually the work was extended to areas further out with the help of trawlers of the then Deep Sea Fishing Station. With the Indo-Norwegian Project's fishing vessel M. O. KRISTENSEN and with Cochin as base regular oceanographic surveys began. With R. V. KALAVA regular oceanographic cruises were conducted along the west coast of India. The area under intensive investigation was the southern section of the west coast from Cape Comorin in the south to Mangalore in the north, as well as the Gulf of Mannar and the seas around the Laccadives.

Oceanographic studies in the area between Cape Comorin and Mangalore showed very interesting features. It was found that the pattern of temperature distribution in most cases (except during the colder months) is bimodal or multimodal. During the southwest monsoon upwelling takes place along this coast when the surface water is displaced by subsurface water. Almost a complete turning over takes place during the process of upwelling and it spreads over the entire continental shelf. The amount of water drawn from the subsurface layers varies with the intensity of upwelling, but in general the upper 100 m of the subsurface water interacts in this process. In the south-eastern

Arabian Sea three major water masses have been recognised in the upper 300 m of the sea (a) the Arabian Sea surface water, (b) the Arabian Sea upper subsurface water, and (c) the Arabian Sea lower subsurface water.

The investigations have revealed the mixing of the Indian equatorial water, which is found between 200 and 2,000 m with the Red Sea water, a process very much similar to the mixing of the Mediterranean water with the Atlantic water. This mixing presumably results in the formation of the intermediate deep water masses in the Arabian Sea. In the Laccadive Sea comparatively low salinity water is found during the dry months. This may indicate the presence of the subarctic bottom drift. Prominent eddy circulations have been noticed between Alleppey and Quilon and in the vicinity of Calicut. The data collected on aspects such as divergence, convergence, upwelling and circulation have given certain clues for a better understanding of the dynamics of the mud bank formation. The circulation pattern and thermal structure show that the region off Calicut serves as a transition zone between the northern and southern water masses.

Upwelling along the southwest coast of India during the southwest monsoon has considerable influence on the coastal fisheries. Due to upwelling the demersal fishes were found to disappear from a rather broad belt parallel to the coast.

Based on plant pigment content an estimate of the resources was made for the first time in the country. After conducting extensive qualitative and quantitative studies on the planktonic organisms in the Gulf of Mannar and Palk Bay, investigations were initiated in the Gulf of Mannar and Palk Bay on the organic productivity using the light and dark bottle technique. With the availability of radioactive C^{14} , intensive investigations were carried out at Mandapam and subsequently on the west coast using the research vessel R. V. VARUNA of the Indo-Norwegian Project. These studies yielded very useful information on the productivity of the Indian Seas which was used for the computation of the resource potential of the Indian Seas and the Indian Ocean in general. Detailed studies on the zooplankton, secondary production and the Deep Scattering Layers on the west coast were carried out in the sixties from observations made on board R. V. VARUNA.

The conservation programme on endangered marine animals and studies on corals, sponges, echinoderms and seaweeds have greatly contributed to development of resource data on these animals.

Projects on marine pollution in relation to protection of living resources, remote sensing in marine fisheries, research on bioactive agents, seaweed culture to augment the natural production and genetic improvement of seaweeds in

recent years and survey of seaweed resources in collaboration with CSMCRI were initiated in the seventies.

The Institute collaborated with Space Applications Centre, Ahmedabad and National Remote Sensing Agency, Hyderabad to develop suitable algorithms for chlorophyll scanning and ocean colour. These investigations were conducted as a Joint Experiments Programme (JEP) for Fisheries for the utilization of satellite data to locate areas of high productivity in the Exclusive Economic Zone of the country. The studies indicated that chlorophyll which is an index of the bioproductivity as well as ocean colour and suspended organic matter could be used as indices of fisheries potential. More recently, FORV SAGAR SAMPADA, Department of Ocean Development's newest research vessel with sophisticated instruments for fishery and oceanographic research has given a new dimension to the programmes of environment management.

Other major achievements have been in the following areas:

Secondary production and its relationship on the distribution of fishes in the EEZ; quantitative and qualitative abundance of fish eggs and larvae on the west and east coast of India; distribution of the Antarctic krill; isolation and mass culture of uni-cellular algae for hatchery development of larvae; ecology of mangrove areas and their influence on the fishery resources; coral resources and behaviour of reef fishes, marine pollution monitoring with reference to heavy metals, pesticides and industrial effluents; formation and environmental characteristics of the mud banks of Kerala; screening of bioactive agents from number of marine animals and plants and development of conservation measures for endangered marine animals and national parks.

Environmental survey of selected ecosystems with the aid of a Mobile Laboratory in Orissa, Kerala and in Tamil Nadu has enabled the identification of sites for mariculture and also liming|fertilizer|requirements to augment the production of culturable species of prawns and fishes in culture systems.

Fishery Economics and Extension

With the declaration of Exclusive Economic Zone and the formulation of integrated rural development programmes in mariculture, a whole range of economics of operations of both capture and culture fisheries and also socio-economics of fisherfolk has gained considerable importance.

An investigation carried out to assess the impact of large scale introduction of commercial purse-seining in Karnataka coastal waters showed that even though the total catches increased through purse-seining the traditional Rampani operators suffered a severe economic set-back. The Institute recommended several remedial measures like providing Rampani owners with purse-seiners through liberal government loan and giving priority for Rampani operators as

crew-members of purse-seiners. A similar detailed study made in Kerala indicated that the effect of purse-seining at the existing level of exploitation was not tangibly felt on the indigenous fishery.

Socio-economic studies of the fishermen families at Puthiappa (near Calicut, Kerala) where the credit was obtained from ARDC indicated that there was marked improvement of economic conditions of families which resorted to mechanisation compared to others. Studies at Sakthikulangara (near Quilon), Kerala) showed that a decade long mechanisation process brought about better economic returns. However it was noticed that families in the middle and higher income groups which have good financial backings were the main beneficiaries of the additional income generated.

A study on income and other associated aspects in selected villages of Maharashtra and Gujarat showed that significant difference exist in income levels between categories based on ownership of craft/gear - the mechanised craft owner getting the maximum annual income and the labour group receiving the least.

A case study on coastal rural indebtedness conducted at Vizhinjam (Kerala) revealed that over 80 per cent of the fishermen families were in debt. Private money-lenders were the major source of borrowing and accounted for 87 per cent of the total credit. A similar study was conducted in Sakthikulangara area (Kerala). It was suggested that institutional agencies should play a more dynamic role as credit agencies so that the fishermen are saved from the money-lenders who exploit them at all stages.

An economic evaluation of paddy-cum-prawn culture in Kerala showed that the deciding factor for increased returns was the availability of *P. indicus* in the fields. Efforts should be made to provide seeds of *P. indicus* to farmers in adequate quantities so as to augment production and income.

A study conducted at selected centres on price spread showed that the fisherman's share in consumer's one rupee for quality fishes was about 65 per cent while it was only about 35 per cent for cheaper and easily perishable fishes.

A study on the comparative economics of different types of mechanised fishing units conducted at Cochin Fisheries Harbour during 1983-84 indicated that the pay back period for a purse seiner was 3.4 years, trawler 5.5 years and gill netter 3.4 years. The ratio of net profit to initial investment was 29 per cent for a purse seiner, 18 per cent for trawler and 29 per cent for gill netter.

A study conducted on the role of women in small-scale fisheries in Vypeenkara (Kerala) helped in identifying the areas and extent of participation by women in fishery related activities. Investigations on nutritional status of the fishermen community in the study area indicated that the diet provided 75%

of calories and 50% of the protein requirements. The weights of pre-school children showed that they were well within the UNICEF standards upto 2.5 years and then showed a decline.

In an attempt to identify the constraints involved in the adoption of technologies developed at the Institute a study on the awareness and attitude of fish farmers towards prawn farming technology was carried out. 80% of the farmers were aware of the practice, the major source of communication being radio and newspaper. The fish farmers tended to have favourable attitude towards the new practice.

Physiology, Nutrition and Pathology

From 1982, the Institute took up appropriate research programmes in physiology, nutrition and pathology of fish and shellfish which formed either complementary or supplementary to the major ongoing research programmes on the culture of candidate species.

Ecophysiology and respiratory physiology of fishes and shellfishes have been the important research aspects studied in this field. The penaeid prawns that migrate to and fro the sea and estuaries|brackishwaters are found to adapt to different saline conditions of the ecosystems through active regulation of the chloride content of the haemolymph. The free amino acid (FAA) and protein levels of *Penaeus indicus* at different saline, pH and dissolved oxygen levels of the backwaters show significant correlation between these biochemical and environmental parameters. However, the variation in the FAA and protein levels in the abnormal 'soft' prawn and in the normal prawn have revealed higher level of protein catabolism in the former. The seasonal fluctuation of the calcium content in the haemolymph, is always found at higher levels than the calcium content of the pond water in which these prawns are cultured. However, relatively higher levels of calcium in the muscle and low levels in the exoskeleton is observed in June when the salinity of the pond water decreases due to monsoon rains. This difference in the calcium levels in the haemolymph, muscle and exoskeleton of the prawn indicates some imbalance in the physiological process and impairment of the carriage mechanism of calcium from the haemolymph to exoskeleton during adverse low saline ecological conditions. The absence of nickel and cobalt in the hepatopancreas and muscle of *P. indicus* is another interesting observation made on the trace metal composition and profile of the prawn.

Researches on the respiratory physiology of *Panulirus polyphagus* have elucidated that the lobster could survive at the lowest oxygen partial pressure for considerable time without using the external oxygen. The tolerance capacity of the lobster to different salinities is found to shift either to higher or lower levels depending on the acclimation of animal to such media.

To facilitate controlled breeding and brood stock development of cultivable fishes and shellfishes, the biochemical and endocrinological strategies of the reproduction are being studied. In the pearl spot, which breeds intensely during December-January, the cholesterol level in the blood and the gonad are found to increase along with the gonado-somatic index. The gonadotrophs responsible for the maturation events are found located in the proximal pars distalis portion of the pituitary gland. In *Penaeus semisulcatus*, the glycogen and carotein contents of hepatopancreas are found to increase along with maturation of the ovary from immature to mature stage. The glycogen content in the hepatopancreas of males, however, has not shown any significant change.

The protein requirement of the larvae of *P. indicus* is found to be initially about 40%. As they grow to postlarval and juvenile stages, protein requirement decreases to the level of 30-35%. The optimum lipid requirement of juvenile *P. indicus* is found to be 6%. For the fry and fingerlings of *Liza macrolepis*, the feed containing 40% protein, 40-50% carbohydrate and 3% lipid has given more efficient growth rate, conversion efficiency and survival rate.

To facilitate selection of ingredients for feed formulation and development, chemical and biological data of about 95 conventional and non-conventional feed ingredients and certain live food organisms are collected.

The common diseases and abnormalities encountered in the farmed fishes and shellfishes at Cochin, Vizhinjam, Manapam Camp, Tuticorin and Madras have been surveyed. The important diseases recorded are the bacterial diseases, ciliate infestation and 'soft' syndrome in the penaeid prawns at Cochin, the digenean trematode infestation by *Bycephalopsis haimeanus* causing castration of gonads in oyster, and haemorrhagic septecemia, skin lesions and columnaris disease in milkfish at Tuticorin; several diseases such as cripple body disease, white patch disease and cauliflower disease in the Indian short-finned eel at Mandapam; 'milk shrimp' or 'cotton' disease in the penaeid prawns from the southwest coast and from Madras, and fungal disease causing mass mortality of *P. monodon* larvae in the experimental hatchery at Madras. Among these, the 'soft' prawn phenomenon and the 'milk-shrimp' diseases are found to cause considerable production loss of penaeid prawns. Appropriate control and prophylactic measures for certain diseases are also prescribed.

The data on the variation of FAA and protein levels in *P. indicus* are found to be useful as indices to identify the 'stressed' and normal prawns. The research results obtained from the respiratory physiological studies have bearings on the transportation of seed to nurseries and stocking ponds and of live animals to markets. The basic information obtained on the nutritional requirements of *P. indicus* larvae and juveniles has enabled to formulate appropriate feed for these stages using the locally available ingredients such as mantis-shrimp meat

and tapioca, which are now used in the hatchery production of seed and for the culture of juveniles in the grow-out ponds.

Library and Documentation

The Central Library of the Institute was established at Mandapam Camp in 1949. Sectoral libraries were formed later at important Research Centres. In 1959, the library holdings reached 10,000 volumes with 160 periodicals, of which 60 were subscribed for the rest being received on free or exchange basis. The sectoral libraries were also developed in all outstations.

The Central Library was shifted to Headquarters of the Institute at Cochin in the year 1971. By then the holdings of the library was 20,000 volumes. With the establishment of the 'Centre for Advanced Studies' in Mariculture in 1979, a 'Book-Bank', consisting of multiple copies of important text-books, was begun to be organised. The present holdings of the library (as on 31-12-'85) includes 14,000 books and 16,000 periodicals.

The library receives 364 periodicals. The 'Colon-Classification Scheme' and 'Colon-Cataloguing-Code' are adopted for classifying and cataloguing the collection of books. The library provides references service and bibliographic service apart from loaning of books and periodicals to the Institute's scientists. Inter-institutional-loan facilities are provided. The library facilities are freely made available to visiting students, scholars and research workers from the country and abroad.

The library issues a monthly publication entitled Current Awareness Service and Selective Dissemination of Information.

LIAISON, COORDINATION AND CONSULTANCY

The CMFRI has maintained and developed linkages with several national and international research and development departments|organisations and universities for collaborative work in marine fisheries. The Institutes with which the CMFRI has collaborative joint programme and linkage are the Central Institute of Fisheries Technology, Integrated Fisheries Project, Central Institute of Fisheries Nautical & Engineering Training, Marine Products Export Development Authority and University of Cochin, at Cochin; Central Institute of Fisheries Education, Bombay; the fisheries departments of maritime states, Central Salt and Marine Chemicals Research Institute, Bhavnagar; Fishery Survey of India, Bombay; Indian Agricultural Statistics Research Institute, New Delhi; Fisheries Colleges of Agricultural Universities, Other Universities, Indian Space Research Organisation, National Remote Sensing Agency, Space Application Centre, Vikram Sarabhai Space Research Centre, Films Division, Government of India, South East Asia Fisheries Development Centre (SEAFDEC), Inter-

national Centre for Living Aquatic Resources Management (ICLARM), and the United Nations Development Programme|Food and Agricultural Organisation.

The Institute has been offering consultancy to various organisations, institutions, departments and entrepreneurs on matters pertaining to marine capture and culture fisheries.

PUBLICATIONS

The publications detailed below are issued from the Institute:

1. *Indian Journal of Fisheries* is a primary journal documenting original research results on marine fisheries and allied subjects from our country as well as from abroad. Started publishing from 1954, the journal was issued as annual volumes of 2 numbers each till Vol. 30, 1983, but from Vol. 31, 1984, onwards the numbers have been increased to 4 quarterlies.
2. *CMFRI Bulletins* are issued from time to time, since 1968, to disseminate current knowledge in the various fields of research on marine fisheries and allied subjects in India. It is monographic in nature. Up till No. 24, 1970, the bulletins were mimeographed, but from No. 25 onwards it is issued in printed form. So far 35 Bulletins have been published.
3. *C.M.F.R.I. Newsletter* is dealing with important activities of the Institute. No. 28 is the current issued.
4. *C.M.F.R.I. Special Publication* is a publication issued at irregular intervals from the year 1977. It incorporates the results of short-term research projects of the Institute. So far 23 numbers have been issued.
5. *Marine Fisheries Information Service: Technical & Extension Series* issued as a monthly since September 1978, envisages the rapid dissemination of information on marine fisheries resources and allied data available with the Fishery Data Centre and the Research Divisions of the Institute, results of researches for transfer of technology to the fish farmers and industry, and of other relevant information needed for Research Development efforts in the marine fisheries sector. No. 63 is the current issue.
6. *Annual Reports of the Institute* are issued for each financial year.

BUDGET

The details of Plan and Non-Plan expenditure of the Institute from the First to Sixth Five Year Plans and the budget estimate for the first year of the VII Plan are given below (figures in rupees):

I Five Year Plan

<i>Year</i>	<i>Non-Plan</i>	<i>Plan</i>
1951-52	3,08,274	
1952-53	3,49,149	
1953-54	4,07,732	
1954-55	3,46,357	1,19,946
1955-56	3,54,615	2,85,598

II Five Year Plan

1956-57	4,08,569	7,58,895
1957-58	5,52,846	7,54,232
1958-59	5,50,974	6,35,598
1959-60	5,42,479	5,23,354
1960-61	6,40,719	4,73,393

III Five Year Plan

1961-62	13,00,069	22,679
1962-63	10,89,027	3,19,113
1963-64	10,96,460	3,06,261
1964-65	11,69,936	4,07,628
1965-66	13,07,887	5,31,505

Annual Plan

1966-67	19,12,123	1,46,106
1967-68	21,72,774	1,38,787
1968-69	22,72,788	50,000

IV Five Year Plan

1969-70	24,08,697	2,43,783
1970-71	25,38,727	8,76,420
1971-72	26,69,766	13,79,135
1972-73	27,25,500	11,47,000
1973-74	29,70,500	12,05,000

V Five Year Plan

1974-75	43,77,000	8,81,561
1975-76	48,54,000	49,94,819
1976-77	48,75,000	122,03,000
1977-78	51,65,700	141,85,881
1978-79*	63,11,000	97,27,855

* Annual Plan

Annual Plan

Year	Non-Plan	Plan
1979-80	91,66,246	105,79,257

VI Five Year Plan

1980-81	102,65,009	68,61,072
1981-82	115,00,502	116,35,936
1982-83	133,08,784	185,07,188
1983-84	153,74,835	178,45,262
1984-85	176,11,062	174,01,123

VII Five Year Plan

1985-86	262,01,000	175,00,000
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FUTURE

Over the years, the fisheries institutes, namely the CMFRI, CIFRI, CIFT, and the CIFE have grown in size and developed several infrastructural facilities and collected valuable data and information on marine and brackish-water fisheries resources. Certain amount of duplication of work could not be avoided and at the same time, the required stress could not be laid in certain areas. With a view to remedy the situation, recently, the objectives and functions of all fisheries institutes under the ICAR have been reviewed.

Based on review, the objectives of the CMFRI for the VII Plan period have been redefined as under:

- To conduct research for assessing and monitoring the exploited marine fishery resources leading to rational exploitation and conservation;
- To assess the under-exploited marine fisheries resources of the Exclusive Economic Zone;
- To understand the fluctuations in abundance of marine fisheries resources in relation to changes in the environment by conducting vessel-based programmes;
- To develop suitable mariculture technologies for finfish and shellfish in open-sea to supplement marine fish production; and
- To conduct transfer of technology and post-graduate and specialised short-term training programmes.

The CMFRI has been conducting multidisciplinary researches in marine capture and culture fisheries for developing methods for increasing marine fish production of the country through rational exploitation, conservation and ma-

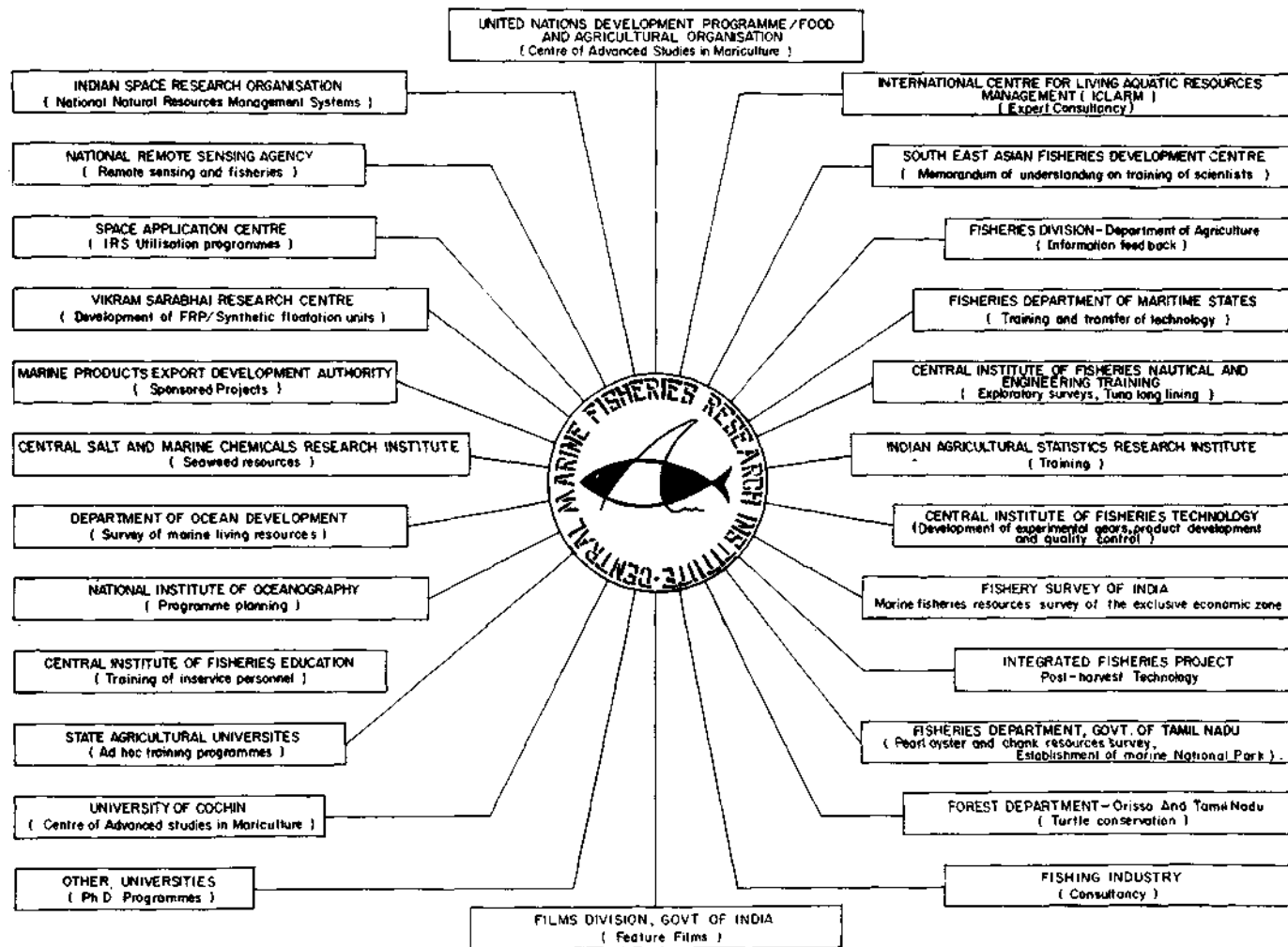
agement of marine fisheries resources. In addition, the Institute has also been conducting post-graduate and doctoral programme in mariculture under the Centre for Advanced Studies in Mariculture supported by FAO/UNDP. Over the years, the Institute has collected valuable information on marine fisheries resources and environmental data which have been processed and disseminated for the use of different States, Organisations, Institutes and the fishing industry. Several mariculture technologies have been developed. The Institute was instrumental in bringing out increase in marine fish production by assessing the resources in the EEZ and by conducting training and demonstration programmes in capture and culture fisheries. In a nut-shell, it may be said that the Institute has been the premier organisation in the country for aiding in planning and development of marine fisheries resources.

For want of adequate sea-going facilities, initially, the Institute had not been able to lay adequate stress on the assessment of offshore and oceanic fisheries resources. At the moment, the Institute is poised to monitor the presently exploited fishing zones and the inshore resources as well as to undertake research programmes for assessing the underexploited, unexploited and new fisheries resources in deep and distant waters with help of the large vessel, *R. V. Skipjack* recently acquired by the Institute and by utilising the facilities available with *FORV Sagar Sampada* whose research programme is planned by the Institute.

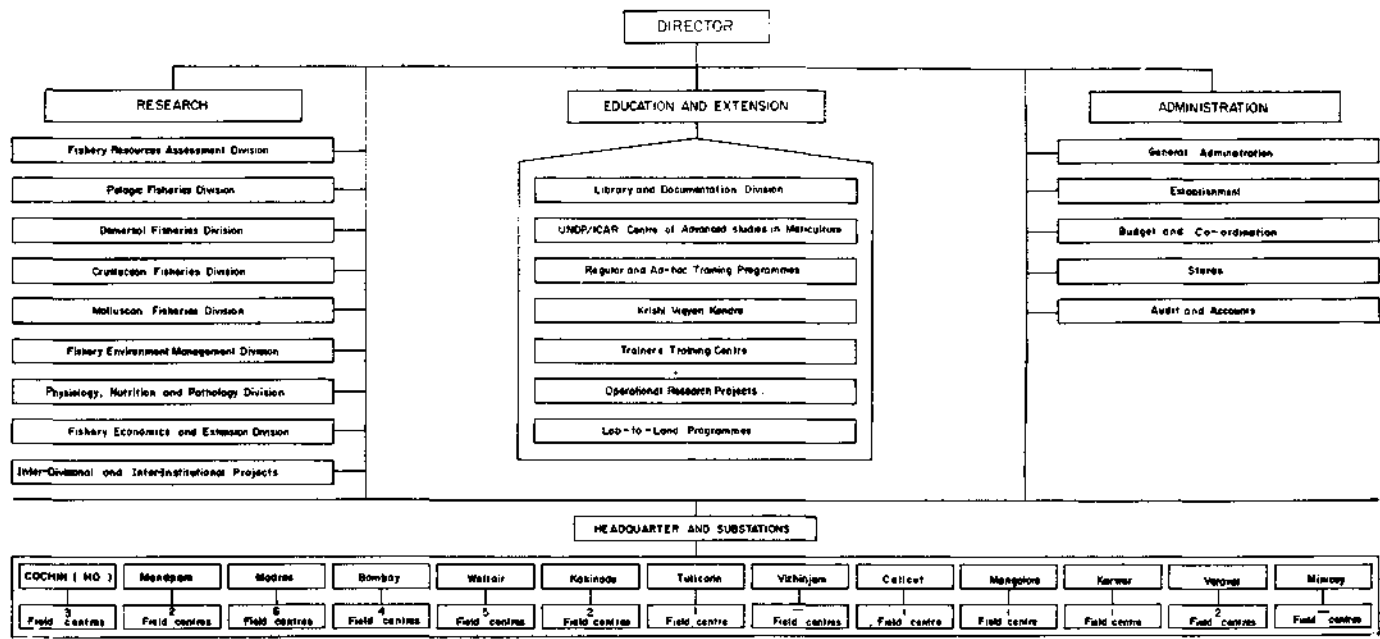
The immediate objectives of the Institute would be to fully utilise the infrastructural facilities available with the Institute at headquarters and other research centres for monitoring the exploited inshore marine fisheries resources leading to rational exploitation and conservation, assess the under-exploited and unexploited marine fisheries resources of the EEZ, understand fluctuations in abundance of marine fisheries resources in relation to changes in the environment by conducting vessel based programmes, development of suitable mariculture technologies for finfish and shellfish production in open sea and conduct transfer of technology programmes and post-graduate education, research and training programmes. Translation of results of research to the fishermen, farmers industry and the development departments will receive high priority.

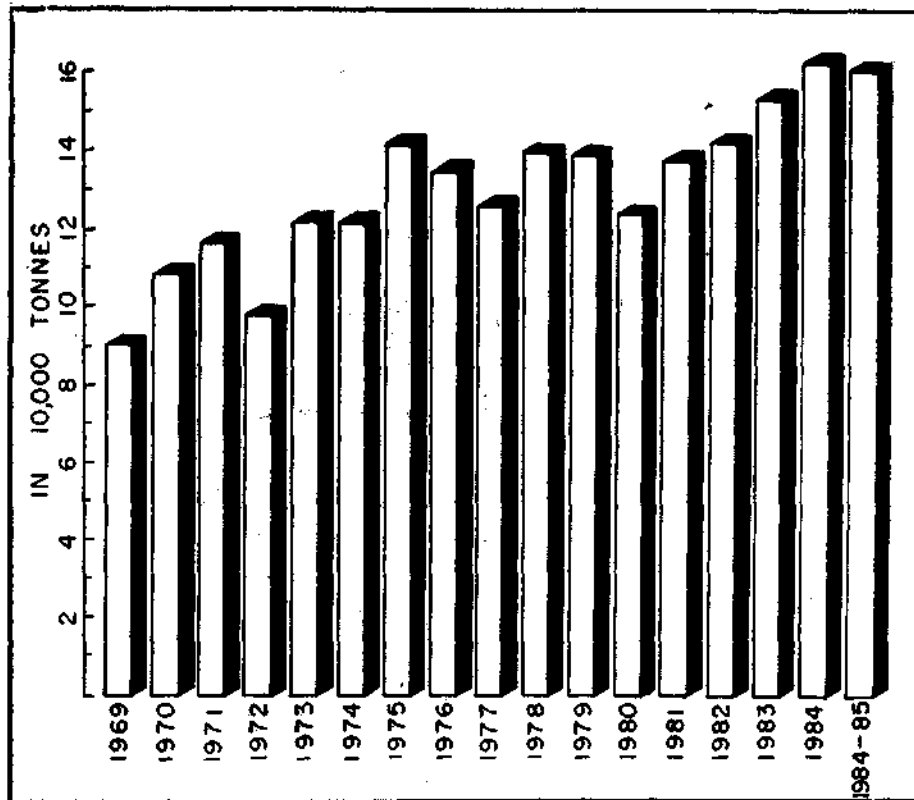
It will be the primary concern of the Institute to monitor and maintain the present level of marine fish production, to advise and formulate guidelines for augmenting production from offshore and oceanic areas of the EEZ as well as further development refinement and propagation of culture technologies, including training and post-graduate education. It is hoped that, with the cooperation of all related institutes, organisations and universities in the country, the CMFRI will embark on the 21st century with a better understanding of the potential, distribution and fluctuations in abundance of the marine fisheries resources for their rational exploitation, conservation and management.

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, COCHIN
(ICAR)
LINKAGES WITH OTHER ORGANISATIONS IN THE ON-GOING RESEARCH PROGRAMMES

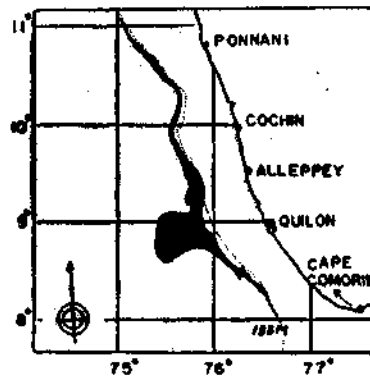


CENTRAL MARINE FISHERIES RESEARCH INSTITUTE (ICAR)-ORGANISATIONAL CHART

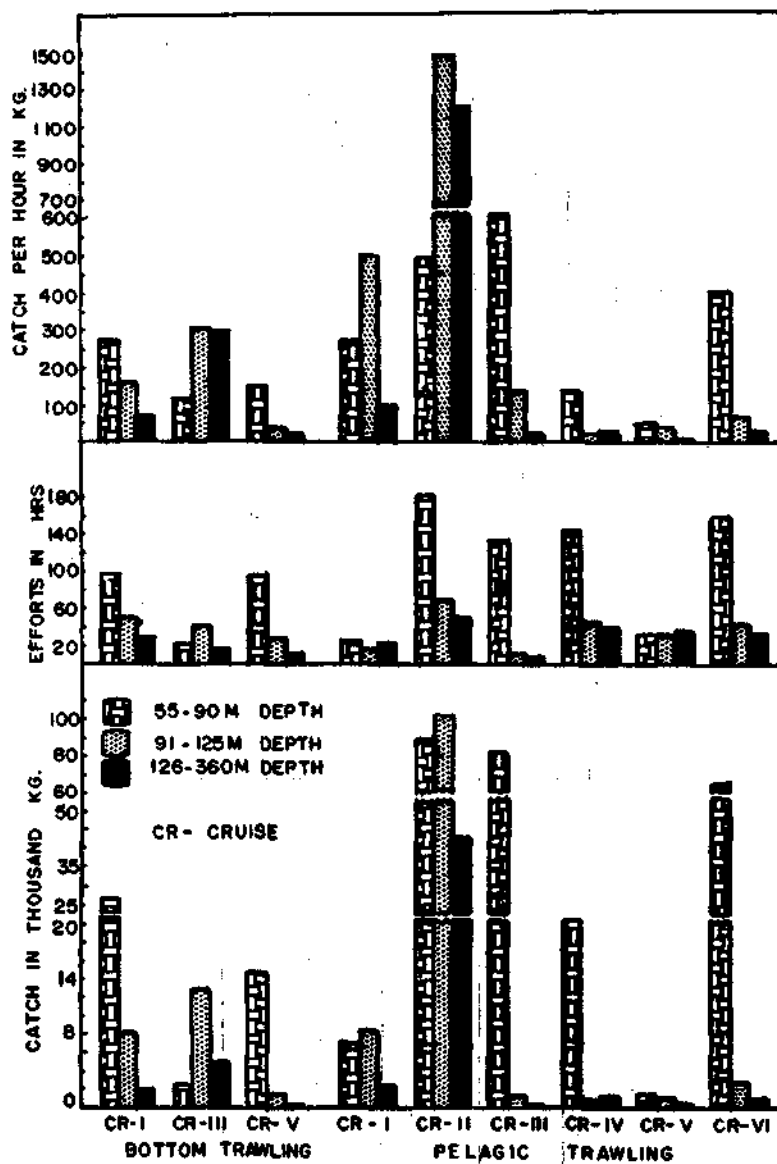




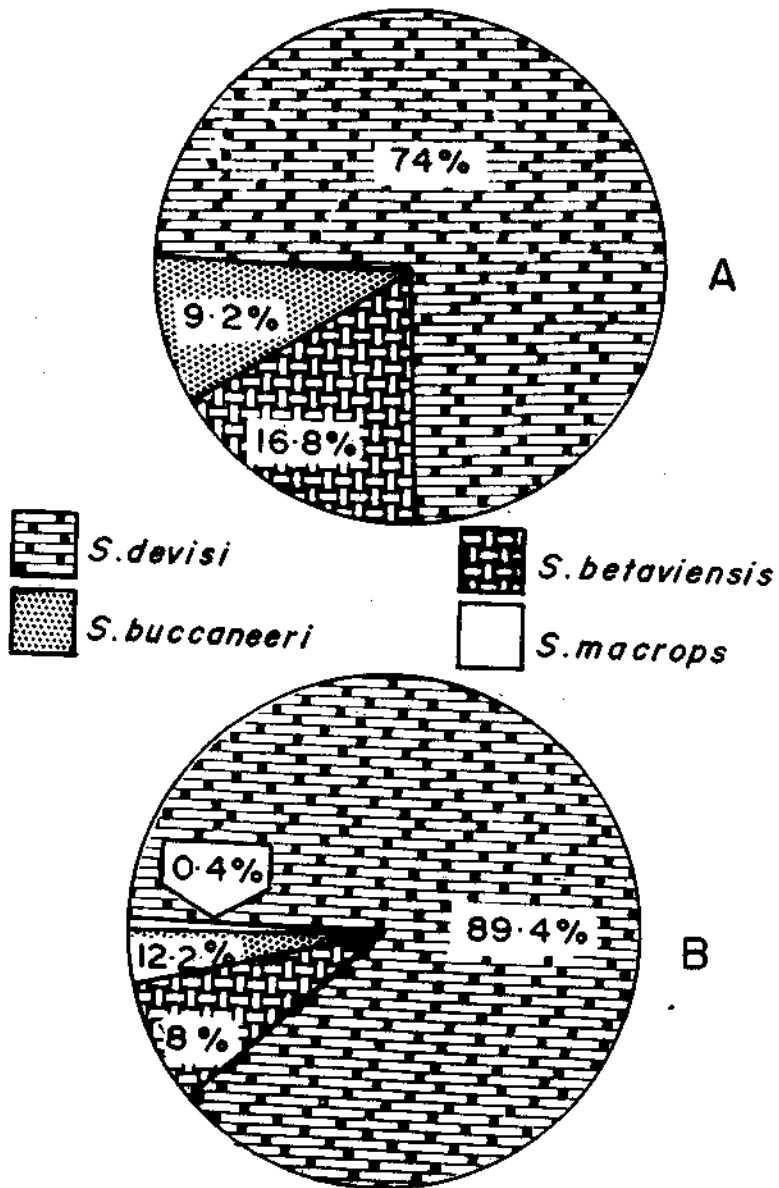
Marine fish production in India, 1969-1984-85.



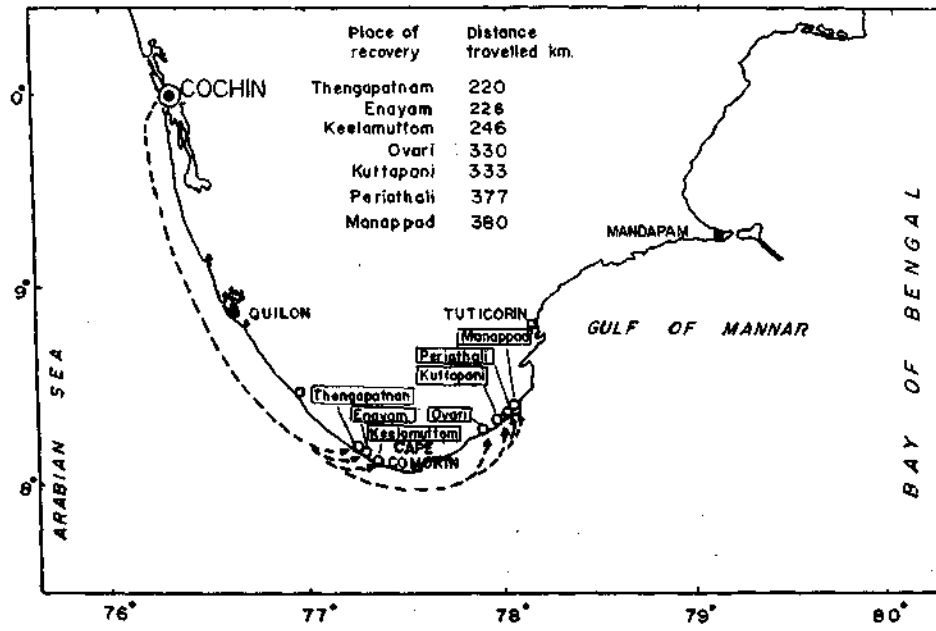
Quilon bank and adjacent area rich in deepsea prawns.



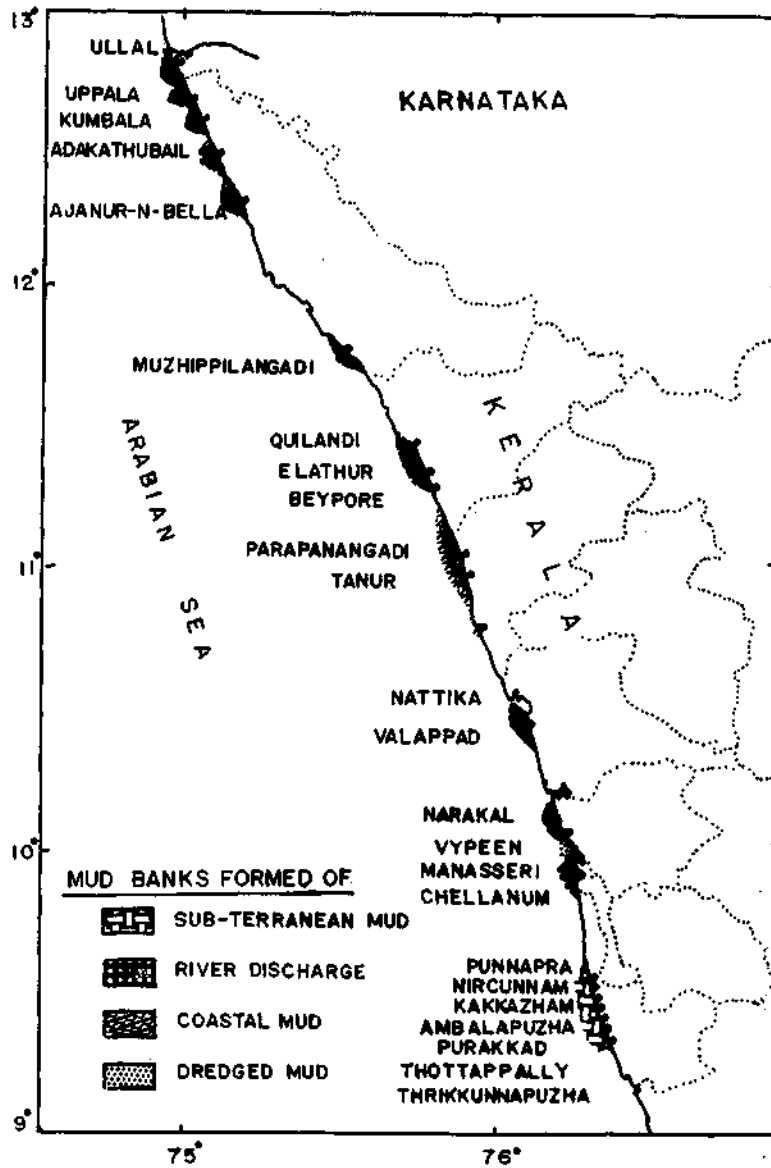
Fishery potential of the North-West Coast of India estimated by bottom and pelagic trawling: cruise-wise, year-wise and depth-wise catch, effort and catch rates.



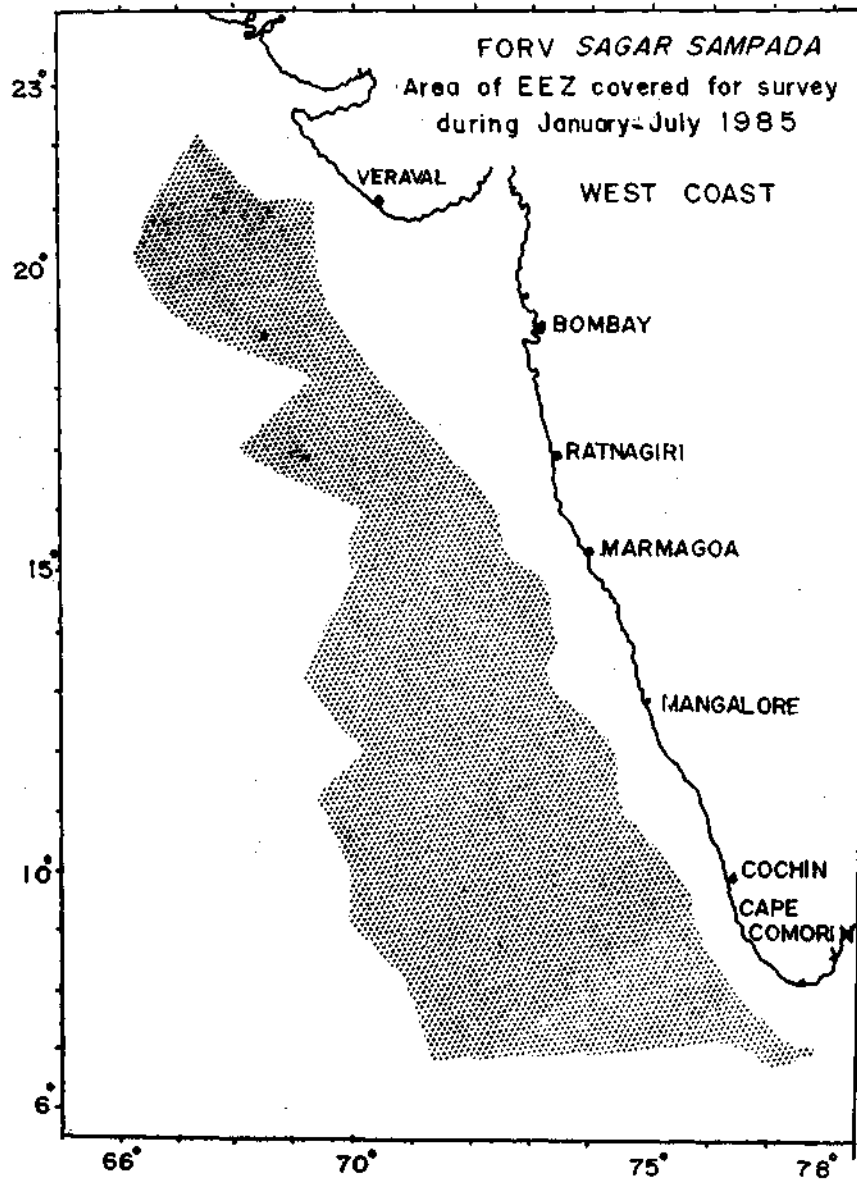
Species composition (% weight) of Whitebait landings during October-November 1980
(A: at Cochin, B: at Mangalore)



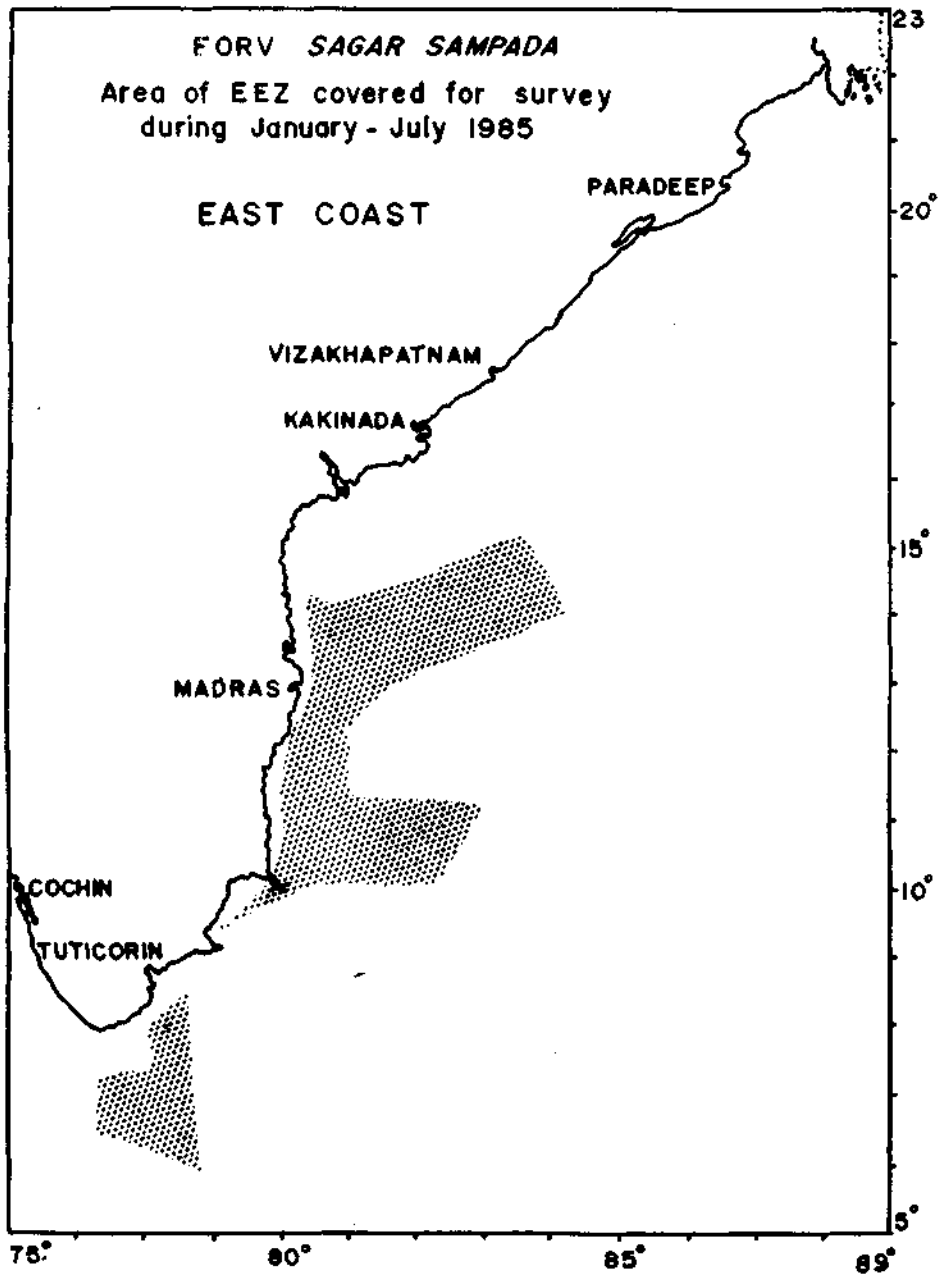
Distant migration of tagged prawns.



Places of recorded occurrence of mudbanks along the Kerala and Karnataka coasts



FORV *Sagar Sampada*: Area of EEZ covered along the West Coast of India for survey during January-July 1985.



FORV *Sagar Sampada*: Area of EEZ covered along the East Coast of India for survey during January-July, 1985.

The Various Committees

Constituted in connection with the inauguration

1. Reception

Dr. P. S. B. R. James, Director,
CMFRI — Convener
Shri. M. R. Nair, Director, CIFT
Shri. M. Swaminath, Director, CIFNET
Shri. R. Sathiarajan, Director, IFP
Dr. K. Gopakumar, Jt. Director, CIFT
Dr. P. V. R. Nair
Shri. S. Mahadevan
Shri. K. Nagappan Nayar
Dr. S. Ramamurthy
Dr. K. Radhakrishna
Shri. K. A. Narasimham
Shri. C. Mukundan
Shri. M. Kumaran
Dr. M. V. Pai
Shri. M. H. Dhulkhed
Dr. (Smt.) P. V. Kagwade
Shri. T. Appa Rao
Shri. G. Gopakumar

2. Pandal, light, mike, dias, seating arrangements

Dr. A. V. S. Murty — Convener
Shri. V. Balan
Shri. P. C. Jacob
Shri. B. S. Ramachandrudu
Shri. S. Natarajan
Shri. U. K. Satyavan
Shri. S. P. L. Sethu
Shri. K. Chacko
Shri. K. L. K. Kesavan

3. Publications

Dr. K. Alagarwami — Convener
Shri. K. N. Krishna Kartha
Shri. C. Mukundan
Shri. K. Rengarajan
Shri. A. A. Jayaprakash

4. Travel & Accommodation

Shri. S. K. Dharmaraja — Convener
Shri. D. S. Rao
Shri. V. K. Pillai
Dr. K. J. Mathew
Shri. K. Balan
Shri. G. Balakrishnan
Shri. K. Subramanian

5. Security arrangements

Dr. P. V. R. Nair — Convener
Shri. P. C. Jacob
Shri. M. P. Lakshmanan

6. Media Liaison

Shri. T. Jacob — Convener
Shri. M. S. Rajagopalan
Smt. Krishna Srinath
Shri. A. K. Unnithan
Shri. S. Narayanan

7. *Exhibition*

Shri. M. S. Muthu — Convener
 Dr. K. Alagaraja
 Dr. M. M. Thomas
 Shri. G. Subbaraju
 Shri. A. Ragunathan
 Shri. N. Neelakanta Pillai
 Shri. C. Suseelan
 Dr. V. S. Kakati
 Shri. P. Nandakumar
 Shri. A. Thirunavukkarasu
 Shri. K. Balakrishna Pillai
 Shri. K. Sankaran

8. *Programme*

Shri K. V. N. Rao — Convener
 Dr. K. C. George
 Dr. A. Noble
 Shri. V. N. Bande
 Shri. G. V. Pednekar

9. *Cultural Programme*

Dr. P. V. R. Nair — Convener
 Dr. V. S. K. Chennubhotla
 Shri. M. Srinath
 Smt. Sivakami
 Shri. M. M. Meiyappan
 Shri. M. Rajamunisamy

10. *Photography*

Dr. P. P. Pillai — Convener
 Shri. P. Raghavan

11. *Hospitality*

Dr. P. V. Rao — Convener
 Shri. P. Gopinathan
 Dr. (Smt.) V. Chandrika
 Shri. P. Aithappa Naik