CENTRAL MARINE FISHERIES RESEARCH INSTITUTE COCHIN

ACTIVITIES, ACHIEVEMENTS AND FUTURE PROGRAMMES

– Prepared in connection with the visit of the Parliamentary Consultative Committee on Agriculture and Irrigation, to the Institute.

September, 1978

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE COCHIN

ACTIVITIES AND RECENT ACHIEVEMENTS

Brief history of the Institute

The Central Marine Fisheries Research Institute was established in February 1947 under the Union Ministry of Food and Agriculture. In October 1967 the administrative control of the Institute was transferred to the Indian Council of Agricultural Research, New Delhi.

Organisational set-up

The Institute has at present five Divisions, *viz*., Fisheries Resources Assessment, Fishery Biology, Crustacean Fisheries, Molluscan Fisheries and Fishery Environmental Division. The subordinate establishments include the Regional Centre at Mandapam Camp; Research Centres at Veraval, Bombay, Karwar, Mangalore, Calicut, Vizhinjam, Tuticorin, Madras, Waltair, Kakinada, Minicoy and Port Blair; and 29 Field Centres along the east and west coasts of India.

Main functions of the Institute

i. Estimation and monitoring of the exploited fishery resources;

ii. Assessment of untapped conventional and non-conventional resources by exploratory, acoustic and aerial surveys;

iii. Strengthening of the Fishery Data Centre for collection and rapid dissemination of integrated fishery data;

iv. Preparation of synoptic fishery maps;

v. Studies on the population and biological characteristics of the commercial fishery resources;

vi. Fishery forecasting;

vii. Monitoring of fishery environmental factors and developing a fishery environmental service;

viii. Monitoring marine pollution in relation to protection of living resources;

ix. Survey of seed resources and location of suitable areas for coastal aquaculture;

x. Development of low-cost technology for the intensive culture of suitable organisms in different ecological systems;

xi. Crop-livestock-fish culture integration;

xii. Improvement of rural economy through blending of capture and culture fisheries;

xiii. Studies on the economics of operation of capture and culture fisheries;

xiv. Undertaking Operational Research Projects, Pilot Projects, National Demonstration Programmes, etc. for the propagation and establishment of mariculture enterprises;

xv. Transfer of technology to public and private sectors through regular Training Programmes; and

xvi. Fishery Extension and consultancy service.

Facilities available at the Institute

The Headquarters of the Institute, the Regional Centre and other Research Centres have fairly well-equipped laboratories for fishery biological work, hydrography and mariculture investigations. Most of the Research Centres have a small museum depicting the fish and other animal fauna of that region and a small library consisting of essential references for day to day work.

A well-equipped research vessel is being constructed for the Institute for carrying out all types of fisheries investigations. 43′ boats have been provided at the Regional Centre and at Cochin and more such boats will be constructed for use in other important Research Centres.

Adequate transport facilities like jeeps, van, staff car., etc. are available at Headquarters and subordinate establishments.

The Institute has permanent buildings at Mandapam Camp, Karwar and Calicut and plans are underway to provide permanent buildings at Cochin and other establishments.

The Institute's museum has a reference collection containing type specimens of new species that have been described by the staff. It has a general section which contains a representative collection of almost all marine fauna and flora. The museum also has charts, models and graphic representations of the work of the Institute.

The Institute's library is one of the best of its kind in southeast Asia and include a wide collection of books and journals, reprints, expedition reports, microfilms and micro-cards. Hundreds of journals and periodicals are obtained every year on exchange basis and new books are added. The Institute also provides a documentation service and has released bibliographies on various subjects.

Staff strength (as on 1-4-78)

Scientists:	185
Technical Staff:	347
Administrative Staff:	132
Supporting Staff:	254

Review of the activities and achievements of the Institute

1.1. Fisheries Resources Assessment

Adopting a well-developed stratified multistage random sampling design, stratification over space and time, data on catch, effort and other details are being collected from the entire coast on the exploited fish stocks. At present the sampling coverage is about 2.5% and it is proposed to increase the coverage to 5% to achieve more precise estimates.

1.2. Frame surveys

Quinquennial frame surveys on marine fishing villages, covering fisherfolk populations, landing centres, crafts, gears and other infrastructures such as ice plants and boat building yards are conducted. These surveys bring out the nature of changing pattern of the fishing industry and its consequent impact on the fishermen. The census collected by the Institute are utilised by State Governments and various fishing agencies.

1.3. National Fishery Data Centre

The National Fishery Data Centre is the repository of all fishery data covering biological, ecolo-

gical and environmental aspects. It has three functional bases *viz.*, data acquisition, storage and analysis and dissemination of data to various national and international organisations.

2. Fishery Biology

The Institute has undertaken investigations on the resource characteristics of fisheries especially of the major groups such as oil sardine, mackerel and Bombay duck; unit stocks of fishes; population parameters for stock assessment; recruitment; forecasting of fisheries; mark recovery studies for growth and migration and preparation of fishery atlases. Bulletins on these fisheries and status reports on the fisheries of oil sardine, mackerel, anchovies, etc., are being prepared.

2.1. Status of oil sardine fishery

A review has been made of the oil sardine fishery during the years 1950–1974. The annual catch has been varying between 76,000 tonnes (1956) and 301,000 tonnes (1968). It formed 1–9% of the annual catch of all fishes from 1950 to 1956 and 10–33% in later years, the highest percentage having been recorded in 1968. The total catch of oil sardine in the country has been declining since 1968.

The catch fluctuations are fishery independent. The year class strength may vary by a factor of 10. The total instantaneous mortality Z, has been estimated as 1.66, M as 1.12 and F as 0.54. Based on these, the average annual standing stock during 1960–71 of the west coast was computed as about 390,000 tonnes. The estimate of the standing stock made later by the Pelagic Fishery Project for 1972–75 is 560,000–700,000 tonnes (average 383,000 tonnes). Taking the standing stock estimate as 380,000 tonnes and other population parameters, the unfished biomass Y-max may be estimated as 212,800 tonnes.

The Institute has published a monograph on the oil sardine and other sardines and this contains detailed information on the fishery and biological aspects of these fishes. Fishery atlases showing region-wise and season-wise and other parameters distribution of oil sardine are being prepared.

2.2. Status of fishery for anchovies

A review has been made of the anchovy fishery in India over the last 25 years. The average annual catch of anchovies in the country was 37,350 tonnes forming 6.6% of the catch of all fishes in 1950–54 but declined to 35,000 tonnes forming 3.2% of the catch of all fishes in 1969–73. The decline was obviously due to the fact that no separate fishery exists for this group on most sections of the coast and that there is diversion of the effort to other fishes of greater unit value.

In the IIOE egg collections those of anchovies formed 13 % of the total number in the coastal and intermediate zones, but are not so abundant in the oceanic zone. Based on the reports furnished by the Pelagic Fishery Project, the annual standing stock of *Stolephorus* spp. off the southwest and southeast coast respectively may be estimated as 232,000 tonnes and 520,000 tonnes in different months and the average annual standing stock as 376,000 tonnes.

Review has also been made of the age composition in the catch, growth rate, mortality, food and feeding habits, spawning and early life history.

2.3. Status of mackerel fishery

A detailed review on the present status of the mackerel fishery has been made. It deals with distribution and bionomics, its growth, fishing grounds, gears used, all India catch, State-wise catch, landings in relation to other fisheries, seasons of fishing in relation to environmental factors, size, mortality, recruitment, migration, unit stock, stock assessment and prospects in the coming years.

The Indian mackerel is widely distributed in the tropical and central Indo-west Pacific and the highest catches occur in India. Distribution of larvae and juveniles also have been noted, but no concentration of spawning fish or large quantities of eggs and larvae were noticed at any time of the year. The mackerel forms distinct schools only from the size of 100 mm onwards. The fish remains in the shelf waters throughout the year but are abundant in waters shallower than 30 m.

The bulk of the catch in the country comes from the region between Quilon and Ratnagiri on the west coast. The fish is at present exploited only from the coastal waters with indigenous crafts and gears. Recently purse seines have been introduced in the Karnataka region with success.

The annual average catch is roughly 70,000 tonnes varying from year to year between 16,431 tonnes in 1956 to 204,575 tonnes in 1971. Mackerel forms 8% of country's marine fish production on an average.

Though the catch is highest in Kerala the catch per Km of coast and catch per Km^2 seems to be very high in Karnataka and Goa. In the case of catch per Km^2 even Maharashtra seems to have a higher turnover than Kerala. It will be apparent from these that the variation in the mackerel catch of the different States is not related to the extent of fishing grounds each State has, but depends upon the availability of the fish and the density of their occurrence in the coastal fishing belt. In relation to other fisheries the mackerel is not the most important in Kerala, whereas it is of high commercial importance in Karnataka and Goa.

Size composition in the commercial catches studied over a long period shows that there has been no major change in the prevailing commercial sizes or mean size of the fish though variations within the overall limits may occur from time to time according to places. The fishery at Vizhinjam comprises of mostly 0–year class (below 155 mm) and 1 year olds at other places (160–225 mm). The stock assessment made by the acoustic and aerial surveys made by the PFP and the data collected by the CMFRI have averaged to be around 127,000 tonnes. The average annual catch is around 70,000 tonnes which leaves an untapped resource of about 57,000 tonnes.

Mackerel shoals are confined mainly to 15 km coastal belt during October-April which is the main season for it. This belt is almost fully exploited in Kerala but not so in Karnataka and Konkan Coast. We are almost exerting maximum fishing effort and are nearer to the optimum yield and further increase in the fishing effort in the area may fetch only marginal increase in the catch.

Electrophoretic studies have shown that heterogenity exists in the mackerel populations and genetically different groups are existent. The finding that before the commencement of the season along the west coast, shoals are confined mainly to the region between Ponnani and Mangalore indicates the south-to-north migration of the shoals in the season.

2.4. Tunas and related species

Estimates of organic production in the Indian Ocean and adjacent seas and the estimates of potential yield of the stocks have shown that several of the shelf oriented species such as little tunny, bonito, northern blue-fin and the frigate mackerel are underfished. The present annual catch of skipjack amounting to about 5000 tonnes could be increased several folds. As against the estimates of potential resources the average annual catch of tunas in India was a meagre 4000 tonnes during the '60s but in the recent years the catch has shown improvement and about 20,000 tonnes landed in 1976.

Excepting in the Lakshadweep Islands where the oceanic skipjack is fished in considerable quantities, there is no organised tuna fisheries along the Indian Coast. The coastal species are obtained as incidental catches in different types of gears operated for other species. Based on the present level of exploitation the constants of yield equation have been calculated for various maritime States. Kerala accounts for about 50% tuna catches in India.

Experimental fishing and exploratory surveys carried out with purse seines, drift nets and long-lines have shown the effectiveness of these gears and new fishing grounds have been located in the offshore waters.

The biology of oceanic skipjack *Katsuwonus pelamis* has been studied in detail at Minicoy with information on the hydrography and meteorology of the locality and also on the bait-fish resources and possibilities of culturing some species like *Tilapia*.

The tuna fishery along the south-west coast of India has been studied in detail including aspects of biology of the most dominant species, *Euthynnus affinis*. Investigations on tunas and bill-fishes have been taken up at Calicut, Cochin, Vizhinjam, Tuticorin and Mandapam.

2.5. Other fisheries

Similar detailed studies on the biology of many other species such as Bombay duck, sciaenids, ribbonfishes, polynemids and silver-bellies, which are commercially important, have been made and a series of bulletins have been brought out. Introduction of mechanised fishing has led to the development of their fisheries in grounds previously not exploited and the catches have been increasing steadily.

2.6. Demersal Resources

The Institute in collaboration with Govt. of India Exploratory Fishery Project has satisfactorily charted demersal resources upto 40 m depth in the seas around India. Except for certain sections off Tamil Nadu, off the southwest coast the charting undertaken in collaboration with the Integrated Fisheries Project went on satisfactorily upto the edge of continental shelf and the upper continental slope. The relative abundance of various groups of fishes in the different grounds has been estimated.

2.7. Synoptic survey of exploited marine fisheries resources

A synoptic survey of the exploited marine fisheries resources of India has been made. Details of the catch by mechanised and non-mechanised boats as well as effort expended have been analysed yearwise for the maritime States. Attention has been drawn to some of our potential resources—conventional and non-conventional demersal and pelagic resources, pelagic oceanic resources and new fishing grounds along the coasts of maritime States and Union Territories.

The trend in the yield of major exploited fisheries of the east coast of India were studied for the period 1952-72. On the West Bengal–Orissa Coast, the yields of elasmobranchs, catfishes, anchovies, whitebaits, other clupeids, sciaenids, ribbonfish and penaeid prawns are good and are expected to maintain the same trend in the future also at the present rate of exploitation. In Tamil Nadu the catches of catfishes, other sardines, anchovies, whitebaits, sciaenids and prawns are expected to increase in the coming years.

2.8. Review of biological aspects on marine fishes

A critical appraisal of the existing knowledge of the food and feeding habits of some marine fishes from Indian waters was made with suggestions for tackling the problem of community nutrition and determining the transfer of energy from one trophic level to another. The organic carbon in the stomach contents of some marine fishes was estimated. The ratio of body carbon to food carbon in a zooplankton feeder and a carnivore were nearer to 1 but in phytoplankton and detritus feeders these ratios were between 5 and 7

An appraisal of the studies on maturation and spawning in marine fishes from Indian waters has been made. Fishes in Indian waters were observed to spawn during all months of the year, but along the east coast spawning largely seems to occur during the pre-monsoon months and along the west coast during the monsoon and post-monsoon months. Similarly a review has been made of the existing knowledge about the age and growth in marine fishes with suggestions for studying this aspect with latest methods.

2.9. Mariculture of fishes

The Institute has developed techniques of culturing fishes such as *Chanos*, mullets, perches and eels in suitable areas. Without much complicated management procedures a production rate of 857 kg/ha/annum was made possible on a demonstration basis. *Sillago sihama* could also be successfully cultured on a commercial scale.

3. Crustacean fisheries

3.1. Crustacean resources

While there are many reasons that can be attributed to the magnificent improvement in All India prawn catches, the better knowledge gained about our resources through research is undoubtedly a significant one. The distributional records and new species described during the past years have considerably enhanced the scope of our prawn resources. The trend of exploitation of resources as manifested

in the fluctuations in yearly landings of prawns was analysed in detail and valid explanations were provided from time to time in order to dispel the various apprehensions raised by the industry.

The most significant development that has taken place in the field of capture fishery for crustaceans in recent years is the discovery of large concentrations of deep water prawns and lobsters on the continental slope along the southwest coast of India and Gulf of Mannar through the work of exploratory vessels.

Area-wise dispositions of each of the species and their succession of appearance in the commercial fishery have been delineated. Detailed fishery atlases have been prepared for the benefit of the fishing industry.

3.2. Larval history of prawns

Larval history of many species of prawns has been traced by laboratory rearing and keys for identification of larval and post-larval stages of penaeid prawns were prepared. Study of the seasonal distribution and abundance of penaeid larvae in the inshore and backwater areas of Cochin, Mangalore and Madras indicated nature of their recruitment and provided indices for forecasting the prawn fishery of the concerned regions. Pattern of larval growth and moulting were recorded.

3.3. Biology of important species

Food and feeding habits, age and growth, maturation and spawning and fecundity of most of the commercially important species have been studied.

The exploited species of prawns off southwest coast of India exhibit certain size oriented movements between depth zones in the fishing grounds. Some of their movements have been correlated with the prevailing upwelling phenomenon. In *Solenocera indica* and *Parapenaeopsis stylifera* the population move *en masse* offshore when the salinity of the coastal water decreases during the monsoon period. Experiments conducted on marking prawns show that the biological stain Fast Green (FCF) could be used for marking our species of prawns. The durations of the estuarine existence of the important species of prawns have been determined. The return migration to the sea seems to be activated by sex instinct.

3.4. Lobster investigations

The biology of shallow water lobsters has been investigated in detail. Tagging experiments have shown that movement of lobsters in the fishing grounds is of restricted nature. The lobsters grow very fast and attain exploitable size by the end of one year.

3.4.1. Deep water spiny lobster

Following the discovery of large concentrations of the Indian deep sea spiny lobster, *Puerulus sewelli* in 1969, a regular seasonal fishery for the species has come into existence in the southwest coast of India and in Gulf of Mannar. The distributional and seasonal abundance of the species in the fishing grounds situated on the continental slope of the above areas have been studied. The biology of this species has been investigated in detail and early developmental stages have also been worked out.

3.5. Mariculture of prawns

Although about 2.0 to 2.5 lakh tonnes of prawn are annually landed in the country, there is increasing demand for prawns and shrimps in the industry for processing and export to various countries. Culture of marine prawns has offered the best solution to the problem of increasing the production.

Within a short period of three years the Institute made rapid progress in prawn culture with significant results. Many species of commercially important marine prawns such as *Penaeus indicus*, *P. monodon*, *Metapenaeus dobsoni*, *M. monoceros*, *M. affinis*, *Parapenaeopsis stylifera* were made to spawn in the laboratory and the eggs were reared successfully through various stages right upto the stocking size. Among these species, it is for the first time in India that *P. indicus* and *P. monodon* were spawned and reared under controlled conditions. Another species *M. dobsoni* was domesticated in the Narakkal farm and the juveniles were able to grow to maturity stage and then spawn again. At Madras farm, the tiger prawn, *P. semisulcatus* was spawned and successfully reared, for the first time in India.

The Institute has demonstrated that by intensive culture of some of these species on scientific lines it would be possible to raise them at a rate of 1000 to 1500 kg/ha/annum valued at Rs. 35,000 to 50,000.

The Institute is perfecting the methods of large scale seed production, mass culturing of food organisms, preparation of artificial feeds, transportation of prawn seeds by air, etc.

4. Molluscan fisheries

The Institute has undertaken studies on the resources of commercially important molluscs occurring along the east and west coasts; population studies and ecology of pearl oysters and chanks at Tuticorin and on mariculture of mussels, oysters, clams and cockles at different centres.

4.1. Resources of commercially important molluscs

4.1.1. Clams, oysters and mussels

The resources survey of commercially important molluscs along the east and west coast of India covering a distance of 260 Km was completed. The work was carried out with bases at Calicut, Vizhinjam, Tuticorin, Mandapam Camp, Madras, Waltair and Kakinada. In some localities estuaries and backwaters were also surveyed. The investigations brought to light the existence of extensive beds of *Donax* spp. in the sandy inter-tidal region, *Perna* spp. in the rocky inter-tidal region and *Meretrix* spp. and *Katelysia* spp. in estuaries and backwaters.

4.1.2. Survey of islands in the Gulf of Mannar

A chain of 20 islands in the Gulf of Mannar were surveyed for edible and commercially important molluscs. The population of *Donax* spp. existed in the sandy beach of almost all the islands except one or two. The most abundant clam was *Mesodesma glabratum* especially in the southern islands, *Gafrarium tumidum* was common in Manoli Island while Puli and Pullivasal Islands were characterised by extensive beds of *Arca* spp.

4.1.3. Cephalopod resources

The commercially important cephalopods comprising the squids, cuttle fishes and *octopods* have assumed great importance in the fishery export trade in the recent years and there is an immense market potential for further development. Besides the resources available on the continental shelf, the exploratory fishery surveys have indicated the presence of large exploitable stocks of cephalopods in the oceanic waters. The resource characteristics, biology, migration and behaviour of cephalopods are being investigated at a number of centres along the east and west coast.

4.1.4. Mussels

The resources survey of mussels occurring at Calicut, Vizhinjam, and Kakinada has been intensified.

Abundant source of mussel spat have been found on groyens put up in the sea along south west coast as part of anti-sea erosion work. This area could be expected to provide an abundant supply of seed requirements for mussel culture.

4.2. Population studies and observations on chanks and pearl oysters

At Tuticorin the SCUBA diving team surveys every year the population of chanks and pearl oysters in the natural beds. These surveys help in predicting the pearl and chank fisheries for the ensuing seasons/years. As regards pearl oysters it is unlikely to expect a pearl fishery for the next two or three years.

4.3. Mariculture of molluscs

4.3.1. Pearl culture

One of the most significant achievements of the Institute is the development of techniques, indigenously, for production of cultured pearls. The pearl culture laboratory set up at Tuticorin is producing good quality cultured pearls. Efforts have been taken to produce indigenously the nuclei required for implantation. The perfection of these techniques has enabled the Institute to train technicians

drawn from various maritime States. Recently good resources of young pearl oysters have been discovered at Vizhinjam. Experiments show that cultured pearls of good quality can be produced here also. Pilot projects for producing cultured pearls are being taken up at Tuticorin and Vizhinjam.

4.3.2. Mussel culture

It has been shown that by culturing mussels on ropes, an annual production of 150 tonnes per hectare can be achieved. The feasibility of culturing mussels on suspended substrata along the open coastal waters has been established at Calicut. The yield of mussels after an interval of 5 months was observed to be as high as 600 kg from 66 kg of young seeded mussel.

4.3.3. Culture of edible oysters, clams and cockles

The Institute has shown that four out of ten species of oysters (*Crassostrea* spp.) which are available along our coasts could be successfully cultured. The work carried out at Mandapam has shown that cultured oysters grew to about 90mm at the end of 14 months. The young ones of oysters are collected on suitable artificial substrata known as cultch and reared in protected waters. Oyster culture work is also in progress at Tuticorin and Madras. Similarly the culture of window pane oysters and cockles have shown promising results at Kakinada.

5. Fishery Environmental Studies

5.1. Physical and Chemical Oceanography

The Institute has conducted oceanographic surveys along the west coast of India and the Laccadive Sea over a period of 10 years in order to determine the relationship between hydrography of the waters and the major fisheries. The results of these surveys are being published and valuable data have been obtained on the commencement of upwelling in deeper waters and the areas of upwelling. These investigations while pointing to the relative richness of the waters along the southwest coast, should also help in a proper understanding of the fluctuations in our major fisheries in this area. Seasonal fluctuations observed in characteristics such as the shifting of the thermocline, the oxygen minimum layer, upwelling and sinking, and related phenomena have a considerable bearing on the fertility of the waters, the production of marine plankton and the commercially important fisheries. Correlation has been found between the occurrence of good fisheries for pelagic fishes (mackerel and sardine) along the southwest coast and surface temperature variations in the area. The most favourable range of temperature for successful fishery was found to be between 27.8°C to 28.2°C. This, if confirmed by subsequent work is of considerable value in locating shoals. Seasonal fluctuations in nutrients (inorganic phosphate, nitrate and silicate) of the shelf waters along the south-west coast have been investigated. The shelf areas between Quilon and Alleppey and off Calicut have been found to be relatively richer in nutrient concentration.

5.2. Phytoplankton productivity

Primary production studies in the Indian seas using radio carbon (C^{14}) technique was initiated by the Institute in 1956. Continued studies on primary production have confirmed the earlier observations by conventional methods of the high magnitude of productivity along the west coast and other areas in the coastal waters. The rates of production computed for the seas around India have indicated that the potential harvest could be increased to 2–3 times the present yield. These studies and the data obtained from other agencies have helped the Institute to estimate the magnitude of production in the Indian Ocean indicating thereby that the potential fish yield could be of the order of about 11 million tonnes.

At Calicut and Cochin, extensive studies have been carried out on the systematic and quantitative distribution of offshore and oceanic phytoplankton. Taxonomic accounts of the Dinophyceae of the Indian seas listing all known species have been published.

5.3. Marine Algal Resources

5.3.1. Resources Survey

Surveys have been conducted jointly with the Tamil Nadu Fisheries Department and Central Salt

and Marine Chemical Research Institute in some areas along the south-east coast with the object of estimating the available seaweed resources, areas suitable for seaweed culture and the species composition and their abundance. The second phase of survey is nearing completion and the system adopted can now be extended to other areas for survey of seaweed resources.

Systematic and ecological studies of commercially important seaweeds have been undertaken. Several new records and species new to science have been described from the Palk Bay and Gulf of Mannar.

Methods of extraction of agar-agar and algin from seaweeds such as *Gracilaria corticata* and *Sargassum wightii* perfected by the Institute have helped to establish a seaweed industry in Tamil Nadu and Gujarat and to start factories for manufacturing the products derived from seaweed. Due to the pioneering work done in this field by the Institute, several enquiries are received requesting information on seaweed resources and processing methods.

5.3.2. Culture of seaweeds

Laboratory cultures of economically important seaweeds to estimate the spore out-put from the fruiting thalli and study the effect of light intensity on growth and spore formation has been undertaken. These have helped in the preliminary investigations on frame culture of economically important seaweeds. The investigations point to the feasibility of large scale culture of seaweed using such techniques in our waters.

5.4. Fish eggs and larvae

Detailed investigations on the fish eggs and larvae occurring in the plankton are being undertaken to locate spawning grounds and study the spawning behaviour of commercially important fishes and to estimate the rate of recruitment to the fishery and other related aspects. Larvae of several of the commercially important species such as Indian mackerel, tunas, ribbon-fishes etc. have been identified and their seasonal abundance, spatial and temporal variations and sequence of development are being studied.

The larvae of Indian mackerel *Rastrelliger kanagurta* have been identified from several stations in the area 8° 50′N to 10° 40′N and 75° 45′E to 76° 16′E chiefly between depth contours 30m and 90m. In some areas, especially around 9° 30′N and 76° 10′E night collections have shown a large abundance of mackerel larvae in the month of May with estimated counts upto 730/1000 m^3 of water strained in collections with the Indian Ocean standard net.

5.5. Fishery Oceanography

Planned exploratory surveys carried out along the south west coast between Cape Comorin and Karwar have helped in the demarcation of three distinct bottom conditions at the depth range of 75 to 450 metres, associated with which are three types of demersal communities. These are characteristic of the depth zones 75 to 100m, 101 to 179 m; and 180 to 450m. The potential demersal fishery resources have been estimated separately for these three depth zones. These no doubt require further detailed studies.

Drift-net fishing has shown the abundance of two species of frigate mackerel, *Auxis thazard* and *A. rochei*, in the open ocean. Both these were formerly known to occur rather sporadically along the west coast. Another important finding was the presence of the oceanic squid *Symplectoteuthis oualaniensis* in schools. These were generally attracted at night by the lights. This is one of the commercially important species fished in the Pacific Ocean.

5.6. Mud banks and their influence on fisheries

The influence of mud banks on the economy of the fishing community along the south west coast is well known. The investigations on the formation, sustenance and dissipation of these mud banks as well as their physical, chemical and biological characteristics together with the role of mud banks in accentuating and augmenting the fish production during monsoon months have been carried out.

5.7. Secondary production

Study of secondary production is of vital importance in ascertaining the concentration of fishes in specific areas. The Institute has carried out con-

siderable investigations on the types of zooplankters and their distribution in our waters; their role in the food chain and their use as indicator species of different water masses.

It has been possible for the Institute to locate and investigate the Deep Scattering Layer in the Laccadive sea where two distinct DSL the first between 300 and 450m, the second between 800 and 900m were found. The DSL is of biological origin constituted by the aggregation of many macro zooplankton and micro nekton. It forms an important source of forage for pelagic fishes such as tunas, bill fishes etc.

5.8. Marine pollution in relation to protection of living resources

With the increasing use of estuarine and coastal areas for development of mariculture, the threat from industrial and sewage pollution has to be monitored intensively. The Institute has planned to identify the areas of pollution and obtain information on the toxicity of various pollutants on the fishes, crustaceans and molluscs. Suitable laboratory experiments have been designed for determining the LC-50 and other factors. The Institute offers consultancy service to industries which require monitoring studies of the effect of factory effluents on the marine and estuarine environments.

5.9. Investigations on ancillary marine living resources

The Institute has been carrying out comprehensive investigations on the ancillary marine living resources such as corals, sponges, echinoderms, marine mammals and turtles and detailed accounts have been published.

6.1. Inter-Divisional Projects

In certain areas where multidisciplinary and integrated approach is necessary to tackle the problems, the Institute has formulated Inter-Divisional Projects. Currently the IDP projects taken up are i) Survey of fish seed resources, ii) fish and shell fish diseases and iii) National tagging programme of fishes and crustaceans.

6.2. Inter Institutional Projects

A co-operative intensive prawn farming project involving the Fisheries Department of the Govt. of Kerala, the Marine Products Export Development Authority and the Central Marine Fisheries Research Institute to demonstrate the economics of intensive prawn culture to entrepreneurs and fish farmers of the Cochin region is progressing at Narakkal.

As a policy, the Institute has been collaborating with sister institutes and organisations in the past also. Some of the projects have been:

i. Exploratory surveys along the east and west coast with Exploratory Fisheries Projects
ii. Exploratory fishing and oceanographic surveys with Integrated Fisheries Project.
iii. Pearl and chank surveys with Govt. of Tamil Nadu
iv. Seaweed resources surveys with CSMCRI.

With Central Institute of Fisheries Technology the Institute proposes to take up projects on fish and prawn feed development; experimental fishing and utilisation of lobsters and stomatopods; and quality control of molluscan products.

Collaboration programmes are envisaged with NIO, IASRI, and Agricultural Universities.

6.3. Pilot and sponsored schemes

The Institute envisages to take up a number of Pilot Projects to make an impact on mariculture and these will be carried out by the respective Divisions. Technical assistance has already been extended to Government of Kerala in organising and implementing a pilot project on pearl culture. Another pilot project on pearl cluture has also been proposed in collaboration with Govt. of Tamil Nadu and National Research Development Corporation of India. The Institute also desires to take up projects sponsored by the private and public sector organisations; one such programme on elver resources survey and eel culture has already been proposed to be sponsored by the Marine Products Export Development Authority.

6.4. Operational Research Project

Although marine fisheries development in the country has been impressive during the past three decades, it is felt that the benefits accrued have not helped the poor fishermen engaged in small scale indigenous fisheries whose per-capita income has hardly improved. In order to benefit the fishermen and their family members whose labour potential has not been fully utilised, it is conceived that blending of culture fisheries with normal capture fisheries would greatly help to enhance the production and the earnings of the rural community. An Operational Research Project has been drawn up for implementing this scheme at Kovalam near Madras. This village has 175 families comprising a total of 975 fishermen. The per-capita income is Rs. 369 per annum. The project will train the fishermen in the methods of mariculture of fishes, prawns and molluscs so that these could be undertaken along with capture fisheries. This would also create a sense of involvement and participation in the sea farming techniques evolved by the Institute and demonstrate the scope for overall improvement of socio-economic conditions of the area. The Integrated approach to blending culture fisheries with capture fisheries for rural development is a new concept in marine fisheries sector.

7. Education, Training and Extension

7.1. Education

The Headquarters of the Institute at Cochin, Regional Centre at Mandapam Camp and the Research Centres are well equipped with laboratory and library facilities and these have been recognised by several Indian universities as centres for advanced research in various aspects of fish and fisheries science. The Director of the Institute and several scientists are recognised guides for scholars working for postgraduate degrees. Over 20 scholars have qualified themselves for Ph. D degree. Some foreign students have also availed of these facilities for education and training. The scientists are invited to give lectures in other Institutes and Universities in India.

7.2. Training facilities

7.2.1. The Institute has regular training programmes for imparting training in fishery survey and statistics, fishery biology, marine biology, oceanography and mariculture on prawns, fishes, molluscs seaweeds etc. Training will be offered for underwater survey work using diving equipments. Training is also imparted to personnel deputed from abroad.

While trying to transfer the technology developed by the Institute on pearl culture, prawn culture etc. at various levels, the Institute has trained in batches interested personnel in pearl culture, and prawn culture.

Periodically the Institute has organised summer institutes on such aspects as coastal aquaculture, marine prawn culture and propagation. The participants in these summer institutes were drawn from fishery departments, universities and other sister organisations.

7.2.2. Krishi Vigyan Kendra

The KVK set up by the Institute at Narakkal, imparts training to actual fishermen or farmers on aspects of mariculture so that they learn the techniques by actual work in the field. 8 batches have already been trained and some of the successful trainees have taken up prawn culture work in their own pond or field. The Institute rendered help in the preparation of the ponds and scientific farming techniques.

7.3. Extension

The Institute publishes its scientific papers in several Indian and foreign journals. The Institute itself publishes the *Indian Journal of Fisheries* of which 22 volumes have been issued so far. The Institute also publishes occasionally Bulletins on selected topics and 27 such Bulletins have been issued. The Institute is also bringing out Special Publications on proceedings of groups discussions, Summer Institutes etc. The CMFRI News Letter which is periodically issued contains information about current activities and achievements of the Institute. The contributions of the scientists are also published in the *Journal of Marine Biological Association of India* and the Proceedings of the various Symposia conducted by this Association as well as other organisations.

7.4. Advisory service

The Director of the Institute and the Scientists serve as members in several committees and panels of the Central and State Governments, Universities, Agricultural Universities and International Organisations. The Institute is rendering consultancy services to interested individuals and organisations on many problems relating to capture and culture fisheries.

7.5. Seminars and exhibitions

Periodically the Institute conducts seminars and symposia on capture and culture fisheries and also participates in symposia and seminars conducted by other organisations. In order to project its activities and achievements, the Institute participates in important exhibitions and fairs. The impressive stalls put up by the Institute are visited by several thousands of people from all walks of life.

7.6. Publicity

The Films Division of the Govt. of India has produced a number of documentary films on aspects of marine fisheries research for showing to various types of audience. The scientists have also given broadcasts over All India Radio on important aspects of marine fisheries research highlights.

Total number of Scientific and Technical papers published by the staff of CMFRI

Year		No. of papers
Upto	1970	981
	1971	77
	1972	116
	1973	146
	1974	52
	1975	54
	1976	36
	1977	58

FUTURE PROGRAMMES

Future programmes of the Institute

The future thrust in the coming years as far as the research inputs of the Institute are concerned will be based on the following considerations:

* Changing pattern in the fishing industry
* Exploitation and utilisation of the fishery resources of the Economic zone.
* The vast areas of brackish waters and costal areas available for mariculture of suitable species
* Improving the rural economy through an appropriate blend of capture fisheries with culture fisheries
* Development of integrated systems of crop-livestock-fish and prawn culture in coastal areas
* Transfer of technology through Training Programmes at different levels and through Pilot Projects, Operational Research Projects and National Demonstrations

In the light of the above considerations the future programmes and strategies of the institute in the coming years are listed below:

National Demonstration Projects

Based on the technical feasibility that has been fully developed, National Demonstration Programmes will be undertaken on the culture of fishes, prawns, pearl oyster, edible oyster, mussels, clams and seaweeds; subsequently on culture of sponges, squids, sea urchin, Beche de mer and turtle farming.

Transfer of Technology

Training programmes in culture of fishes, prawns, pearl oyster, edible oyster, mussels and seaweeds;
Training in under-water diving by SCUBA
Training programmes in population dynamics
Training programmes in other disciplines

Operational Research Projects

Operational Research Project on blending culture and capture fisheries to be extended to more villages along the east and west coast

Integrated Rural Project

Crop-livestock-fish and prawn culture programmes for integrated rural development in costal areas

Fishery biology and resource characteristics

* Ensuring effective management of the resources through concerted research efforts
* Investigations on the effect of introduction of purse seine and other gears along the west coast for mackerel and oil sardine fisheries on the stock of these fisheries in the traditional and non-traditional fishing grounds
* Intensive studies on the fishery and biology of the coastal and oceanic species of tunas, billfishes and seerfishes through exploratory surveys both in conventional and non-conventional grounds
* Resources survey and culture of bait-fishes for tuna fishery
* Strengthening the investigations on Bombay duck and extending the same to east coast
* Survey of spawning grounds, distribution and abundance of young fish of important finfish resources
* Investigations on non-conventional resources such as meso-pelagic and deep water fishes
* Major thrust on the demersal resources in the non-conventional grounds
* Improvement of fish culture techniques, induced breeding of fishes such as milk fish, mullet, sandwhiting and eels. Polyculture of compatible species of finfish and shellfish.

Crustacean Fisheries

* Strengthening of all on-going projects
* Monitoring the exploited resources both in the marine and estuarine environment for formulating suitable management policies
* Intensive studies on lobsters, crabs and stomatopods
* Exploratory surveys on the resources of the economic zone including studies on deep sea prawns, lobsters, crabs and other crustaceans
* Development of hatchery techniques for large scale production of prawn seed; polyculture of prawns and fishes; site selection and farm engineering for prawn culture; genetic improvement of stock; assessment of nutritional requirements of prawns; developing remedial measures for combating diseases

Molluscan Fisheries

* Proper assessment of the exploited molluscan resources through improved sampling design; to assess potential resources to raise the present level of sustenance fishery to a major industrial fisheries
* to organise resources surveys of cephalopods (squids, cuttlefishes and octopods) in the economic zone and adjacent oceanic waters to meet increasing market demands
* culture operations will be rural based to generate additional employment potential besides improving socio-economic conditions
* Large scale production of molluscan seed through hatchery techniques
* to develop diversified low cost molluscan products acceptable to wider section of the community.

Fisheries Resources Assessment

* Strengthening of all on-going projects
* Increasing the coverage of sampling from 2.5% to at least 5% to increase the pre-

cision of estimates and for better stock assessment of our commercially important fisheries

* Strengthening the Fishery Data Centre to cover the activities both in culture and capture fisheries, especially in the new Economic Zone

* Survey of estuarine resources

* Intensifying the programmes on fishery economics

Fishery Environmental Studies

* When the Research vessel is put into operation it is envisaged to obtain synoptic pictures of relevant environmental parameters by extensive and intensive coverage of the seas around India

* Preparation of fishery oceanographic atlases

* The feasibility of enrichment of lagoon waters of Minicoy island through artificial upwelling will be explored

* Intensive investigations on mud banks along the south west coast and their influence on the fishery

* Investigate the effect of oil drilling in the continental shelf on the marine ecosystem

* Work on marine pollution in relation to protection of living resources will be intensified through GC and AAS techniques

* Productivity of different ecosystems including mangrove swamps in coastal zone will be estimated to promote mariculture

* Studies on inter relationship of animal communities in coral reef areas, food chain of reef fishes, toxicology and pharmacology of reef dwelling animals

* Investigations on the availability and uses of anciliary and non-conventional resources

* Intensive mass-culturing of phyto-and zooplankton to be used as live food in mariculture

Inter-Divisional Projects

Strengthening the on-going inter-disciplinary projects such as:

Resources survey of fish, prawns and molluscan seeds.

National tagging programmes.

Fishery resources of the economic zone.

Effect of man-made changes on environment

Special surveys relating to mariculture

Inter-Institutional Projects

In collaboration with Central Institute of Fisheries Technology the following projects will be undertaken:

Fish and prawn feed development

Experimental fishing with new/improved gears

Study of the resources and their utilisation of lobster and stomatopod fisheries

Product development and quality control of molluscan products

With Departments of Fisheries of maritime States and organisations such as MPEDA the Institute proposes to take up cooperative projects for accelerating development of mariculture in different regions.

New Divisions

In order to meet the various requirements of large scale mariculture, the extended economic zone, extension, training and other activities which will together promote better exploitation of our resources the Institute proposes to form the following new Divisions:

Nutrition Division

Physiology Division

Fish Pathology Division

Genetic Resources Division

Marine Farm Engineering and Instrumentation Division

Fishery Economics Division

Maritime Fishery Law Division

Library and Documentation Division

Extension Division