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# RESEARCH IN MARINE FISHERIES MANAGEMENT AND DEVELOPMENT – CAPTURE AND CULTURE FISHERIES

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## ABSTRACT

The paper deals with the research contributions of the Central Marine Fisheries Research Institute for the management and development of marine capture and culture fisheries of the country during the past four decades.

The development of a stratified random sampling method for estimating the marine fish landings from the mostly artisanal type of fishing; the assessment of stock magnitudes of several exploited commercial species and underexploited potential resources have been the major contributions in the field of capture fisheries.

Apart from routine monitoring of the environmental parameters influencing the abundance and availability of commercial stocks, the Institute undertook studies in basic problems like upwelling, organic production and pollution.

Concurrent problems arising out of increasing mechanisation of fishing such as impact of purse seining on pelagic fishes and other schooling fishes like cat fishes and shrimp production have been studied and concerned states have been given appropriate advices.

In the culture sphere success has been achieved in breeding commercially important penaeid prawns, oysters and mussels under controlled conditions and maintenance of brood stocks, for raising seeds in the hatcheries. Techniques of pearl culture, edible oyster, mussel and sea weed culture have been perfected for local conditions.

By the systematically planned research activities since 1947, the Institute built up a firm foundation for marine fisheries development in the country on modern lines and generated base line information for the rational exploitation and management of the marine fishery resources of the country.

## INTRODUCTION

The need for research support for Management actions in respect of renewable living resources like the fisheries is well known. Countries all over the world with developed domestic and high sea fisheries have strong research inputs to back up their development and administrative policies.

As an imortant step for organising the sea fisheries of India on a sound footing, the

Central Marine Fisheries Research Station, later designated Institute, was established in 1947. During the last four decades this establishment made its contributions to help in the management of the marine fisheries of the country and its development on modern lines.

The main objectives set forth for the Institute have been to conduct investigations which would lead to estimation of marine fishery resources; to gather detailed information on the individual species of fishes of commercial importance, their potential, rational exploitation and conservation and also to study such environmental factors which are likely to influence the nature and magnitude of these fisheries. As the national priorities in the fisheries sector were undergoing reorientation, since the early 70's, with the emphasis on mariculture and exploitation of the resources of the Exclusive Economic Zone, the basic objectives underwent modification to cater to the needs of the industry and development agencies.

The main objectives of the Institute for the VII Plan period have been redefined as under:

i. to conduct research for assessing and monitoring the exploited marine fisheries resources leading to rational exploitation and conservation;

ii. to assess the underexploited and unexploited marine fisheries resources of the Exclusive Economic Zone;

iii. to understand the fluctuations in abundance of marine fisheries resources in relation to changes in the environment by conducting vessel based programmes;

iv. to develop suitable mariculture technologies for finfish and shellfish in open sea to supplement marine fish production; and

v. to conduct transfer of technology and post-graduate and specialised short term training programmes.

The Institute strived to achieve the above objectives in a systematic manner, eventhough for a long time since its inception, an ocean going research vessel of its own was not available. During the occasion of the 40th year of its establishment it is relevant to make a stock taking of the Institute's achievements and contributions to the development of marine fisheries of the country.

*Asessment of Fishery Resources*

The Institute developed a multi stage stratified random sampling design for the estimation of marine fish landings in the country at national and state levels. The design developed by the Institute has been recommended by the FAO for adoption by other developing countries. Resource wise and region-wise production 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 stretch of the 6100 km Indian coastline.

Based on the data on exploited resources collected in the past years, assessment of some of the commercially important fish stocks such as oil sardine, mackerel, Bombay duck, catfishes tunas, prawns and cephalopods have been made.

Information on fishermen population, gears crafts, employment details, educational standards and infrastructure facilities available in the marine fisheries sector have been collected periodically through frame surveys. The most recent census was conducted in 1980. This census data is widely used by the State and Central agencies for planning and developmental purposes.

For application of stock assessment models and proper interpretation of results, training course for personnel engaged in fisheries research and teaching have been taken up periodically. Ttaining programme on the sampling desigin of CMFRI is also conducted for the benefit of personnel of Fisheries Departments of maritime states and Union Territories.

A very recent significant achievement has been the development of management advice for each maritime state based on analysis of data

collected on the exploited marine fisheries resources for 10 year period (1975-1984).

*Pelagic Fisheries*

The rate and pattern of exploitation of pelagic fish resources of the west and east coast 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 investigations have also brought to light the high potential of pelagic fish resources such as whitebaits, horse-mackerel and several mesopelagic fishes. Feasibility of exploitation of oceanic resources like tunas and related species have been highlighted.

Studies on the stocks of oil sardine (*Sardinella longiceps*) on the west coast of India indicated high potential (annual average stock size of 400,000 tonnes) and the possibilities of increasing the catches by stepping up fishing effort in the offshore grounds employing efficient fishing methods like purse-seining.

The stock assessment studied on Indian mackerel (*Rastrelliger kanagurta*) have revealed an average annual stock level of 265,000 tonnes off the south west coast of India (7°-17°N) and about one third of this stock is found beyond 25 m depth. 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 by increasing mesh size.

A critical study of the exploited resources of the anchovies from Indian seas have revealed that species belonging to the genera *Stolephorus, Thryssa, 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. Since the present catch is very meagre compared to the potentials, substantial expansion of the fishery is recommended along the coasts of Kerala, Tamil Nadu and Andhra Pradesh for *Stolephorus* and *Thryssa;* along northern Maharashtra-Gujarat sector for *Coilia* and along northern Orissa-West Bengal sector for *Setipinna.*

Studies on the stock assessment of Bombay duck, *Harpodon nehereus* revealed that at Nowabunder, Saurashtra coast, the present level of exploitation is close to the maximum sustainable yield and that any further expansion in the fishery would result in the over-exploitation of the stocks. However higher sustainable yield is possible by increasing the size at capture.

The estimation of the fished stocks of the little tuna (*Euthynnus affinis*) and the frigate mackerel (*Auxis thazard*) indicated that their average annual stock levels were of the order of 206,000 and 7,700 tonnes. The exploitation rate 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*), the exploitation rates were estimated at 0.64 and 0.85 and total mortality rates 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 emphasised that substantial increase in the production from these stocks is possible by increasing fishing effort.

Stock assessment studies on seerfishes off the Karnataka coast showed that it was under-exploited and an expansion in the fishery would result in increased production without affecting the stocks The potential resources of horse mackerel consisted mainly of *Decapterus* sp. and *Megalaspis cordyla.* An average standing stock of about 34,400 tonnes was indicated for the southwest coast of India and the Gulf of Mannar. The bulk of this biomass was located in 20-75m depth in Gulf of Mannar and 50-100 m depth in the south west coast. An extension of the distribution of the above species along the N.W. coast has been indicated by the M. T. *Maurena* surveys conducted in 1977. Based on the present level of exploitation of these stocks a substantial increase in the catches by the expansion of the fishing is possible. Studies on the stocks of ribbon fishes (mainly *Trichiurus lepturus*) of Andhra-Tamil Nadu and Kerala-Karnataka coast indicated that these resources were under-

exploited and greater fishing effort may be applied to get increased yield from the stocks. Special studies are undertaken on the marine phase of Hilsa along the coastal waters of Orissa and West Bengal.

*Demersal Fisheries*

Studies on demersal fish resources of the west and east coasts of India have been based on the close monitoring of the exploited fisheries by the artisanal sector using the traditional gear and also the mechanised sector of small and medium-sized boats using bottom trawls, bottom-set gill nets or hooks and lines.

During the 1949-55 period the ground fish resources studies were conducted based on exploratory fishing by large trawlers of the Government of India Deep Sea Fishing Station and the New India Fisheries Co. in the Bombay-Saurashtra waters. With the expansion of exploratory fishing programmes by Government of India vessels and the setting up of additional bases along the east and west coast, exploratory surveys 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 grounds for sciaenids of Kutch, Dwaraka and Porbunder, for eels off Bombay and Cambay, for prawns, nemipterids and perches off the south west coast; silverbellies off southwest coast and catfishes off north east coast emerged out of the analysis of these fishing results by the CMFRI.

The deep shelf and slope off the S. W. coast were particularly studied, based on exploratory cruises of the vessels of the Government of India and the Integrated Fisheries Project. 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 EEZ 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 mainly the northwest zones, from 15° to 24°N (55 to 360 m depth). Abundance of threadfin breams at 125-360 m depth, serranids and larger carangids in 90-125 m ribbon fishes, pomfrets, horse-mackerel and eels in the 55-90 m depths were observed by the vessel.

In addition to such over-all studies and charting out of the productive fishing grounds of the demersal fisheries resources, detailed investigations on individual fish species/groups that contributed to major commercial fisheries, chiefly catfishes, threadfin-breams, silver bellies, sciaenids, perches, eels, flatfishes and lizardfishes have also been made. The estimations on the fished stocks of the five species of catfish *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.

Stock assessment studies carried out on *Nemipterus japonicus* off Kakinada revealed that any increased effort on the presently fished stocks at the present size of capture would only result in lesser yield. However, at Madras, the stock is not fully exploited and greater fishing effort may be applied to get increased yield without adversely affecting the stock.

Investigations on the presently exploited demersal resources have shown that with the rapid development of the mechanised trawling in recent years, many of the inshore fisheries are under heavy 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 fishery resources.

*Crustacean Fisheries*

The rapid expansion of the export market for prawns and the consequent introduction of large number of small mechanised boats for prawn fishing necessitated a concerted effort by the Institute to study the prawn fisheries on an all India basis. A wealth of information was

collected on the distribution and the abundance of the prawn species in space and time, growth, feeding habits, fecundity, sex ratio, and movements. Life cycles and juvenile phase of prawns in brackishwater environment have been studied in detail.

The deep sea lobster (*Puerulus sewalli*) and the deep sea prawn resources of the southwest coast of India were studied in detail. A total of 22 species of deep sea prawns have been observed in the catches. *Heterocarpus woodmasoni* forms the mainstay of the fishery. Relatively high concentration of prawn exists on the "Quilon Bank" at 301-375 m depth zone and in slightly deeper areas off Ponnani, on the upper continental slope. The potential resources of deep-sea prawns that could be commercially exploited from the "Quilon Bank" have been estimated to be about 5,300 tonnes from a productive area of about 5000 sq. km.

Realising the fact there has been some economic over-fishing for prawns in certain sectors of our coast, detailed stock assessment studies of important prawn species have been made. Using the data on catches and fishing effort collected over a period of ten years the magnitude of the prawn resources, the maximum sustainable yield and corresponding optimum fishing effort were estimated for nine important fishing centres, namely Sasoon Dock in Bombay, Karwar, Mangalore, Calicut, Cochin, Sakthikulangara, Mandapam, Madras and Kakinada. The estimates showed that increasing the fishing effort beyond the optimum level is not likely to increase the prawn yield from all these centres, except Kakinada. In Kakinada there is a possibility of increasing the yield by putting in more fishing effort.

Based on the abundance and distribution of prawn seed in the estuaries and backwaters, attempts are being made to forecast the prawn fishery at sea.

Intensive tagging programme coupled with drift bottle studies showed that the tagged white prawns *Penaeus indicus* migrated from Cochin on the southwest coast to Tuticorin on the east coast following the coastal currents. They completed 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 intensive studies on the prawn resources of the country the other crustacean resources such as rock lobsters, crabs and stomatopods have also been the subject of study.

*Molluscan Fisheries*

An inventory of the molluscan resources such as clams, oysters and mussels has been made covering the entire mainland coast as well as the Andaman and Nicobar Island.

The clam resources of the estuaries in Karnataka and Kerala have been investigated in detail in the context of recent spurt in the export of clams including baby clams. The commercially important species identified are *Meretrix meretrix, M. casta, Katelysia opima, Paphia,* spp. and *Villorita cyprinoides*. Such resource survey have also been carried out on green mussel *Perna viridis* and brown mussel *P. indica*, along the west coast. The standing stock of *P. indica* was estimated at1610 tonnes (1983-84), while the landings were only 556 tonnes along the southwest coast.

The molluscan resources of Kakinada Bay, along the east coast, particularly those of the blood clam *Anadara granosa* and windowpane oyster *Placenta placenta*, were surveyed in detail and the potential for further development indicated. Underwater surveys of the pearl banks of the Gulf of Mannar using SCUBA equipments and assessment of the population of pearl oysters (*Pinctada fucata*) and chanks (*Xancus pyrum*) in the natural beds were made. These surveys helped in predicting the pearl and chank fisheries in the region.

The vast potential resources of oceanic squid *Symplectoteuthis oualaniensis* in EEZ of India have been indicated based on the exploratory survey results of FORV *Sagar Sampada*. Resource characteristics and stock assessment of most of the commercially important species of *Loligo* and *Sepia* have been made.

*Fishery Environment Management*

The study of fishery related environmental factors which received considerable attention were initially confined to the coastal belt. Since late fifties, facilities of the Indo-Norwegian Project's vessels have been availed to study the oceanographic features of the entire shelf and the Lakshadweep. Better understanding of the seasonal phenomenon such as upwelling and dynamics of the mud bank formation resulted from these studies.

Estimates of the potential fish resources were made for the first time in the country on the basis of primary productivity studies using $C^{14}$ technique.

Studies on marine mammals and turtles were taken up from a conservation angle with repeated seasonal observations on the 'Aribada', the mass nesting of turtles at Gahirmatha beach in Orissa. Surveys and ecological studies in connection with establishment of a marine national park in the Gulf of Mannar were completed. Studies on ancillary resources like corals, sponges, echinoderms and seaweeds contributed to development of resource data on these. Studies on marine pollution and bioactive agents in marine organisms received attention in the programmes of the Division.

In recent years the Institute collaborated with Space Application Centre, Ahamedabad and National Remote Sensing Agency, Hyderabad, in Joint Experiments for the utilization of satellite data to locate areas of high productivity in the EEZ. The studies using an Ocean Colour Radiometer indicated that chlorophyll densities, an index of the bioproductivity, could be mapped and used as indices of fisheries potential.

Other studies include secondary production and its relationship to the distribution of fishes; qualitative and quantitative abundance of fish eggs and larvae; distribution of the Antarctic Krill; isolation and mass culture of uni-cellular algae for hatchery development of different larvae; ecology of mangrove areas and their influence on the fishery resources; coral resources and behaviour of reef fishes; formation and environmental characteristics of the mud banks of Kerala.

In addition to the national programme of tagging prawns and fishes to study their migration and growth, drift bottle experiments were under taken to understand the coastal drifts that aid the migration of these groups. A systematic programme of release of drift bottles from different centres along the east and west coast have resulted in recoveries which indicate a general southward drift of coastal current during the summer months, February to March. The recovery of drift bottles from the Sri Lanka coast and Somali coast is worth mentioning.

*Fishery Economics and Extension*

With increasing emphasis on the utilization of the resources 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.

Investigations 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-seines through liberal Government loans and giving priority for Rampani operators as crew-members of purse-seiners.

Through a number of case studies, the socio-economic aspects of fishermen families in Kerala, Maharashtra and Gujarat have been investigated and the attention of institutional agencies was drawn to play a more dynamic role as credit agencies to the fishermen, so as to save them from the harassment of middlemen. The Institute has also conducted studies on the

ecnnomics of different types of fishing units, especially the traditional crafts fitted with outboard motor, marketing aspects such as price spread at various levels and also the role of women in small-scale fisheries activities. Projects aimed at evaluation of economic returns in mariculture operations have also been undertaken in recent years.

*Physiology, Nutrition and Pathology*

Since 1982, the Institute took up appropriate multi-disciplinary programmes on physiology, nutrition and Pathology of fish and shellfish, which formed either complementary or supplementary effort to the major ongoing research programmes in mariculture. The current programmes concentrate on problem oriented research such as, ecophysiology and respiratory physiology of fishes and shellfishes, protein variation and nutritional requirements of prawns; reproductive physiology of grey mullets; nutritional needs of milkfish and survey of finfish and shellfish diseases and pathology of soft prawns. Studies indicate that keeping the pond environment healthy by proper management practices is the best way to prevent the occurrence of the soft prawn disease.

*Mariculture*

*Prawn culture*

The Institute took up experimental studies on various aspects of prawn culture since 1975 and all the commercially important species of penaeid prawns such as *Penaus indicus, P. monodon, P. semisulcatus, Metapenaeus dobsoni, M. monoceros, M. affinis, M. moyebi* and *Parapenaeopsis stylifera* have been made to spawn in the laboratory and their larvae reared up to the post larval stage under controlled conditions. Recently, similar success has been achieved in the case of *P. japonicus*, and *P. latisulcatus*. 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. The Institute has by now evolved a totally indigenous, low cost technology for the hatchery production of penaeid prawn seed, specially suited to the Indian conditions.

To enable the interested entrepreneurs 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 the Institute. Under the transfer of technology programmes the Institute recently initiated providing technical assistance to State Governments for establishment of hatcheries for production of prawn seed The Institute also provides technical assistance to prawn farmers and development agencies for accelerating the programmes in prawn culture. Recently at Tuticorin, the scientists helped a private prawn farmer to culture prawns in salt pan areas and a record production of 1200-1600 kg/ha was obtained in a period of 4½ to 6 months.

A technique of artificial insemination of *Penaeus 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 *P. semisulcatus* in the Palk Bay to augment the natural stock of this species in the Bay has been initiated.

Employing scientific methods in the field culture of prawns, using laboratory reared post-larvae for stocking, a production rate upto 600 kg/ha/54 days has been obtained. A pelletised feed, compounded from locally available raw materials has been developed.

*Culture of other shell fishes*

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 eye stalk ablation.

*Indigenous technology for oyster and mussel culture*

A significant breakthrough was achieved in developing indigenously the techniques of pearl culture, which led to the establishment of a commercial pearl culture project in India for the first time. Cultured pearls are produced through raft culture with a production rate of 60-70% in nuleus implanted oysters in 3 to 24 months. In order to repopulate the pearl banks of Gulf of Mannar, a sea ranching programme of pearl oyster seed produced in the laboratory has recently been initiated at Tuticorin.

Another major achievement has been the development of techniques for oyster 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 development programmes. The problem of paucity of seed for large scale culture operations of economically important bivalve molluscs has been solved.

Open-sea mussel farming techniques developed at the Institute have given high production rates (10–15 kg of mussel per metre length of rope, equal to 60-70 tonnes/ha). Edible oyster farming technology has been established to produce 150 tonnes/ha/annum.

*Fin fish culture*

Experimental finfish culture had been part of the Institute's programme from the early years, at Mandapam. The culture programme was intensified and extended to other centres like Tuticorin, Madras, Calicut and Narakkal by mono- and poly-culture-techniques, in ponds, cages and pens. Milkfish and mullets have been reared successfully in ponds and pens. Preliminary studies with species of *Lethrinus*, *Epinephelus* and *Lates* at Mandapam and Tuticorin yielded promising results. Induced breeding experiments conducted on *Mugil cephalus* with H. C. G harmone along with pituitary-gland extract have yielded encouraging results.

*Seaweed culture*

Experimental field cultivation of the agarophytes *Gracilaria edulis* and *Gelidiella acerosa* in the Gulf of Mannar showed that *Gracilaria edulis* grew to harvestable size within 60 days yielding 3 kg/Sq. m *Gelidiella acerosa* attained the same rate of production in 75 days. This yield is about 3 times the rate of natural production.

*Special Surveys of Lakshadweep group of Islands*

In recent times, the Lakshadweep islands have been in the limelight owing to the special considerations shown by the Government of India towards its all-round development. The Institute had already contributed to the management of marine fisheries resources of the area and steps are now being teken to expand and intensify its research activities in the relevant fields.

A series of special surveys were conducted since January 1987, aimed at an overall assessment of various types of fishery and ancillary living resources and their potentials. Three teams covered 10 islands, from January to March '87 (Agatti, Amini, Androth, Bitra, Chetlet, Kadamat, Kalpeni, Kavaratti, Kittan and Minicoy) and collected valuable information on the resource potentials, status of the coral reefs and the traditional fisheries.

During the surveys, it was found that considerable damage had taken place to the coral reefs around Minicoy and certain other islands due to dredging, silting and sand mining.

Skipjack *(Katsuwonus pelamis)* and young yellowfin tunas *(Thunnus albacares)* constituted the major tuna resources exploited by the islanders by live-bait pole and line fishery. Tuna formed 85% of the total fish landings in the islands and Agatti and Bitra alone accounted for more than 60% of the total tuna catches.

There seemed to be no scarcity for live baits in the islands surveyed except in Amini and Kiltan. Over 15 species of live baits were observed during the survey. *Spatelloides delicatulus* and *S. japonicus* dominated among them.

The common food fishes other than tuna in the islands were sharks and rays, goat fishes, carangids, perches, barracudas, half beaks and filefish.

The survey results also indicated that over 70 species of ornamental fishes occur in these islands, of which 30 are exportable. The survey teams collected information on seaweeds, sponges, echinoderms, crustacean resources and other invertebrates and gathered interesting data on marine mammals and seabirds and locations which could be developed as marine parks.

Suitable recommendations have been made for the protection of the ecosystem and development of fisheries.

*Extended research programmes in the EEZ*

CMFRI is the nodal organisation for the planning and execution of the research programmes of FORV *Sagar Sampada* of the Department of Ocean Development.

The vessel commenced its regular cruises from January 1985 and completed 33 cruises upto August 1987 spending 589 days at sea. A great deal of information on various fishery resources and related environmental parameters of the EEZ have been collected by the vessel.

The highlights of the results are the location of:

- The large deep sea prawn *Plesiopenaeus edwardsianus* at 870 m depth off Trivandrum.
- Spawning grounds of several species of fishes over the Angria Bank.
- Spawning/nursery grounds of ribbon fish off Veraval around 50m depth.
- Nursery ground of *Lactarius* at 100 m depth off Okha.
- Extensive swarms of oceanic crabs along the south-west during the south-west monsoon season.
- Large tuna shoals during post-monsoon time off Central west coast.
- Abundance of lobster larvae in the offshore waters (75 m) along Kerala-Karnataka coast in November.
- A variety of juvenile fishes, especially tunas in the Lakshadweep area in December-January and July-August periods, and dominant oceanic squid component in July-August.
- Large quantities of lantern fishes in the lower Bay of Bengal and equatorial region during Jan-February period.
- Confirmation of the phenomenon of the seasonal concentration of whitebaits in the Gulf of Mannar during the southwest monsoon season.
- Large concentration of threadfin bream, cuttlefish and squids in the Wadge Bank in August-September period.

These results are highly relevant for planning our future developmental programmes for exploiting the underexploited resources of the EEZ.

In conclusion it may be stated that the Central Marine Fisheries Research Institute by its planned activities during the past 40 years built up a firm foundation for marine fisheries development in the country and generated all base line information for the management of the resources.

It is by now fairly clear that the traditional fisheries can contribute only marginally to the augmentation of marine fish catches in the country. However, exploitation of these resources has to be carefully monitored and protected from the changes that may be taking place in the coastal environment. Conservation measures, where needed have to be developed based on sound scientific knowledge. Future research from vessel based programmes aims at understanding the fluctuations in abundance of commercially important species in relation to environmental characteristics, development of forecasts for fisheries and assessment of stocks of uuder exploited or unexploited resources including the deep shelf resources and the virtually untapped resources like the oceanic tunas, squids and mesopelagic fishes should be our targets for exploitation for enhancing fish production. The CMFRI has set its direction in this regard by extending its research programmes to the boundaries of the EEZ for assessment of the potentials of these resources for their eventual commercial exploitation.