GOVERNMENT OF INDIA

MINISTRY OF AGRICULTURE

HANDBOOK OF INDIAN FISHERIES

PREPARED FOR THE THIRD MEETING OF THE INDO-PACIFIC FISHERIES COUNCIL MADRAS, FEBRUARY, 1951.

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Foreword

by the

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1, Queen Victoria Road,
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8th January 1951.

F O R E W O R D.

It gives me great pleasure to write this foreword to the handbook of Indian Fisheries, which is being brought out on the occasion of the third Annual Session of the Indo-Pacific Fisheries Council in Madras.

The development of fisheries is one of the most effective means of increasing food production. If properly exploited, the supplies are almost inexhaustible. Fish are, besides, the least expensive source of protein and, as such, are of the highest importance from a nutritional point of view. Inadequate scientific data, old fashioned techniques and depressed condition of the fishermen have, however, restricted development in the Indo-Pacific region and I hope the Madras Session of the Indo-Pacific Fisheries Council will succeed in finding a solution to these urgent problems.

(K.M. Munshi)

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Editor.

Equivalents.

Maund.	-	approx. 82 lbs.
Seer.	-	" 2 lbs.
Ton.	-	" 27.2 maunds.
Rupee.	-	18 d sterling.
Acre.	-	4840 sq. yards.
Lakh.	-	100,000.

INDIA AND THE INDO-PACIFIC FISHERIES COUNCIL.

The development of fisheries in all areas for augmenting food supplie
a view to meeting food shortages that were becoming more and more acute
many parts of the world at the end of Second World War was rightly regarded a
one of the important items in the programme of the United Nations. Special
stress was laid on the conservation and development of fishery resources in t
inaugural Session of the Food and Agricultural Organisation of the United Nat
at Quebec in 1945. It was, however, felt by the Indian Delegation to this Co
ference that too much stress was being laid by the representatives of most
European and American countries, where fisheries were well developed, and eve
over-exploited through the use of mechanised craft and gear, on the conservat
of the resource by controlling production, laying down standards and so forth
The Indian Delegation, together with the representatives of other areas where
fishery resources were far from developed, on the other hand felt that the
problems of fisheries for such under-developed areas were so radically differ
from those in well developed areas, that it was essential to consider these o
zonal basis in accordance with the state of development of their fisheries an
the needs of these areas. The Indian Delegation, therefore, suggested that it
would be desirable to institute regional councils for various areas, on the l
of the North Sea Council which had proved so valuable for the conservation an
development of the fisheries resources of the North Sea and the adjacent area
The Indian representative pressed this view in the Fisheries Advisory Committ
meeting at Bergen in 1946 and at the second session of the F.A.O. at Copenhag
in the same year. The question was also pursued in a conference of fisheries
interests which was called at Singapore under the aegies of the Special
Commissioner for South East Asia in January 1947, and as a result the proposal
for the establishment of a regional council for fisheries work in the Indo-
Pacific area began to take a tangible shape. The recommendations of the Sing
pore Conference were communicated to the Director General, F.A.O., and, as a
result, the Food and Agricultural Organization of the United Nations convened
conference at Baguio in the Philippines in February, 1948, to draw up the rul
and regulations for the proposed Indo-Pacific Council as also the Agreement
which the Member nations of the Council were to subscribe to. An Indian
delegation took part in this Conference also.

The Indo-Pacific Fisheries Council came into being in December 1948, after notifications of acceptance of the Agreement by France, Philippines, United States of America, Siam and India were received by the Director General of the Food and Agricultural Organization of the United Nations. It was then decided to hold the first meeting of the Indo-Pacific Council at Singapore from 24th to 31st March 1949. In addition to scientific meetings, the main work of the Session was in connection with the drafting and adoption of rules and regulations and the rules of procedure etc. In this meeting the leader of the Indian Delegation was elected as the first Chairman of the Indo-Pacific Fisheries Council, not only for the Session at Singapore but also for the second Session which was proposed to be held in Australia in 1950. It was unfortunate that owing to various reasons no Indian Delegation could attend the second meeting of the Council in Australia, but from the brief outline given above it is obvious that India has played a very important part in connection with the formation of the Indo-Pacific Fisheries Council. It is hoped that the third Session which is being held in India will result in still closer ties between India and the Council

Part I - General

1

GENERAL SURVEY OF INDIAN FISHERIES.

INTRODUCTION.

India has considerable marine and inland fishery resources, but the extent of these resources has not been properly assessed so far. Judged by the fact that there is a coast line of some 29,000 miles; a continental shelf, from the shore to the 100-fathom line, of more than 1,00,000 square miles, into which numerous large and perennial rivers discharge their silt-laden waters; two wide arms of the Indian Ocean, the Bay of Bengal and the Arabian Sea; a number of smaller gulfs and bays all along the coast; a large number of small oceanic islands with their innumerable creeks, bays, mangrove swamps and extensive coral reefs, the marine fishery resource must be fairly extensive. Similarly the extensive backwaters, tidal estuaries, lagoons and swamps scattered along the entire coast line, a large number of rivers, streams and channels and an enormous number of perennial and semi-perennial lakes, beels, reservoirs, tanks, ponds and other stretches of water, most of which though culturable, are almost fallow at present, are a rich potential source of inland fisheries. Both these resources, apart from being unestimated, are at present far from fully exploited or developed.

The total annual production of fish in India was estimated in 1948 at 142.1 lakh maunds (1169 million pounds), of which two-thirds consists of sea fish. Fish is eaten by nearly 50% of the population of India, but the *per-capita* consumption is estimated only at 3.36 pounds per year, which is much less than that of many other countries. It has been roughly estimated that production of fish in India must be increased by about 10 times if the people are to have an adequate supply of this highly nutritious and protective food. Judging by the extent of our resource, such an increase should not be very difficult.

It is estimated that the population of adult fishermen in India is of the order of 5,00,000. The total number of boats, dugouts, catamarans and other craft has been estimated at more than 70,000. The boats are generally small and the nets and other tackle used are also more or less primitive. With the craft

and gear available, fishermen are able to fish only in inland waters and in a narrow coastal belt.

The management and administration of fisheries in the various States in India has always been the direct responsibility of the State Governments concerned. Although fisheries are a source of revenue, very little attention was paid in most of the States to the development of this valuable resource. The State Governments concerned themselves mainly with administering the Fisheries Act and issuing licences for fishing or leasing out government-owned fisheries. Separate Fisheries Departments existed only in a very few States and the work was generally done through various departments, such as those concerned with Revenue, Irrigation, Agriculture, Veterinary or Forests, etc. Even in the new Constitution of the Indian Republic, the management and development of fisheries of the country is on the "State" list. The Central Government are responsible for fishing and fisheries beyond territorial waters and for fisheries research and these subjects are on the "Union" and "Concurrent" lists, respectively.

On account of the prevailing food shortage in the country towards the end of the last war, the Government of India began taking an active interest in the development of fisheries in 1944. A Fish Sub-Committee of the Policy Committee No.5 on Agriculture, Forestry and Fisheries was appointed to review the position of fisheries and to report on the measures necessary for the improvement and development of fishery resources of the country. The recommendations of this Committee received immediate consideration by the Government of India and steps were taken to implement them as far as possible.

In the meantime, a Fisheries Development Adviser to the Government of India had been appointed in the Ministry of Agriculture and subsequently a Deputy Fisheries Development Adviser and an Assistant Fisheries Development Adviser were also appointed. These Officers carried out a rapid survey of the areas where fisheries could be developed and suggested measures to the various State Governments for developing these areas. Technical and financial assistance was also provided by the Central Government for the implementation of suitable schemes of fisheries development in the various States. In addition, the Central Government set up agencies for carrying out research and exploratory work under their direct control. All these steps have resulted not only in increasing fish production in the country but have also made the Governments and people of India

more fish-conscious. Small Fisheries Departments have also been established in many States, in which such departments did not exist previously.

RESEARCH.

Extensive scientific investigations and surveys are necessary for undertaking proper measures for the conservation, development and exploitation of the fishery resource of any country. As research and exploratory work of this kind is a long-term and expensive proposition, the Government of India, in the Ministry of Agriculture, have assumed responsibility for this work so far as basic problems of all-India importance are concerned. They have set up two Fisheries Research Stations, one for research on fresh and brackish-water fisheries and the other for that on marine fisheries.

The Central Inland Fisheries Research Station was established in 1947 and is located at Barrackpore, near Calcutta. There is a sub-station at Cuttack in Orissa. The Station is under the charge of a Chief Research Officer, who is assisted by a band of research workers properly qualified in different branches of fisheries research. The work is broadly divided into three main sections, Estuarine, Pond Culture and Riverine and Lacustarine. Investigations are in progress on the rearing and transport of fish-seed, food habits, growth, maturity breeding habits and on many other problems of fresh water and estuarine fishes of commercial importance. The Cuttack Sub-Station is specially engaged on investigations in connection with the unduly high rate of mortality in fry, fingerlings and stocked fish in the State.

The Central Marine Fisheries Research Station was also established in 1947 to carry out research on marine fisheries with a view to estimating our resource, the rate of present exploitation, the possibilities of increasing production and adopting methods of conservation, if necessary. This Station is located at Mandapam (S.India), with Sub-Station at Calicut and Karwar. The Station is under the charge of a Chief Research Officer who has a team of trained zoologists, botanists, chemists and others to assit him. Work has been in progress on the survey of fish and fisheries, biology of fish, factors controlling fish populations, physiology and adjustment of sea fish to brackish and fresh waters and a number of other problems.

The Indian Council of Agricultural Research have also been taking keen interest in fisheries research. During the last several years, they have sponsored and financed many ad-hoc schemes of State Governments and Universities

etc. They are also awarding scholarships for fisheries research at a number of Universities.

Many of the States Fisheries Departments are also engaged on research, mostly on problems with which they are immediately or directly concerned. A number of them have set up research stations and laboratories, where useful work is being carried on in connection with biological and technological problems. Research Centres at Lucknow (Uttar Pradesh), Calcutta (West Bengal), Cuttack and Chilka (Orissa), Bombay (Bombay), Trivandrum and Cape Comorin (Travancore-Cochin) and Calicut, Krusadai, Ennure, Tuticorin, Tungabhadra, Madras and Ootacamund (Madras) deserve special mention.

Preliminary enquiries had indicated that on account of the greatly scattered and unorganised nature of the fishing industry and lack of suitable administrative machinery, it was difficult at present to obtain reliable statistics and data about fisheries and fishing industry of the country. Though the Central Marine Fisheries Research Station and the Indian Council of Agricultural Research are collecting fisheries statistics and some States have also begun to take interest in the collection of statistics about their inland fishery resources in order to assess the possibilities of their development, the methods followed by different agencies are not uniform and the data collected by some of them far from standard. To remove these drawbacks a Fisheries Statistics Committee was set up by the Government of India in 1949 for suggesting standard forms and means for the collection of fish and fishery statistics on a uniform basis. The Committee has submitted its Report and its recommendations are now under the active consideration of the various Governments concerned.

A Fisheries Research Committee was also set up by the Government of India in 1949 for co-ordinating research on Indian Fisheries carried out by the Central Fisheries Research Stations, Fisheries Departments of the State Governments and the Universities. Though a large mass of valuable information regarding research work that is being carried on at present by different agencie has been collected and is being analysed, the work of this Committee is still in an initial stage.

OFF-SHORE FISHING.

Fishing in the Indian seas is generally confined to a narrow coastal belt of 5-7 miles only and the rich off-shore and deep-sea waters are left

practically unexploited. This is largely because the equipment used for sea fishing consists mostly of small boats, canoes and catamarans and small nets and tackle which cannot stand the rigour and requirements of off-shore or deep-sea fishing. In recent years some private companies have made sporadic efforts to undertake off-shore fishing with power-propelled vessels but have not met with much success, partly on account of lack of adequate finances and trained personnel and partly for want of essential data regarding fishing grounds, types of craft and gear suitable for Indian conditions, kinds of fish that may be available in different parts of the sea in different seasons, etc. With the object of collecting data of this kind, carrying out other exploratory work and training the much-needed personnel, the Government of India established, in 1946, a Pilot Deep-Sea Fishing Station at Bombay. The Station is under the charge of a Superintendent Engineer. Experimental deep-sea fishing operations were started in 1948 with a reconverted steam trawler 'Meena'. This vessel was, however, decommissioned in 1949 as her running and maintenance expenses were unduly high on account of her large size and coal burning engines. The operations are being continued with four new fishing vessels imported from Europe, two Dutch Motor Cutters, M.T. 'Ashok' and M.T.'Pratap', and two Reekie Boats, M.F.V.'Bumili' and M.F.V. 'Champa'. A part of the sea off Bombay coast has been charted, but the work is still in its initial stages.

With financial assistance of the Government of India, some maritime States have also taken up off-shore fishing with power propelled vessels.

PROCESSING AND TRANSPORT,ETC.

A serious handicap in the marketing of a perishable commodity like fresh fish is the lack of transport, ice and cold-storage facilities in different parts of the country. Large quantities of fish, which could be made available to the consumers in fresh condition, either perish and have to be converted into manure or have to be dried or otherwise processed. It is estimated that 49.3% of the total production of fish is sun-dried or processed and in 1949 nearly 6.6% of the total catch was converted into manure. The methods of curing range from drying in the sun to salting and pickling, but the product is generally of a somewhat poor quantity.

The Governments of Bombay and West Bengal have introduced in recent years Carrier Motor Launches for transporting fish from the catching centres to the

Bombay and Calcutta markets, respectively. In Bombay these launches operate over long distances and as they carry adequate quantities of ice, spoilage that occurred previously during the transport of fish from the fishing grounds to the shore in undecked country craft has been considerably reduced. Madras has also introduced a number of insulated and other motor vans for the quick transport of catches by roads from the fishing centres to consuming markets. Most of the Indian Railways have now made arrangements for the quick transport of fish from large catching and assembly centres to some of the larger towns. They are also providing special facilities for the transport of fish-seed at reduced rates.

After the acute shortage of ice during the last war, the supply of ice has been steadily increasing in most parts of the country, though it is still insufficient to meet the demand. Cold storage facilities for fish are utterly inadequate, except in one or two large towns. The Government of India are putting up a freezing and cold storage plant with a total capacity of 300 tons and, with financial assistance of the Government of India, Madras Government are also instal ing two, similar but smaller, plants at Calicut and Mangalore on the West Coast.

TRAINING.

The development and management of fisheries of a country of the size of India require a large personnel trained in the methods of conservation, development, exploitation and administration. In order to meet this demand, the Government of India established, in 1944, two centres for training in marine and inland fisheries. The centre for training in marine fisheries, which was originally at Madras and subsequently shifted to Mandapam has since been closed, but the inland fisheries training centre is still functioning at the Inland Fisheries Research Station, Barrackpore. More than 150 Officers deputed by various States and private candidates have so far been trained for inland and marine fisheries work and most of them have been employed in the Fisheries Departments of different State Governments. Besides, some States have been training independently their own subordinate staff and giving short courses on fisheries management to private individuals and demobilized soldiers.

For training personnel for work on modern power fishing vessels, a number of candidates were sent for a short course of preliminary training to Grimsby in the United Kingdom. Five of them have subsequently received practical training for two years on vessels of the Pilot Deep Sea Fishing Station and are now

ployed as Mates and Bosuns on these vessels. In addition, about 50 Indian khands have been trained in the use of trawl and other power fishing equipt. Efforts are now being made to employ and train fishermen as far as ssible.

DEVELOPMENT.

With growing consciousness of the importance of fish in the food of the ple and with financial assistance from the Central Government, most of the te Governments have undertaken schemes for increasing fish production in ir areas. Many of these are long-term schemes and their results are becoming parent only gradually. In addition, short-term fishery schemes have been luded within the ambit of the "Grow More Food" campaign of the Government of and financial assistance is being given by the Centre to the State Governfor implementing these schemes. Upto date about 50 such schemes, at a l estimated cost of Rs. 1,30,00,000/- have been launched in various States. financial assistance given so far to the States amounts to Rs.23,60,000/- as loans and Rs.34,65,536/- as subsidy. Considerable additional quantities of are being produced as a result of the implementation of these schemes and is estimated that by the end of 1951-52 the total additional production will to nearly 20 lakhs maunds. These schemes are of various kinds and a very account of some of the important kinds is given in the following paragraphs

CTION AND DISTRIBUTION OF FRY. Sources of spawn and fry of carps, which extensively used for stocking in India, have so far been located in a few only and one of the biggest handicaps in the extension of pisciculture large areas of the country has been the lack of fish-seed. To overcome this, rangements have been made for the collection and supply of spawn, fry and erlings from surplus States to deficit States or deficit areas within the State. The Government of Madras have set up machinery for the collection, ing the current year, of 500 lakhs of fish-seed of carps and some estuarine ies, mostly for stocking within the State. The Government of Orissa have lected 50 lakhs of fry of major carps for stocking in the State. A flourishtrade in fish spawn has existed in Calcutta from a very long time past and trade not only supplies fish-seed for stocking in the State but large ntities are also exported to deficit areas like Madhya Pradesh, Bombay etc. Bihar also large quantities of fry are collected both for internal stocking

and export. The Government of India have also set up a fish-seed supply cent at the Central Inland Fisheries Research Station, Barrackpore. In the curre year nearly 44 lakhs of fish-seed has been supplied to deficit areas.

Stocking of Inland Waters. As a result of the efforts of the Government of India and the States concerned, large areas of fallow waters have been stocke and converted into productive fisheries. The extent of stocked areas in Wes Bengal, Orissa, Bihar and Assam, which are among the most important States s far as pisciculture is concerned, is not known, but from information availab from most of the remaining States, it appears that nearly 65 thousands acres fallow and semi-fallow waters have been stocked upto date.

OFFSHORE FISHING. The Government of Madras have been carrying on offshore an deep-sea fishing with eight motor fishing vessels. In addition to fishing, these vessels have been employed for towing country craft to the fishing grou and back. In Bombay, one Motor fishing vessel, "Tapase", had been carrying ou shark fishing for some time but has recently been engaged in catching other kinds of fish. This boat is now being operated by a private company under th supervision of the Bombay Government. In Travancore-Cochin, one M.F.V., "Chand is being utilized as a "Mother" vessel. Ten to twelve country boats and thei crew are towed to offshore fishing grounds and fishing is done from the count boats, mostly with long lines. Government of Bengal have imported two Danish Cutters with Danish crew for operations in the Bay of Bengal.

IMPROVEMENT IN THE QUALITY OF CURED FISH. In order to improve the quality of cured fish both for export and internal consumption, better facilities are bei provided at the Fish Curing Yards. Financial assistance has been given to som of the maritime States to improve their yards and a Model Curing Yard has been put up at Cape Comorin in Travancore-Cochin. Subsidies are also being given f the supply of salt at concessional rates for the curing of fish in the yards.

TRANSPORT AND PRESERVATION ETC. The Government of Madras have started employi a fleet of motor vans for the transport of fish and the fishermen from the catching and assembly centres to some of the large consuming markets. Two Col Storage plants are also being put up for the better preservation and utilizati of fish catches.

SUPPLY OF FISHING REQUISITES. A large number of co-operative societies of fishermen have been set up and many of them are supplying the necessary fishi

...isites to the fishermen at subsidized rate for increasing their catches and ...oving their socio-economic condition.

ORGANISATIONAL SET UP.

The appointment of Fisheries Development Adviser, who is assisted by ...uty and Assistant Fisheries Development Adviser, has already been referred ... Their function is to advise the Government of India on all matters connected ... fisheries development and research. Whenever required, they also give ...ical advice to the State Governments and public bodies in connection with ... fisheries activities.

Most of the State Governments also have set up large or small Fisheries ...ments. Of these, the Fisheries Department of Madras is the oldest and the ...t. It is headed by the Director who has two Deputy Directors and a number ...istant Directors and other staff to help him. The programme of work of the ... Fisheries Department is very comprehensive and comprises conser ation, ...opment, exploitation, marketing, research both biological and technological, ...economic work etc.

The Governments of Bombay and West Bengal have also Directors of ...ries with adequate technical and other staff. In Bombay, special stress ...d on the increased exploitation of sea fisheries while in West Bengal ...ial emphasis is on stocking operations.

Fisheries Departments in many other States are under the charge of ...y Directors, Fisheries Development Officers and Wardens or Deputy Wardens ... In Orissa, special work is being done in connection with the collection of ...nd reclamation of swamps. In Bihar, Madhya Pradesh, Uttar Pradesh, ...abad and some other States, stocking of impounded waters is being given ...al attention. In the Punjab, stocking operations have been started recently ...exploitation of fisheries and marketing of fish are receiving particular ...tion. In Travancore-Cochin, very intensive fishing is carried on in ...re waters and the State Fisheries Department is paying special attention ... management of their fisheries and culture of brackish-waters.

The fisheries of India, as they are at present, have been briefly ...ewed in the preceding pages. Many of the subjects referred to in this ...er are dealt with in greater detail in subsequent chapters of the Handbook.

2

GEOGRAPHICAL AND CLIMATIC FEATURES OF INDIA AND THE HYDROLOGY OF THE SURROUNDING SEAS.

The peninsula of India can be divided into three distinct segments: (1) the great alluvial plains of north India, (2) the peninsula of Deccan, south of the Vindhya mountains and (3) the great mountain barrier which surroun the plains to the west, north and east, known as the extra peninsula. Climatic India presents as great contrasts as any area of similar size. In the north-we lies the Rajaputana desert with an average annual rainfall of less than 5 inche and at the north-east in Assam is Chirrapunji with an average of about 430 inch Temperatures as low as -49°F in Kashmir and as high as 121°F at Jodhpur have be recorded several times. Humidity practically zero in November to 100% in Septe ber may be present in some places like Kashmir. The mean annual range of temperature, 20°F in several places at the southern tip of India is less than t daily range at many places in north India and is only about one-third of their annual range. Northern India alone presents the greatest possible contrast of dampness and dryness and if we compare this with the most southerly part such a Travancore we have in the former a climate of extreme summer heat alternating w winter cold that sometimes sinks to freezing point, and in the latter an almost unvarying warmth in conjunction with a uniformly moist atmosphere that is characteristic of the shores of the tropical seas.

Although several theories have been put forward to explain the origin of the seas around India, at the close of the Mesozoic Era the Indian Ocean was composed of a northern and southern part, while from east to west a circum-terrestrial sea, the Tethys, passed to the north of India and Arabia, terminati in what is now the Bay of Bengal. At the beginning of the Kainozoic Era, the Tethys sea began to be interrupted by the upheaval of the Alpine-Himalayan rang and at the same time the uprising of the Central Asian plateau caused the obliteration of the northern part of the Indian Ocean. How far south this upheaval affected the Indian Ocean, is not yet determined but it seems probable that at the close of the Miocene a mass of land occupied the area between India Arabia and north-east Africa and similarly a vast tract of land again extended eastward from India to the Andaman Islands obliterating the Bay of Bengal. At present, India forms a triangle of land thrusting southwards into the Indian

Plate 2

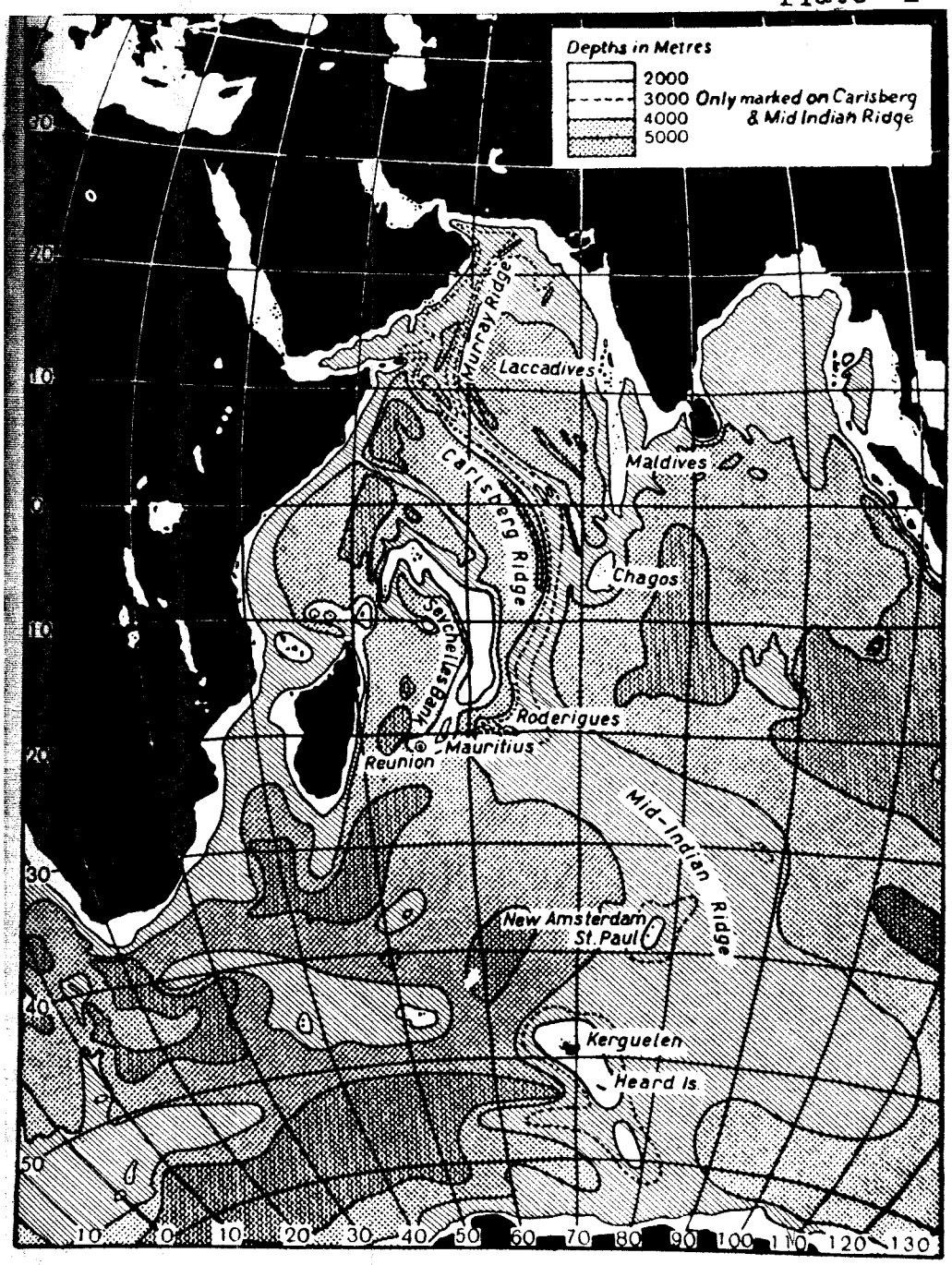

Fig. 1. Bathymetric chart of the Indian Ocean and adjacent seas.

ocean, dividing its northern area into two parts, the Bay of Bengal on the east and the Arabian Sea on the west. Each of these areas is again subdivided into a main area and a subsidiary region by a range of islands; to the east of the Bay of Bengal the chain of Andaman-Nicobar islands forms the western boundary of the Andaman Sea and on the south-west of India the Laccadive-Maldive and Chagos Archipelagoes form the western limit of the Laccadive Sea. The slope of the continent is generally rather steep and consequently the continental shelf is a narrow belt mostly about twenty to fifty nautical miles in width. The bathymetric features are given in figure 1.

The weather in India is characterised by an alternation of seasons known as monsoons. During winter, the dry surface air blows from land to sea in the north-east direction resulting in the north-east monsoon which is followed in summer by a complete reversal of these conditions with the moist winds of the south-west monsoon blowing from sea to land. The precipitation accompanying the north-east monsoon is small and during this period the rainfall is heaviest in the north-west and decreases towards the south and east. The humid winds of the south-west monsoon burst on the Malabar coast early in June, gradually extend northwards and establish in most part of India by the end of June. Between these principal seasons of the year there are transitional periods of hot weather months and of the retreating south-west monsoon. From January to May or June the temperature rises more or less steadily, and is followed by a steady decrease from June or July to December.

Our knowledge of the oceanography of the waters around India is derived mainly from the observations of the Challenger (1872-76), Investigator (1884-1925), Vitiaz (1886-1909), Egeria (1894), Valdivia (1898-1899), Gauss (1901-1903), Sealark (1905), Planet (1906), Dana (1920-22), Snellius (1929), Discovery II (1929-31), and Mabahiss (1933-34) and also from observations taken mostly by the surveying ships of the British Admiralty.

In the Indian Ocean, the southernmost limit of which extends, oceanographically approximately to lat. 40°S i.e., the region of the Subtropical Convergence. below the surface waters three or even four water masses exist and each stratum is in a stage of continual movement. At subsurface depths, three large water masses, the Indian Ocean Central water, the Indian Ocean Equatorial water and the the Deep water, have been shown to exist below a depth of approximately 2000

meters. In addition to these, there are two types of water at mid-depths, the Antarctic Intermediate water and the Red Sea water. The boundaries of the upper water masses of the Indian Ocean are shown in fig. 2. The influx of the cold Antarctic bottom water, referred to above as the Deep water, from the south polar region through the Indian Ocean to the Arabian Sea and Bay of Bengal has great significance in the organic productivity of the water masses influenced by this. According to Sewell, there are three main tongues in this drift, the first ending on the east coast of Madagascar while the second and the third can be traced into the Arabian Sea and Bay of Bengal respectively. The second tongue strikes against the Carlsberg ridge and is deflected to the surface where the presence of this cold water of low salinity and rich in nutrients can be detected at the surface. The third tongue, part of which enters the Bay of Bengal, gets subdivided into two branches; one travels northwards between Carpenter's and Andaman-Nicobar ridges and the other meeting the obstruction of Ceylon gets divided into two, one portion continues into the Laccadive Sea while the other flows up north along the east coast of Ceylon (fig.3.)

The presence of Red Sea water in the Arabian Sea is well known and it is believed that this water penetrates southwards in depths around 500 to 1000 meters but stops its advance almost at the equator where it meets the Antarctic current. These different water masses have characteristic hydrological features

Temperature and salinity of surface waters.

Within the surface waters, temperature increases rapidly towards the north from the Subtropical Convergence and, in the equatorial regions, it is uniformly high (25° to 30.5° C) during the greater part of the year. Temperatur as low as 22°C have been found, in August, as far south as the equator, in consequence of the upwelling under the influence of the prevailing south-west monsoon. In February, lower temperatures are similarly found in the Bay of Bengal owing to the effect of the north-east monsoon. According to Schott, the range in annual fluctuations in temperature of the surface waters of the Bay of Bengal increases from 2° to 5°C from lat.10°N to 20°N whereas, off the Ganges Delta there exist a narrow belt with temperatures ranging from 5° to 10°C. Similarly, within the same latitudes the fluctuations are within 3° to 5°C in the Arabian Sea and within 5° to 10°C in the Gulf of Oman. In the central portion of the Indian Ocean, between lats. 10°N and 10°S, is a region where th

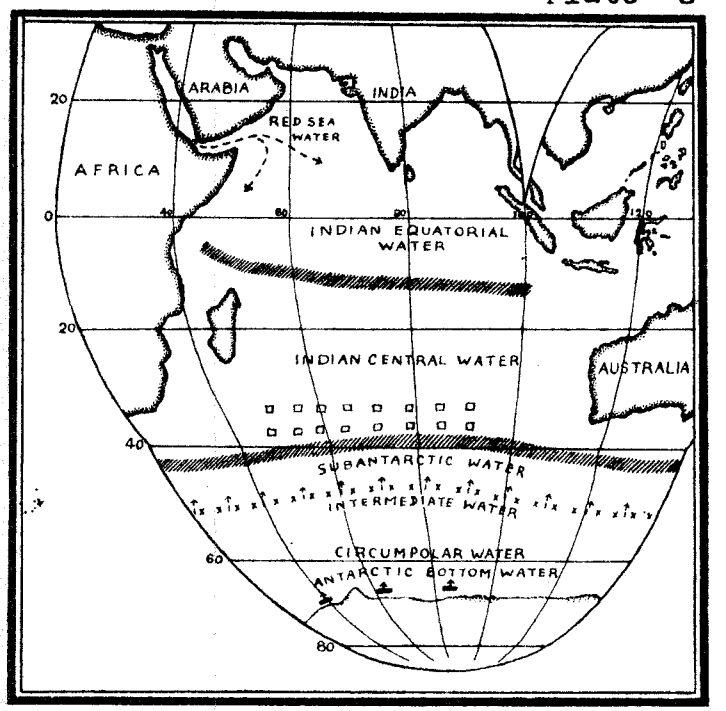

Fig. 2. The approximate boundaries of the upper water masses of the Indian Ocean. Squares indicate the regions in which the central water masses are formed; crosses indicate the lines along which the Antarctic intermediate water sinks. (After Sverdrup et al., The Oceans, 1942).

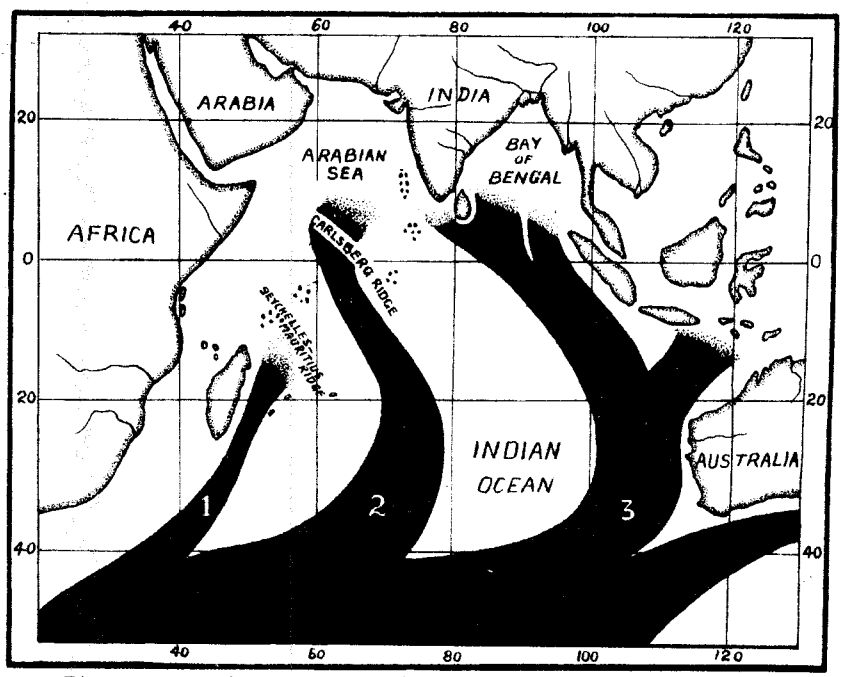

Fig. 3. showing the probable distribution of the Antarctic bottom water in the Indian Ocean. (After Sewell, 1932 with slight modifications).

ange of temperature varies from less than 1° to 2°C showing typical equatorial onditions. But surrounding this area on the west (towards the east coast of frica), the surface water has an annual range from 2° to 4°C. Between lats. 30°S nd 40°S, stretching from the east coast of Africa to almost the west coast of ustralia, the surface temperatures show the greatest range, from 4° to more than °C.

It is a common experience that in low latitudes insolation warms the pper layers, and below a depth of about 100 meters there is usually a layer of apidly decreasing temperature, the discontinuity layer or thermocline. In everal places in the Indian Ocean, approximately between Chagos Archipelago and auritius the water temperature falls from 25°C at the surface to 20°C at about 0 fathoms and to 15°C at 90 to 100 fathoms. Somewhat similar results have been btained by Sewell from the Bay of Bengal which have also been confirmed by ecent observations.

The salinity of the surface waters in the equatorial and northern regions is subject to considerable annual variations which can be related to the monsoons nd the annual variations in precipitation. The extent to which rainfall will influence the salinity of sea water varies from region to region and also according to the number and size of the rivers opening into it.

The highest salinities, from 36.0 to 36.5%, are found at all times of the ear in the Arabian Sea, due partly to intense evaporation under high temperatures nd partly to the influence of high salinity water from the Red Sea and the Persian Gulf. Further the rainfall does not appear to be heavy and there are no large rivers flowing into it, except for the Indus, Narbada and Tapti opening at its north-eastern angle. But at the time of the south-east monsoon, the current sets to the south and east along the west coast of India carrying away the rain-fall of the Western Ghats round Ceylon to the Bay of Bengal. Another area of high salinity, over 36 or even 36.5%, is at about lat. 30°S on the eastern side of the Indian Ocean between longs. 80° and 110°E.

In the Bay of Bengal, which is in the same latitude as the Arabian Sea, low salinities are found because of the influx of large quantities of river water and also the lack of influence of water of high salinity corresponding to the Red Sea and Persian Gulf waters. No less than six large rivers, viz., the Cauvery, Kistna, Godavari, Mahanadi, Ganges and Brahmaputra, in addition to a large number of smaller rivers open in the Bay; further east the Irrawadi,

Sittang, Salween and Tenasserim open into the Andaman Sea. The range of salini in the Bay of Bengal is approximately from 30.0% near the mouths of the Ganges to slightly over 34.0% across the mouth of the Bay.

Surface currents.

Unlike other great oceans, the Indian Ocean is subject in places to a complete reversal of its currents with the change of the monsoon winds. In the tropical and subtropical regions of the Indian Ocean, the surface water of the southern hemisphere is driven along by the south-east trade winds and in the northern hemisphere by the alternating north-east and south-west monsoons, so that during the winter months the bulk of the surface water tends to conve: o the African coast. The westerly flowing current divides into two streams in th neighbourhood of Madagascar, one turning north to form the Somali Current, whil the other is reinforced by part of the south-equatorial current and these two water masses form the Agulhas Stream. The greater volume of the water of the Agulhas Stream bends sharply to the south and then towards the east thus returni to the Indian Ocean by joining the flow from South Africa towards Australia acr the southern part of the Indian Ocean. During the north-east monsoon, there is strong flow of water from the Pacific to the Indian Ocean through the Straits o Malacca into the Andaman Sea and then to the Bay of Bengal, where it joins the low salinity water of the Bay and can be traced flowing west- ward as far as th Seychelles; during the south-west monsoon this flow, from the Pacific to the Indian Ocean is either reversed or stopped, but there is, at this season, a str flow of water westward between Malay Archipelago and Australia. In the equatori region between lats. 5° and 10°S, there is a reverse flow from west to east, constituting the Contra-Equatorial Current.

Distribution of oxygen.

The observations made by the Discovery II indicate that the oxygen conte of the Indian Ocean decreases from south towards the equator. Although the Red Sea water is characterised by low oxygen contents, increase in oxygen is evident in the direction in which Red Sea water spreads, indicating a probable mixing o the over- and under-lying water masses. There is a fair supply of oxygen in the upper levels but it diminishes rapidly with depth. At a depth of about 100 mete there is usually less than 1.0 cc of oxygen per litre of water and at 800 to 1000 meters the concentration is less than 0.1 cc. Below this minimum, there is

increase until in the deepest depths the amount present may be as much as 2.5 2.75 cc. per litre. This increase in the bottom levels is attributed to the sence of the Antarctic bottom water which is relatively high in oxygen.

Nutrient salts.

The data on the distribution of the nutrient salts in the Indian Ocean mostly from the investigations conducted by the John Murray Expedition. though it is generally believed that tropical waters are poorer in nutrient its than temperate waters, recent observations of the John Murray Expedition ow that there are several places in the Indian Ocean where there are high ncentrations of nutrients. It is also believed that there is an azoic area tending eastwards from the Arabian Coast into the Gulf of Oman, between depths about 250 to 600 meters and about 1500 meters, the upper limit varying on the sides of the Gulf. Data collected in several stations in the Arabian Sea licate that the nutrients are always poor in this area. The waters near the dive ridge are, during the north-east monsoon, characterised by relatively high rate content, because of the influx of water from the Bay of Bengal and Andaman rich in nutrients brought down by the large rivers emptying into them. Areas r the Carlsberg ridge and near Mahe and Seychelles Islands show relatively h percentage of nutrients, owing to the upwelling of the Antarctic bottom er. Table 1 shows the maximum surface values of nutrient salts recorded in hore waters at two places along the east coast.

Table 1

Nutrient salts - Maximum surface values recorded in inshore waters only.
Units: ug-atoms/litre.
(Data from the Central Marine Fisheries Research Station).

Months	Madras Coast Lat. 13° 10'N			Gulf of Manaar Lat. 9° 10'N		
	NO_3 -N	PO_4 -P	SiO_3 -Si	NO_3 -N	PO_4 -P	SiO_3 -Si
-Feb.	4.7	0.63	19.7	6.5	0.37	9.4
-May	4.4	0.64	7.0	5.3	0.29	10.7
-Aug.	20.0	1.60	23.7	4.4	0.40	6.7
-Nov.	10.0	1.00	21.8	4.0	0.32	8.3

The slightly higher values obtained off the coast of Madras than in the of Manaar are due to the influence of city effluents, a fact which has been tantiated by bacteriological investigations.

Organic production.

In the Indian Ocean, considerable growth of phytoplankton is initiated in places where upwelling causes renewal of nutrients. This occurs near the Seychelles bank and over the Carlsberg ridge. Calculations of the Phytoplankto production in eight stations between lats. 6° and 9°N and longs. 50° and 70°E, made during the John Murray Expedition, show that the production rate is 14.4 gm/m^2/day or 2.2 kg (wet weight) per square meter of sea surface in 150 days. When compared with other areas, the production rate is high and except for upwelling areas, this represents the major part of the year's production. From these observations, it may be assumed that in the waters around India, in areas where upwelling occurs, the productivity exceeds that of any temperate sea and that the open ocean is by no means as barren as has been commonly believed.

MARINE AND ESTUARINE FAUNA

Introduction.

The marine fauna of India comprises a large assemblage of species but of the several thousand kinds of organisms that exist, only a fraction could be said as being known to science. Most of the larger animals have been described, more especially the vertebrates. There are several groups of lower invertebrates which have hardly been touched upon.

The history of marine zoological work in India may be said to begin with the starting of the Indian Marine Survey Department in 1875 and the launching of the Survey Ship "Investigator". The successive Surgeon-Naturalists attached to this ship have really been the pioneers of marine biological investigations in the Indian seas. The work of the "Investigator" was continued without interruption till the first world war and after that on a restricted scale till 1926. Many expeditions have visited Indian waters and have made contributions to some aspect or other of Indian marine fauna but two of these at the early part of this century deserve special mention. They were the study of the Gulf of Manaar and adjacent seas by Sir William Herdman in connection with the work on the Ceylon Pearl Fisheries and the expedition led by Gardiner to study the fauna and flora of the Laccadive and Maldive Archipelagoes. By far the most detailed survey made has been by the John Murray Expedition (1933-34) to the Arabian Sea led by Sewell. In addition to the reports of these expeditions, many aspects of Indian marine fauna are dealt with in the various volumes of the Records and Memoirs of the Indian Museum, and a somewhat comprehensive account of the fauna associated with the coral reefs of Gulf of Manaar and the marine fauna of Madras may be found in the Bulletins of the Madras Museum.

Zoogeography.

The Indian seas form part of the larger marine zoo-geographical division, the Indo-Pacific, more specifically designated as the Indo-West Pacific or East Indian area. The faunal elements include (1) species that belong to the circum-tropical marine littoral fauna, (2) species which are common to the Indo-Pacific area as a whole, (3) species common to the Indian Seas, Red Sea or the South African Seas and (4) a considerable number of species endemic to Indian waters.

There is very close affinity between the marine faunas of the Indian and Malaya Seas. Of thedifferences between the marine fauna of the Arabian Sea and the Ba of Bengal, the most notable is the pre-dominant euryhaline element in the fauna of the of the Bay of Bengal, mainly brought about by the fact that while numero large rivers open into the Bay of Bengal, with the exception of the Narbada and Tapti there is no large river opening into the Arabian Sea in the Indian area.

Fauna of the sandy beaches.

Many regions of the Indian coast have broad sandy beaches, more especial the surf-beaten shores of the Bay of Bengal. At first sight this habitat would appear to be poor in fauna but close scrutiny will reveal a number of character tic species. Ocypoda ceratophthalma, O. macrocera and O. platytarsis are Ocypodid crabs, which move about with great rapidity and are coloured like the sandy substratum, inhabiting the dry areas just above the surf. In the sand itself in the zone washed by sea water, can be found several archiannelids (Fam Pisionidae), numerous polychaetes (mostly eunicids, capitellids and glycerids), and well known bivalves like Donax, Tellina, Cucurbitula and Siliqua. Still further down in the water, some of the commonest inhabitants are the gastropods Oliva, Harpa, Tonna, the mole crabs Emerita asiatica and Albunea symnista and t crabs Philyra and Matuta and the hermit crab Eupagurus spp. inhabiting various shells covered with anemones of the genus Paracalliactis. Anemones like Peachi Bunodactis, Ixalactis and Actinoporus are found burrowing in the protected sandy areas not subjected to surf action and in most parts of the country echiuroids and sipunculids are also common in similar habitats. Two king crabs (Xiphosura) Carcinoscorpius rotundicauda and Tachypleus gigas have also been noted from the sandy shores of Chandipore in Orissa and the Gangetic Delta but they are not common in other parts of the country. The mud flats associated with sandy beach in the Gulf of Manaar have dense communities of the Actinarian Edwardsia and the Balanoglossid, Ptychodera flava, and near the shore it is usual to find Cerethidea cingulata often occurring in enormous numbers, along with Umbonium vestiarium and Natica sp. Hermit crabs are also usual in similar places, specie of Clibanarius near the water line and species of Diogenes in the dry zone, ofte occurring with members of the Scopimerinae (Dotilla and Scopimera). Sandy areas near coral reefs harbour the large anemones Stoichactis and Discosoma, the Alcyonarians Cavernularia, Virgularia and Pteroides and the Sea Cucumber Holothu

Rocky coast Fauna.

The rocky coast shows a richer fauna than that of the sandy beach and is varied in composition. The rocks and their crevices give shelter to numerous crabs, molluscs and fishes. Grapsus grapsus in the exposed regions and numerous littorinids (Tectarius trochoides and Littorina spp.) in the terrestrial region kept wet by spray, Patella (Cellana) in the tidemarks, Thais in the crevices and Balanus amphitrite attached to rocks are very characteristic of most regions. Among the organisms attached to stones and algal encrustations, may be mentioned the hydroids of the genera Pennaria, Syncoryne, Bimeria, Obelia, Plumularia, Aglaophenia and Lytocarpus. Species of Bunodactis and Cradactis are found attached to stones in the open coast. In the sheltered rocky areas, numerous simple ascidians (Herdmania) and compound ascidians (Polycarpa and Diandrocarpa), tube dwelling polychaetes, zoanthids (Epizoanthus, Isaurus and Palythoa), numerous polyzoans (Bowerbankia scrupucellaria and Bugula) and sponges (Geodia, Chalina, Spirastrella, Callyspongia, Tedania, and Halichondria) are encountered, forming extensive encrustrations and harbouring amongst them numerous polychaetes, crabs, amphipods, isopods, alpheids and pycnogonids. Large colonies of the green mussel Perna viridis and the oyster Ostrea are also found in similar habitats in most parts of the coast.

Level Sea-Bottom Fauna

The 2-10 fathom line in areas where it is sandy is usually rich in animal life and the dredge will often bring up large numbers of the Cephalochordate Branchiostoma indicum, together with many echinoderms mainly echinoids (Clypeaster, Salmacis, Lovenia) and ophiuroids (Ophiocnemis, Ophiothrix), polychaetes of the family Aphroditidae and Glyceridae, solitary corals of the genera Heterocyathus and Heteropsammia, the sand encrusting zoanthid Sphenopus and the Scaphopod Dentalium. The molluscan element and the tube-dwelling polychaetes, such as ammocharids, terebellids, serpulids, and sabellarians, in the dredge collections in this depth increase in areas of muddy influence, and it is usual to find there large numbers of sand coated membranous tubes of Owenia and several small gastropods and bivalves. Star-fishes (Pentaceros, Astropecten, Palmipes) and brittle stars (Ophiactis) as well as some of the large burrowing anemones like Paracondylactis are common in the same depth but in sheltered coasts, occurring along with some of the large sized gastropods. In deeper

areas Crinoids (Tropiometra, Oligometra etc.) are found in places where th substratum is hard, and the long-spined Echinoid Stomopneustes variolaris amid rocks.

Deep Sea Fauna.

The deep sea fauna of Indian waters is mainly known from the work of th "Investigator". The fish fauna is particularly rich and similar to the abyssa fauna of other oceans and includes examples which show the various types of modification in structure of the eyes and luminous organs. Crustacea of the deep sea, which are predominantly members of the order Decapoda, include sever species which are represented in the littoral marine fauna of the temperate waters by similar or even identical species (Ex. Crangonids and Munida spp.). Numerous molluscs and echinoderms have also been described; among the latter, t crinoid fauna is particularly rich, the majority of species being comatulids. Other forms of scientific interest from the deep waters include the glass rope sponges Hyalonema and Pheronema, solitary deep sea corals, the giant isopod Bathynomus giganteus, the cephalapods Nautilus and Spirula whose shells are of encountered and the brachiopod Lingula.

Fauna of Coral Reefs.

Coral reefs of the fringing type are found around Southern India and Ce and around the Andaman and Nicobar Islands while the extensive coral reefs associated with the Maldives and Laccadives are typical atoll formations. The coral reefs which are built up of the well known madreporarian forms, with a wi distribution in the Indo-Pacific (Porites, Galaxea Meandrina, Favia, Montipora, Pocillopora and Dendrophyllia), harbour an extremely rich fauna consisting of sponges (Spiras-trella, Suberites, Hircinia), Alcyonarians (Lobophytum, Sclero-phytum and Telesto), encrusting polyzoans, compound ascidians, numerous crustac polychaetes, and brittle stars. Creeping below the corals, are numerous gastropods (including Chiton and the rare Haliotis) and planarians. Several species of brilliantly coloured fishes belonging to the families Pomacentridae, Chaetodontidae, Pseudoscaridae, Blenniidae and Serranidae are also seen near the corals.

Estuarine and backwater Fauna.

Animal life associated with estuaries and backwaters is particularly ri on the Indian coasts owing to the high biological productivity of these areas.

numerous fishes and almost all marine invertebrate groups, with the exception of the echinoderms and brachiopods, are seen in the estuarine regions. From the point of view of fisheries, may be mentioned the Crustacea which include the penaeid prawns of the genera Penaeus and Metapenaeus and species of the Palaemonid genus Leander. The mollusca include the oysters and clams like Meretrix, Tapes and Modiola. Among fishes are several clupeoid species (Elops, Megalops, Chanos), mullioids, percoids, mugils and polynemids. The largest number of species are of the family Gobiidae which are not only very resistant to salinity changes but have also developed powers of aerial respiration. In the mud flats and mangrove habitats associated with estuaries and backwaters are to be found the air-breathing fishes Boleophthalmus and Periophthalmus, while burrowing in the mud may be found numerous Ocypodid and Grapsoid crabs of the genera Uca (= Gelasimus), Cardisoma, Sesarma, Metasesarma and Varuna, amongst which the calling crabs or species of Uca with the enlarged claws in the male are characteristic inhabitants of back-water tracts.

Of scientific interest in the Indian estuarine fauna is the occurrence of numerous burrowing anemones in the mud-flats (Phytocoetes, Pelocoetes, Stephensonactis, Mena) which are so far known only from the Indian coasts, the scyphozoan Acromitus, the hydromedusae Campanulina and Dicyclocoryne, several species of mysids (Rhopalophthalmus, Macropsis and Gastrosaccus), numerous polychaetes, one of the commonest inhabitants of mud-flats being the eunicid Marphysa, and the semi-terrestrial and hermaphrodite nereid Lycastis indica, and species of algae-inhabiting nudibranchs (Cuthona and Stiliger).

The estuarine habitat also includes a small number of organisms of fresh-water origin which have become adapted to salt water (Palaemon spp. among Crustacea, Hydrobiid Molluscs and fishes of the family Cichlidae).

Plankton..

The inshore plankton is rich in species and individuals. The Diatom peak is reached during April-June period at Madras and Mandapam and probably all along the east Coast of India, with a secondary peak in the autumn months. On the West Coast the plankton peak is during July to September and there does not appear to be any indication of a secondary peak. The predominant phytoplanktonic forms are species of Chaetoceros, Rhizosolenia, Biddulphia and Coscinodiscus. The copepods are represented by several calanoids, harpacticoids and cyclopoies, among which

may be mentioned the genera Eucalanus, Eucheta, Undinula and Labidocera which mainly the larger forms, and species of Oithona, Temora, Pontella, Acartia, Centropages, Tortanus, and the iridiscent Sapphirina. Among the Dinoflagellat the phosphorescent Noctiluca is quite typical and widespread as also are sever species of Sagitta. Amongst the larval forms decapod (including Lucifer) and polychaete larvae (including Tomopteris and Autolytus) occu at most times of year, while smaller numbers of molluscan veligers and all he well known larva forms Auricularia, Bipinnaria, Ophiopluteus, Echinopluteus Actinotrocha, Pili Phyllosoma, Tornaria, Semper's larvae and Arachnactis are encountered in the plankton, especially during the colder months of the year. Pteropods of the genera Creseis and Cavolina, the Ctenophores, Beroe, Ocyroe and Pleurobrachia, numerous hydromedusae of the genera Eirene, Phortis, Liriope, Sarsia, Obelia a Aequorea, and most of the Indo-Pacific pelagic tunicates (Cyclosalpa, Brooksia, Thalia, Salpa, and Doliolum) are represented in Indian waters. The larger pla tonic forms include the numerous Scyphomedusae of the genera Lobonema, Rhizosto Pelagia, Rhopilima, Charybdea and Cyanea and other tropical jelly fishes, and occasional examples of the Ctenophore Cestum amphitrite. The Siphonophores Porpita, Physalia and Velella, the nudibranch Glaucus, and the Gastropod Ianthi are often washed ashore after stormy weather. The planktonic fish Pegasus is also occassionally obtained in the townet.

Among the free swimming marine forms of special interest is the marine insect Halobates which is essentially oceanic in habits but, towards the shore and in the estuarine waters, its place is taken by the related Euratus. Species of Squilla, Lysiosquilla and Gonodactylus contribute to a rich stomatopod faun Swimming crabs of the family Portunidae, marine prawns of the genera Hyppolysma Penaeus, and Leander, Periclimenes, Anchistus and Stenopus, Porcellanids of the genera Porcellana, Callianassa and Upogebia are some among the highly developed crustacean fauna.

Marine Mammals.

The marine mammals of Indian waters include a few species of Cetacea and a single species of Sirenia and several of them, ranging from about 38 to 100 ft have been stranded on the coasts of Bombay, Malabar, Kanara, Travancore and Ceylon. The genus Balaenoptera is represented by three species. Balaenoptera musculus, the Blue Whale, the largest whale recorded, has been occasionally

ashore at Ceylon, Malabar, Kanara and Travancore. One specimen of Fin B.physalus measuring 41 ft. in length was stranded south of Bombay. The Whale, B. acutorostrata is reported as having been stranded in the Sittang The Indian Pilot Whale (Globicephalus indicus) appears to have been seen salt lakes near Calcutta and Pseudorca crassidens off the coast of Trivan- The sperm Whale Physeter macrocephalus and the smaller Sperm Whale Cogia inhabit Indian seas and both have been captured from the Bay of on the East Coast. One species of Megaptera, popularly known as the Hump- Whale, is not rare off Baluchistan coast. Of the porpoises, the Indian that is particularly interesting is Phocaena phocaenoides generally frequenting the tidal zones of large rivers, such as the Hughli at Calcutta, and shallow waters along the Indian coast. An adult female specimen of the Finless Porpoise, Neomeris phocaenoides, was once entangled in the drift net off Rameswaram Island in the Gulf of Manaar and the species is said to be common off Two species of Orcella, O. brevirostris and O. fluminalis, occur in the of Bengal. The dolphins of the genera Lagenorhynchus, Delphinus and Steno been reported to live in the Indian seas but they are not as common as the poises. The only Indian representative of Sirenia is the India Sea Cow, Dugong dugong, recorded from the coast of Malabar, Gulf of Manaar and Andaman lands, which is hunted for its excellent meat and valuable oil; the species is rare.

Marine reptiles.

The marine reptiles include only a small number of species. The leathery tle Dermochelys coriacea, which is the largest of all chelonians, is rare and nd only in the southernmost parts of the country but is more common on the st of Ceylon where the logger-head turtle Caretta caretta also occurs. The en or Edible turtle Chelone mydas is common in the Palk Bay and Gulf of Manaar d around the Andaman Islands; it is collected and exported to Ceylon where re is a good market for it. The Hawksbill (Eretmochelys imbricata), which lds the turtle shell of commerce, is widely distributed on the different parts the coast. Among sea snakes, the two species commonly found are Hydrophis anocinctus and Enhydrina schistosa.

Fishes: Sharks, Rays & Skates.

Well over a thousand species of fishes are known from our coastal waters.

The elasmobranch fish fauna is represented by 40 species of sharks and 33 specie of skates and rays, belonging in all to 33 different genera. The majority of f are those also found in the Red Sea and in the Indo-Pacific but about a dozen species appear to be endemic to Indian waters. Freshwater elasmobranchs are absent but species of Trygon and Hypolophus among the rays and Carcharinus gangeticus among sharks migrate into rivers and estuaries well above tidal influence.

The largest shark encountered is Rhinodon typicus or the Whale shark but specimens are rather rare. The common large and ferocious species are Galeocerd tigrinus (tiger shark), and Carcharinus melanopterus (black-finned shark). Other sharks observed belong to species of Scoliodon, Carcharinus, Hemigaleus, Mustelu Sphyrna (the hammerheaded shark) and among dogfishes Stegostoma tigrinum is probably the largest and found in deep offshore waters. Species of the small dogfishes Chiloscyllium are common in the neretic zone. Inha[illegible]ing the shallow waters, are the sting rays (Trygon and Hypolophus) and the electric rays (Torped and Narcine). Of the Myliobatidae, the bat-rays (Aetobatis narinari), the cow-r (Rhinoptera javanica), the eagle-ray (Myliobatis) and the Butterfly-ray Pteropl micrura are often caught in the 10-15 fathoms area. The giant devil rays (Dicerobatis) and the spiny ray Urogymnus are also occasionally obtained in dri nets. There are also several species of skates, the most important being Rhinob granulatus, Rhynchobatus djeddensis and species of the sawfish Pristis, the commo one being Pristis cuspidatus which migrates to the shore in large numbers at certain seasons.

Fishes: Teleostei.

It is difficult to deal adequately with the teleost fauna but passing men may be made of some of the more important families. Species of special fishery importance are mentioned in the various Chapters dealing with the fisheries.

The Isospondyloidea are represented in the Indian seas and estuaries by a very large number of species, most of which are valuable food fishes. These include Elops, Megalops and Albula, numerous sardines particularly of the genera Sardinella and Kowala, the well known migratory Indian shad Hilsa, the rainbow sardines of the genus Dussumieria, the milk fish Chanos, which has great importan in fish culture, and numerous anchovies of the genera Engraulis and Stolephorus, some of which are estuarine like the featherbacks (Notopterus) belonging to the

order. The scopelids are represented by the genera Harpodon, Saurida and ...chum. The marine cat-fishes comprise two well known genera Arius, a few ...es of which show the phenomenon of oral gestation, and Plotosus notable for ...warning coloration. There are numerous species of Eels (Anguilla, Muraena, ...nesox and Gymnothoroax); various leptocephali have been observed in the ...ton. Among the Synentognathoidea, mention may be made of the several ...es of gar-fishes (Belone and Tylosurus), half-beaks (Hemirhamphus spp.) ...flying fishes (Cypselurus spp.). Species of pipe fishes (Syngnathus) ...the sea horse (Hippocampus) are common. Barracudas (Sphyraena spp.) ...often obtained but not in large numbers in inshore waters. Mugils are ...esented by numerous marine and estuarine species. The thread fins which ...ral species of Polynemus and Eleutheronema constitute the Rawas, and the Mango ..., all found in coastal waters and entering estuaries and highly esteemed as ...fishes. The true perches are very numerous and mention may be made of Apogon, ...nus, Epinephelus, Chrysophrys, Sargus, Lethrinus, Lutianus, Synagris, Sillago ...Therapoperca. The silver bellies (Leiognathus and Gerres), the red mullets ...nus), sciaenids (Otolithus and Sciaena), stromateids or pomfrets (Stromateus ..., S. argenteus and S. sinensis) and the butter fish (Lactarius lactarius) ...noteworthy as they are very valuable food fishes. The perches inhabiting ...shore are mainly species of Therapon and Pristipoma. The percoids are also ...minent inhabitants of the coral reefs and shallow waters being represented there ...several forms (Psettus, Platax, Chaetodon, Zanclus, Heniochus, Scatophagus ...ch is also euryhaline) Drepane, Toxotis, and Teuthis) as also scorpion fishes ...rois, Apistus, Scorpaena and related genera.

The blennies encountered are mainly littoral in habits, but special mention ...be made of species of Petroscirtes in the coast and brackish water and Andamia ...and attached to the surf-beaten rocks, showing adaptations both for attachment ...aerial respiration.

The ribbon fishes represented by three species of Thrichiurus are shoaling ...of the East Coast. A group of fishes of great commercial value second only ...the clupeoids are the scombroids which include the mackerel (Rastrelliger), ...seer fishes (Cybium guttatum, C. commersonii, C. Kuhli and C. interruptum), ...the tunnies (Euthynnus and Thynnus).

The Gobiiformes are represented by a large number of species on the coast and

in the brackish tracts. Glossogobius giuris is probably the only edible species occurring in both fresh and salt waters. The estuarine and brackish waters harbour various species of Gobius, Acentrogobius, Ctenogobius, Oxyurichthys, Eleotris, Periophthalmus, Boleophthalmus and Apocryptes. Taeniodes and Trypauch are inhabitants of the muddy tracts where the visibility is low and include species which are either blind or have reduced eyes. Of the Scleroparei, species of Platycephalus are frequently seen on the sandy shores and estuarine tracts.

The Pleuronectoidea, although containing numerous species in Indian water do not attain the same fisheries importance they have in the colder seas. Most the species are small and the common genera are Psettodes, Citharichthys, Pseudo hombus, Solea, Synaptura and Cynoglossus.

Species of the Plectognathoidea are numerous and they are of no economic value, some of them even being poisonous. The common genera are the trigger fi (Balistes), the puffers (Tetrodon and Diodon), the coffer fishes (Ostracion) and Triacanthus which is also found in estuarine waters. Various species of deep sea anglers have been described from both the Bay of Bengal and Arabian Sea.

Fouling Organisms.

The principal organisms which cause fouling of our marine structures are the marine bacteria, the young stages of sea weeds of every type, diatoms, and the larval and adult forms of many sessile marine animals such as molluscs, barnacl tubiculous worms, ascidians and polyzoans. The ship worms which are common in ship fouling are the molluscan borers belonging to the two genera of Teredinidae Teredo and Bankia. Another molluscan borer of importance causing a great deal o damage is Martesia striata, a pholadid. These three forms which are abundant an are resistant to changes in salinity do considerable damage to wooden structures along with sessile barnacles of the genus Balanus (B. amphitrite and B. tintinnabulum), the pedunculate Lepas, and the burrowing isopod Sphaeroma. Among the molluscan forms the rock oysters, Ostrea cucullata and among the annelids, the tube builders Dasychone, Hydroides and Polydora form the majority. Compound ascidians of the genus Diandrocarpa and the small common reddish leathe ascidian Polycarpa are the most conspicuous among the tunicates. The organisms which are responsible for the fouling of most harbour installations are molluscs crustaceans, annelids and hydroids with Balanus, Bryozoa, Hydrozoa, the green mussel, Mytilus viridis and the limpet Patella taking the predominant place.

4

Freshwater Fauna.

Introduction.

Owing to the great range of topographical and climatic features prevailing the subcontinent of India, the freshwater fauna is not only rich in individuals the same species but is also rich in the varieties of organisms of different nds. From near the glaciers in the Himalays to the seas in the tropics, eshwater organisms of varying interest and utility have been recorded. For the geographical affinities of this fauna, one has to look to the geological anges undergone by the structure of India in the past and to its relationships th the neighbouring countries. The fossils of the Dipnoan fishes from the Kota ileri Beds of the Godavari River and the Osteoglossid and Ganoid fish fossils om the Intertrappan Beds of Deothan and Kheri remind one of the Gondwanaland en India had land connections with Australia in the east and S. America in the st. A Phreatoicid freshwater Isopod, recently discovered from the deep wells Uttar Pradesh is a living fossil probably of the same period. The modern fauna ems to have replaced the cretaceous forms in the Eocene period but itself derwent a high rate of speciation during the orogenic movements that gave birth the Himalayas and produced the marshy conditions of the Siwaliks. There is nsiderable evidence that the original home of the freshwater fauna of India as in South China, possibly Yunnan, whence it migrated not only to all parts South-east Asia (Oriental or Indian Region of Zoogeographers) but also extended Africa. One remarkable feature of the present-day freshwater fauna of India the presence of a large element of Malayan forms in the Malabar sub-region of eninsular India. Recently this discontinuous distribution has been explained on e basis of Hora's Satpura Hypothesis.

Changes in the configeration of land and sea during the Pliocene and the leistocene have left many marine relicts in the freshwater fauna of India. The eshwater Dolphin, Platannista gangetica, not only reminds one of the Siwalik the Indo-Brahm River of the early Pleistocene but takes us back to the time en the bed of the Tethys Sea began to rise and lagoons were formed which ltimately became freshwater lakes. The freshwater Medusa, Limnocnida indica, e Littorinid Cremnoconchus Gastropod and the Sting Ray, Dasyatis fluviatilis, re some of the other examples of the marine relicts now found in the freshwaters

of India.

The extensive estuaries of the Indian rivers falling into the Bay of Bengal provide a highway for the movements of a number of marine animals into freshwaters and vice versa. Among the animals of this category, the anadromou Indian Shad, Hilsa ilisha, is of the greatest value and forms an extensive fi all along the rivers flowing in low plains.

Brief Review of Freshwater Fauna Groupwise.

Mammals.- Reference has already been made to the truly freshwater Gange Dolphin, Platannista gangetica. It lives in large rivers of northern India and mostly feeds on fishes and prawns. The Otters, Crab-eating Mungose (Herpestes urva) and the Himalayan Water-Shrew (Chimarrogale himalayica) freely take to water for feeding on fishes, crabs and other aquatic animals. The Fish-eating (Prionailurus viverrinus) partly feeds on fishes and molluscs, while in the c of the jungle Cat (Felis chaus), Civet (Viverra zibetha), Fox (Vulpes bengale Pole Cat (Putorius) and the Hog-Badger (Arctenyx collaris), fish, crab and oth freshwater animals sometimes form part of the food.

In the Sundarbans (Gangetic Estuaries), Otters are used for commercial fishing.

Birds.- Among the freshwater birds of India, the more important are the Kingfishers, Rails, Crakes, Waterhens, Jacanas, Snipes, Plovers, Skuas, Gulls, Terns, Pelicans, Cormorants, Snake-Birds, Ibises, Storks, Herons, Flamingoes, Swans, Geese, Ducks and the Grebes. These birds feed largely or exclusively o aquatic animals and nest mostly on aquatic plants, or in burrows on the bank o ponds, rivers, etc., or on trees in the vicinity of water.

Reptiles.- The Crocodiles are represented by 3 forms in India, of which two, Crocodilus palustris and Gavialis gangeticus, are chiefly confined to fre waters, while C. porosus inhabits estuaries or muddy rivers and canals near th sea.

There are 15 genera of freshwater tortoises. Of these, Geoemyda trijug Hardella thurgi, Kachuga tactum, K. dhongoka and Batagur baska are much esteem as food among a certain section of the people. The meat of some of the Mud-Tu (Lessemys, Trionyx and Chitra) is considered of high nutritive value, and a gre delicacy.

Water-Monitor (Varanus salvator) is the only lizard which is somewhat

atic in its habits. Its skin is valued.

Natrix piscatoris, a Colubrid Snake, leads a semiaquatic life, chiefly in ds, and is destructive to fisheries.

Amphibians. - Newts (Tylotriton verrucosus) are only known from the tern Himalayas, while frogs and toads abound everywhere. The tadpoles of se living in torrential streams have undergone remarkable adaptations for bering to rocks and stones (Rana afghana) or floating away lightly during ods (Megophry spp.). Even the adults are variously modified for life in hill-reams, on trees and other habitats.

Fishes.- There are approximately 360 known species of freshwater fishes n Indian waters, of which nearly 64% belong to the order of Carps (Cyprinoidea) d 22% to the order of Catfishes (Siluroidea). The Carps and the Catfishes are reality the true freshwater fishes, whereas the others, such as Rays, Clupeoids, ds, Gobies, Mullets, Pipe-fishes, Globe-fishes, Cichlids, etc. have no doubt olonised freshwaters by migrating into them from the sea. Some of the Catfishes rius, Plotossus, Ketengus, etc.) have in the same way gone out to the sea from shwaters. Some species of Arius have, however, recolonised freshwaters and are found considerably beyond the tidal limits.

Three species of Trout (Salmo), one species of Top Minnow (Gambusia), one pecies of Gorami (Osphronemus) and some Carps (Cyprinus, Tinca, etc.) have been troduced in Indian waters for sport, larvicidal and pond cultural purposes.

During the last 40 years, a large number of papers have appeared in the ecords of the Indian Museum on faunistic studies, taxonomy and systematics of freshwater fishes of India and a large number of new forms have been discover It has now become abundantly clear that no proper revision of the Indian freshwat fishes can be attempted unless the fauna of South-east Asia is taken as a whole and its affinities worked out against the background of the Indian element now found in the fauna of Africa.

Structural modifications undergone by fishes to different ecological conditions, such as marshy areas, torrential streams, lakes, etc. have been specially studied by workers in India. Considerable work has also been done on the utility of the various types of indigenous Top Minnows, Carp Minnows and other varieties of smaller species in the control of mosquitoes. The food and feeding habits of quite a number of freshwater species, used for pond culture,

have been investigated.

There are as many as 50 or 60 sporting fishes in Indian fresh waters a the art of angling seems to have originated in India, for as early as 1127 K Somesvara wrote Matsyavinoda (the Pastime of Angling) in his encyclopaedic w Manasollasa.

Of the migratory fishes of India, reference has already been made to t Indian Shad, Hilsa ilisha. The migratory movements of Mahseers (Tor spp.) ar similar to those of Trout while the Carps of the plains move into shallow wa during floods for breeding purposes. The larvae and young of the major Carps (Catla catla, Labeo rohita, Cirrhina mrigala, etc.) are collected from river for stocking in nurseries or rearing ponds.

Molluscs.- The freshwater molluscs belong to 21 families, 17 of which purely aquatic. The amphibious forms include the remarkable genera Cremnoch (Littorinidae), Lithotis (Succineidae), Sataria (Amnicolidae) and Hydrocena (Hydrocenidae). As carriers of Cestode parasites, common forms like Lymnaea, Indoplanorbis and Planorbis are of medical and veterinary importance. The b molluscs of the family Unionidae are fairly common, grow to a large size and of economic importance. They are valued both as food and as producers of se pearls.

The forms like Pila, Lymnaea, Viviparus and Lamellidens are marketed food but not in very large quantities.

One of the curious freshwater mollusc is Balwantia (Unionidae) of the Mishmi Hills, It has the habit of making deep burrows in sandstones.

Crustaceans.- The freshwater Crustacean fauna of India comprises a l number of Entomostraca (Phyllopods, Ostracods, Copapods, etc.) and a relative much smaller number of higher forms. The Decapods are represented by about 8 species of the Potamonid crabs of the genera Potamon, Paratelphusa and Gecarc and Palaemonid and Atyid prawns and shrimps. Some species of Palaemon, which number 40, grow to a large size and are of economic importance (P.carcinus, P.rudis, P. malcolmsonii, P.choprai, etc.).

Reference has already been made to the Phreatoicid Isopod of the Creta period. The smaller crustaceans, particularly the copepods and ostracods, ha special value as food of fishes or forming a link in the food chain of fishes. Some of them, such as Ergasilus and Argulus, are parasites of freshwater fish and cause considerable damage to fisheries.

Insects.- All the nine orders of aquatic insects are well represented in the fresh waters of India. Of these, May-flies (Ephemeroptera), Caddis-flies (Trichoptera) and Midges (Diptera) are the most abundant and form food of fishes, particularly in hill-streams. In pond-fisheries, the larvae and adults of Beetles (Coleoptera), nymphs of Dragon-flies (Odonata) and Hemipterous Bugs are destructive to eggs, larvae and young fishes. The nymphs of stone-flies (Plecoptera), and larvae of a few Lepidoptera also enter into the dietry of fishes. Besides these, Sialids of the order Neuroptera are also found in Indian fresh water. Special mention may, however, be made of a Grass-hoppers Hieroglyphus and Scelimena spp. (Acrididae : Orthoptera) which lead a semi-aquatic life in the fresh waters of Bengal and Assam respectively.

The adaptations of torrential insects have been specially studied in India. Mosquitoes have also received special attention in view of their role in the spread of Malaria.

Other Invertebrates.- There is a great variety of Protozoans found in the freshwaters of India. Of these, the ciliates, amoebae and flagellates form the bulk and enter into the food of fishes. Some genera of Myxosporidia, such as Myxidrium, Ceratomyxa, Henneguya, etc. are parasites of fishes.

The freshwater sponges of India possess resting bodies (gemmules) and belong to the genera Spongille, Trochospongilla, Pectispongilla, Corvospongilla, Euphydatia, Dosila, etc.

Coelentrates and Rotifers are also represented.

Polyzoa are represented by the genera Hislopa, Lophopobdella, Plumetella, Pectinatella, Fredericella, Victorella and Stotella. They also produce resting bodies (Statoblasts).

The freshwater leeches belong to the families Ichthyobdellidae and Glossiphonidae. The freshwater Oligochaeta belong to the genera Nais, Chaetogaster, Dero, Aulophorus, Pristina, etc. The genus Branchiodrilus is peculiar to India.

Free living worms, Planarians, Temnocephaloids and Turbellarians, are also found in Indian waters.

Among the parasitic worms, the Trematode fluke, Isoparorchis hypselobagri, is quite common. The Cestode, Ligula intestinalis has been frequently recorded from fishes. Other common Cestodes are species of Caryophallaeus. Lytocestus, Amphilina, Gangesia, Gymnorhynchus, Proteocephalus, Ancistrocephalus, Bothriocepha

Bothriocephalus, etc. The common Nematodes belong to the genera Porrocalcum Contracaecum. Of the Acanthocephala, species of Neoechinoshynchidae are comm found.

Conclusion.

The richness of the Indian freshwater fauna will be evident from the fact that a pond of average size in Bengal would probably contain more varieties of organisms than are to be found in the entire freshwater fauna of Great Britain. The number of workers being comparatively few, much remains t be done with regard to the taxonomy, ecology and bionomics of these organisms on a purely academic basis.

Part II - Fisheries.

5

PRINCIPAL FRESHWATER FISHERIES AND FISH CULTURE.

INTRODUCTION.

In India there are large-scale freshwater fisheries in rivers, canals irrigation channels, pools, lakes, jhils, beels, tanks, ponds and in low-lyi areas of any size which contain water, either perennially or for a part of t year. In addition to natural fisheries, pisciculture has been practised in Bengal from ancient times. In recent years, its practice has been extended practically all the States of India.

The extensive riverine network of the Ganga system in North India, th Brahmaputra in Assam, the Mahanadi system in Orissa, the Narbada and the Tap in Central India, the Godavari, the Kistna and the Cauvery systems in Penins India, and the Indus system in the Punjab, form the main sources of freshwa fisheries. The principal rivers of India, including their main tributaries have a total length of about 17,000 miles. Canals and irrigation channels, about 70,000 miles in length, also form a network throughout the country. T Loktak lake in Manipur (Assam) and the Collair lake in Madras are large fres areas of considerable fishery importance. The Wular lake in Kashmir and the mountain lakes in the Tal area in Uttar Pradesh are less important. In addi to these, numerous small lakes and beels scattered all over India are of po value. There are also many artificial reservoirs formed as a result of dam constructed in the courses of rivers and streams. Important amongst these, present, are the Mettur and Mopad reservoirs in Madras. There are also cer large water reservoirs in Hyderabad, Mysore, Madras, Bombay and other State these are not fully utilised for fishery purposes. Tanks and ponds scatter over the country make a very valuable source of fisheries. Further, the wa flooded paddy fields serve as areas for fish culture and there is a growing consciousness, particularly in Bengal, for what has come to be known as pad fish culture.

PRINCIPAL FISHERIES AND THE SPECIES EXPLOITED.

In order of importance, the principal freshwater fisheries are those of (1) Major carps (2) Cat fishes (3) Live fishes (4) Prawns (5) Mullets (6) Feather backs (7) Miscellaneous, including minor carps, perches, loache

etc. (8) Eels and (9) Herrings and Anchovies. The yield of these fisheries i terms of percentage is illustrated in Figure 4*

The important species of fish under the various groups given above are

1. Major carps	1. Catla catla (Ham.) 2. Labeo rohita (Ham.) 3. Labeo calbasu (Ham.) 4. Labeo fimbriatus (Bloch) 5. Cirrhina mrigala (Ham.) 6. Barbus spp. (Large-scaled Barbels)
2. Cat-Fishes.	1. Wallagonia attu (Bloch) 2. Bagarius bagarius (Ham.) 3. Pangasius pangasius (Ham.) 4. Silonia silondia (Ham.) 5. Mystus seenghala (Sykes) 6. Mystus aor (Ham.) 7. Eutropiichthys vacha (Ham.) 8. Rita rita (Ham.) 9. Callichrous bimaculatus (Bloch)
3. Feather-backs.	Notopterus chitala (Ham.) Notopterus notopterus (Pallas)
4. Herrings and Anchovies	Hilsa ilisha (Ham.) Setipinna phasa (Ham.)
5. Live Fishes	1. Clarius magur (Ham.) 2. Heteropneustes fossilis (Bloch) 3. Anabas testudineus (Bloch) 4. Ophicephalus spp.
6. Mullets.	Mugil (Liza) corsula (Ham.)
7. Eels.	Anguilla bengalensis (Hem.) Amphipnous cuchia (Ham.) Mastacembelus armatus (Lacepede)
8. Miscellaneous.	Cirrhina reba (Ham.) Labeo bata (Ham.) Barbus spp. Chela spp. Barilius spp. Nandus nandus (Ham.) Etroplus spp. Colisa spp.
9. Prawns.	Palaemon carcinus Fabricius.

PRODUCTION OF FISH.

With the exception of the statistical information given by the Director of Marketing and Inspection, Ministry of Agriculture, Government of India, practically no statistics are available with regard to fishery resources, fish catches, fish consumption, etc. The figures mentioned in the Marketing Report are neither complete nor absolutely accurate and, compiled as they were for undivided India, they do not fully represent the present status of the differen fisheries. However, the information furnished in the above report on the estim marketable surplus of different fish groups in the various producing areas is

*Figures 4 and 5 are reproduced from the "Rep. Marktg. Fish, India", Marketing series No. 52, 1946, New Delhi.

INDIAN FISH PRODUCTION CLASSIFIED ACCORDING TO COMMERCIALLY IMPORTANT GROUPS.

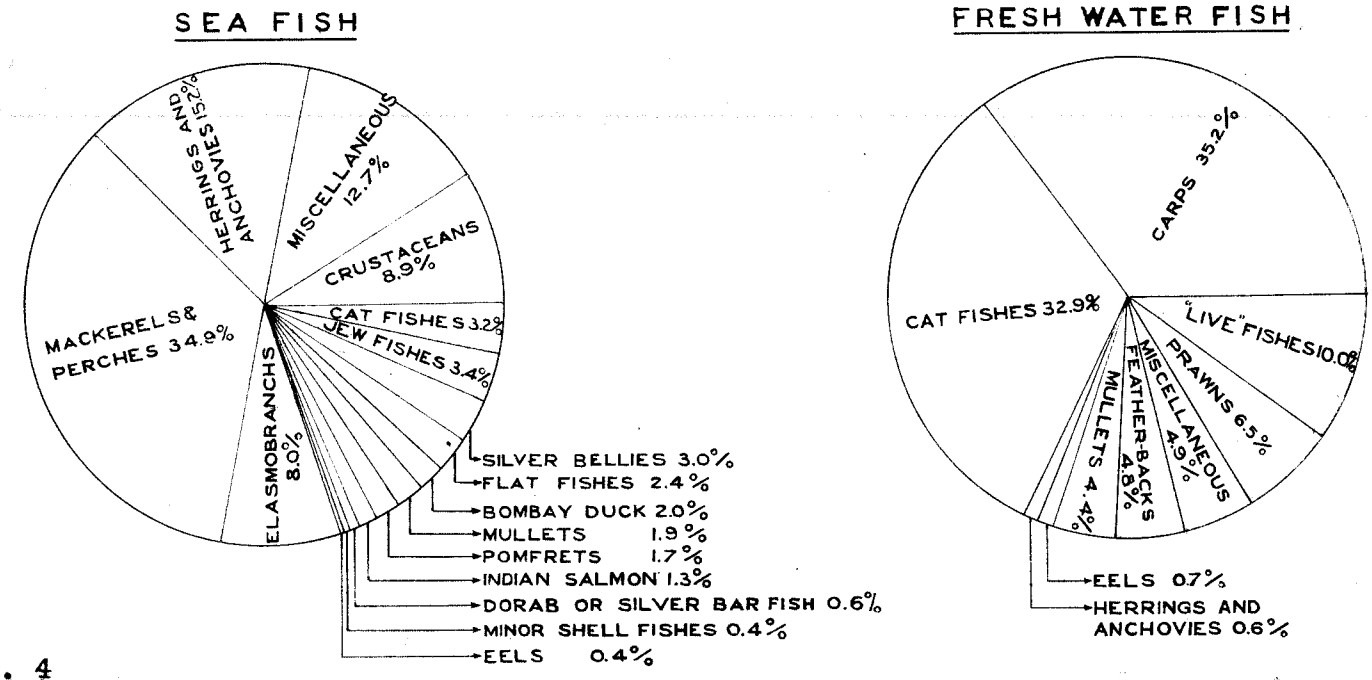

Fig. 4

Plate 4

DIRECTORATE OF MARKETING & INSPECTION		
S.D 1765 (10)		
DRAWN BY	BARTHWAL	18/4/58
TRACED "	J.B.KES	10/2/59
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Plate 5

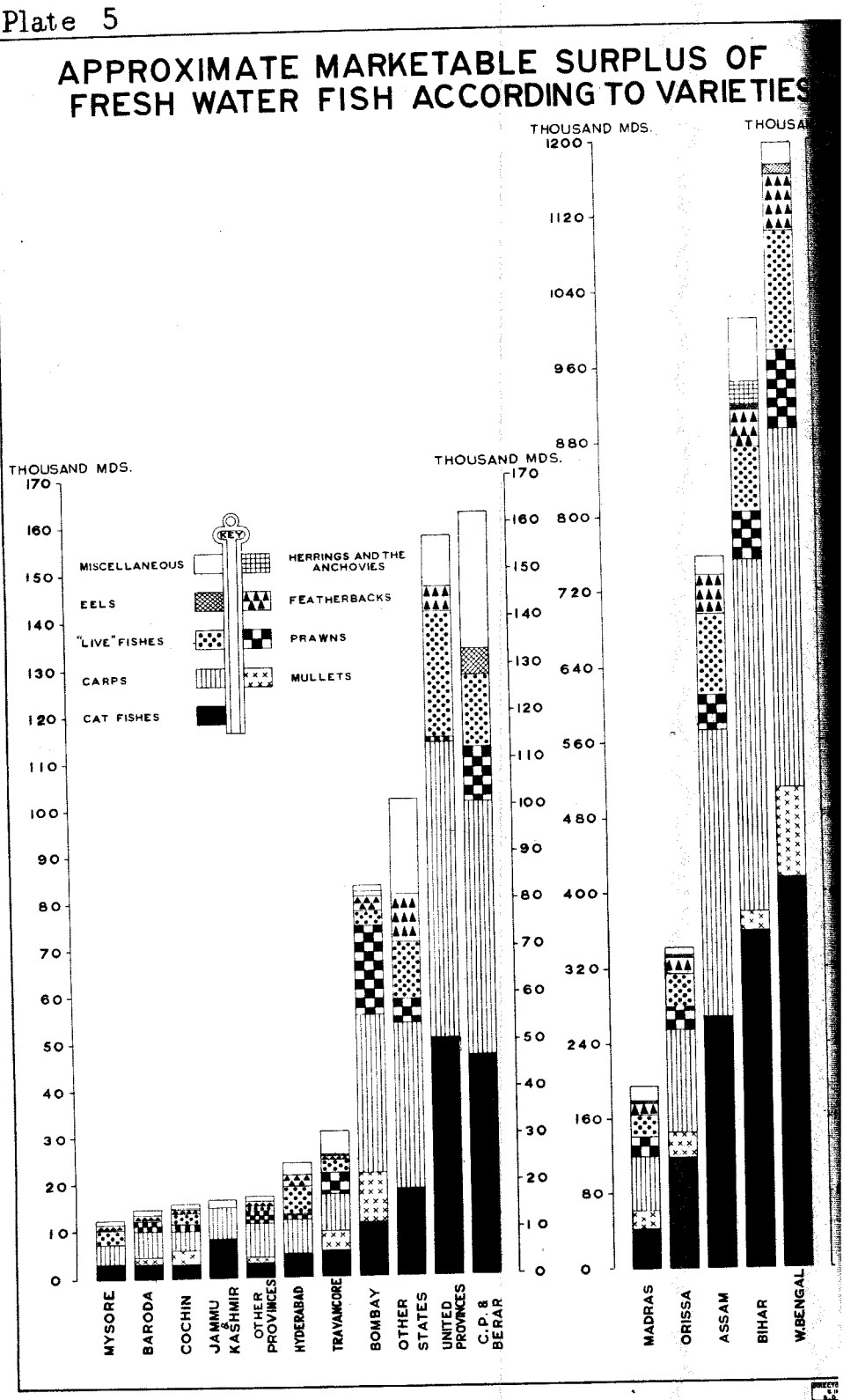

APPROXIMATE MARKETABLE SURPLUS OF FRESH WATER FISH ACCORDING TO VARIETIES
THOUSAND MDS.
KEY
MISCELLANEOUS
EELS
"LIVE" FISHES
CARPS
CAT FISHES
HERRINGS AND THE ANCHOVIES
FEATHERBACKS
PRAWNS
MULLETS
MYSORE
BARODA
COCHIN
JAMMU & KASHMIR
OTHER PROVINCES
HYDERABAD
TRAVANCORE
BOMBAY
OTHER STATES
UNITED PROVINCES
C.P. & BERAR
MADRAS
ORISSA
ASSAM
BIHAR
W.BENGAL

Fig. 5

...ly represented in Figure 5. For other statistical information also ... is invited to the Marketing Report.

POND FISHERIES.

...s already stated, the cultivable area of stagnant fresh water in India ... While the bulk of this area is left uncared for, a large number of the ... ponds and village tanks, particularly in Bengal, Bihar and Orissa, are ... every year with mixed fry collected from rivers. But fish-culture on ...ic lines is at present not much practised and the produce from these ~~fish~~ ...es has, therefore, been limited. The yield varies from about 800 to as ... 3,750 lbs per acre-annum. Harnessing all cultivable pieces of water ...ientific methods of fish culture thus offers immense scope for the ...ment of inland fisheries.

...nt Species Stocked. Quick-growing species of fish with non-predaceous ... habits are generally selected for cultivation in ponds. Besides, certain ... which breed in lentic environments, selected exotic food fishes, a few ...ater fishes easily acclimatisable to fresh water and even some predaceous ...s are cultured in different parts of the country. The following species ...erally stocked in ponds:

1.	Catla	Catla catla (Ham.)
2.	Rohu	Labeo rohita (Ham.)
3.	Fringe-lipped Carp	Labeo fimbriatus (Bloch)
4.	Black Carp	Labeo calbasu (Ham.)
5.	Karimuli	Labeo kontius Day
6.	Bata	Labeo bata (Ham.)
7.	Mrigal	Cirrhina mrigala (Ham.)
8.	White Carp	Cirrhina cirrhosa Day
9.	Reba	Cirrhina reba (Ham.)
10.	Carnatic Carp	Barbus carnaticus (Jerdon)
11.	European Carp	Cyprinus carpio (Linn.)
12.	Pearlspot	Etroplus suratensis (Bloch)
13.	Gouramy	Osphronemus gorami (Lacepede)
14.	Milk-fish	Chanos chanos (Forskal)
15.	Grey Mullet.	Mugil cephalus (Linn)
16.	Murrel.	Ophicephalus marulius (Bloch)
17.	Murrel.	Ophicephalus striatus (Bloch)

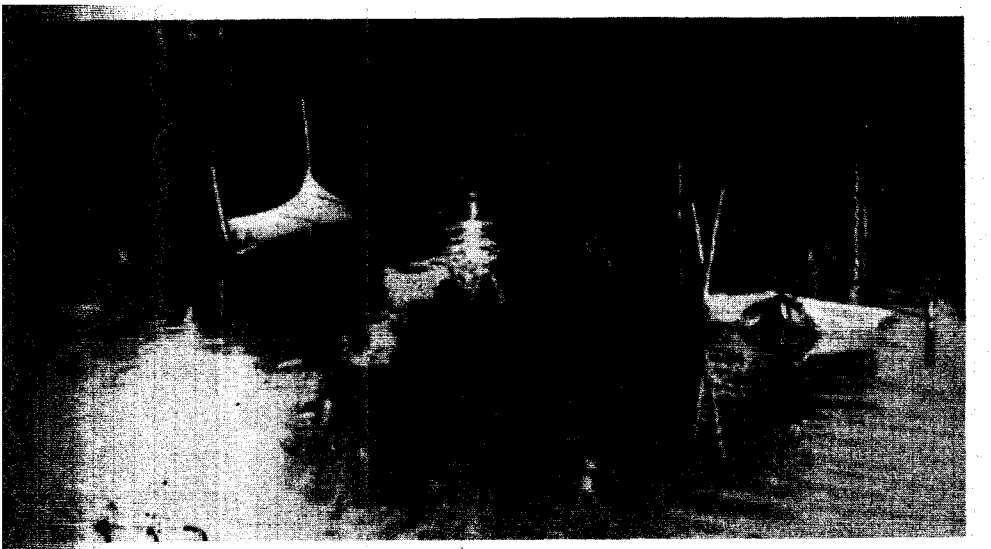
POND CULTURE PRACTICES.

Fish Seed. The major Carps of India do not breed in confined waters, except ...dh-type of tanks in Midnapur and Bankura districts of West Bengal. It is, ...fore, necessary to obtain their fry or fingerlings for pisciculture from the ...l habitats, the rivers. Fry of the major Carps, almost invariably mixed

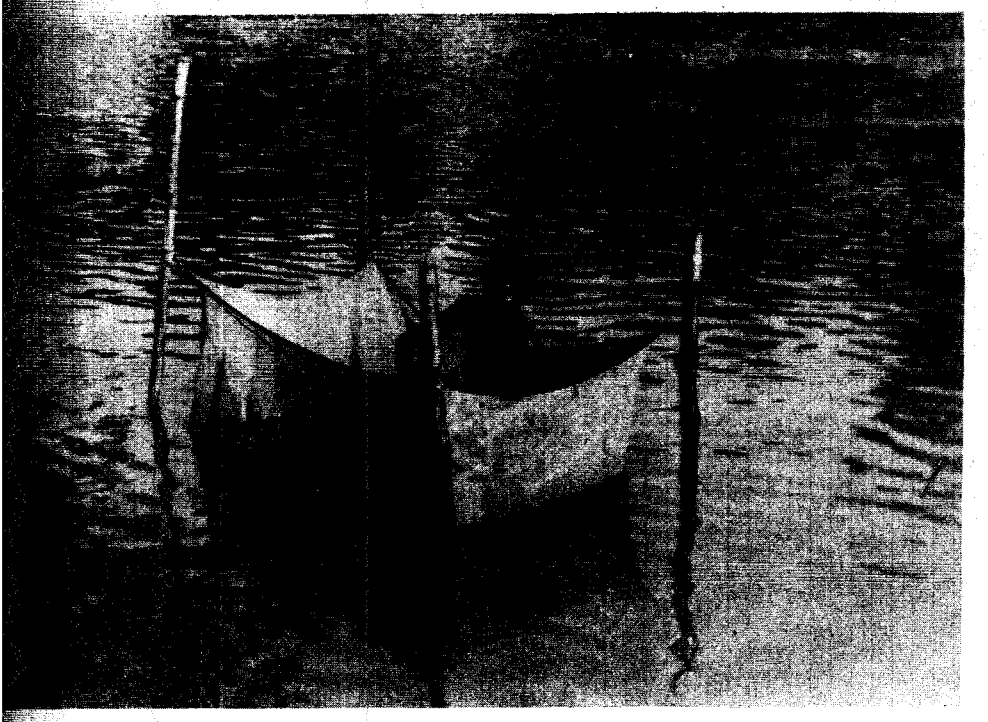
with those of uneconomic varieties of fish, is available in plenty in rivers, rivulets and other fluviatile areas in West Bengal, Bihar, Orissa, Uttar Prade Punjab, Delhi and Madras. Carp fry and fingerlings are supplied from these ar to other States where they are not known to occur at present. Major Carps bre throughout the monsoon months, June-August, when their fry is collected with a special type of close-meshed, funnel shaped net, with a tail cloth termed Gamch (Plate 6 , fig.1). The net is fixed to bamboo poles with its mouth facing th current in shallow waters. The fry collects in the gamcha from where it is periodically scooped and transferred, either to a trough-shaped device made of cloth (called Hapa) supported on poles (Plate 6 , fig.2) in the water or to shallow pits (also called hapa) dug nearby on the bank, with arrangement for water circulation. In West Bengal, there is a flourishing carp fry trade, in which, the fry mostly collected by private agencies, is transported to importan marketing centres and sold to the public. Fry is transported in earthen hundie which have to be constantly shaken during transit for aeration of the water. Some alkaline earth is occasionally added to the water of the hundi, probably t buffer pH fluctuations. In Madras and Orissa, tin containers are used for transporting fry and fingerlings. In Orissa, aeration of water in the tins containing fingerlings has been recently attempted with attached hand pumps, which circulate the water in the form of a spray. The use of oxygen in sealed containers for transport of fingerlings is coming largely in vogue. During 195 the Central Inland Fisheries Research Station supplied about 10 lakhs of carp fingerlings to different States, about half of which was sent in specially desi sealed containers with great success.

Preparation of Pond and Stocking. Construction of new ponds, except in demonstration farms, does not appear to be at present necessary in India, since numerous waters of all sizes and depth are naturally available for utilisation. Since Carps and salt water species do not ordinarily breed in ponds, no special spawning and brood ponds are required, but a set of small, shallow nursery pond (depth, 3' to 5') to receive fry and a series of larger ponds (depth, 6' to 8') for rearing fingerlings, are necessary. According to the existing practice, however, deeper perennial ponds, 5' to 8' in depth and one-third to half an acre in area, are commonly used as nurseries.

Traditional methods of preparation are followed before fry are planted in



1. Nets used for the collection of carp fry.



2. Hapa in which fry is temporarily stored.

urseries. The ponds are thoroughly netted out and the majority of fishes, which ften include several predators, are removed. Organic manures, mainly cowdung d stable refuse, are then dumped in the ponds, before the onset of rains. Within month, when plankton become rich, fry are stocked. In most cases the fish crop urns out to be poor and in certain instances the entire stock disappears. Mortality, us is very high. Recent investigations carried out at the Central Inland isheries Research Station at Cuttack have demonstrated that the survival of fry an be as high as 88% (a month after stocking) in small shallow nursery ponds, hen fully drained before stocking, all the predatory forms scrupulously eliminated, he bottom heavily manured with organic fertilizers and the density of plankton aintained by repeated application of smaller doses of manure.

Rearing. The nurseries are usually over-stocked and within a fortnight to month after stocking, when the fry grow to 1" to 2" in length, the population s thinned out by transferring part of the stock to other nurseries. When they row to 4" to 6", they are liberated in stocking ponds. Usually only Catla, Rohu, rigal and Calbasu are selected and stocked together and the rest are discarded s uneconomic species. A combination of 30% Catla, 30% Rohu and 40% Mrigal is said o be generally stocked in ponds in West Bengal.

Systematic manuring of stocking ponds is seldom done, though small quantities f organic manure, such as cowdung, paddy straw and green leaves are sometimes ept in the corners of the pond. Though use of sewage is not common in India, emarkable growth of fish has been reported from sewage-fed fisheries in the idyadhari and the Hanakali in West Bengal. Artificial feeding of fingerlings is lso not generally practised in India.

Harvesting. Harvesting of ponds on the principle that removal of the larger ish will provide more room for the smaller ones and enable them to grow quicker, s still a new technique to the Indian fish farmer. In many cases the entire crop f fish in the pond is harvested, regardless of size. The seasonal ponds are sually fished out completely in summer and the fish are marketed even though they ave grown only to large fingerling size. In some of the well-organised fisheries, owever, fishes below a particular size are not generally captured.

PADDY-CUM-FISH CULTURE.

In the expansive rice fields of the deltaic areas where water supply is lmost unfailing, conditions are ideal for the culture of Carps. Similar conditions xist in certain parts of Malabar also. Preliminary experiments on paddy-cum-fish

culture have been carried out in Bengal. Utilisation of paddy fields for fish culture, so long as they hold sufficient water for the purpose, offers good scope for augmenting fish production.

LIVE FISH FISHERY.

Live fishes (Anabas, Heteropnuestes, Clarias, Ophicephalus) comprise an important group of fishes and account for about 9.8% of the total marketable surplus of fresh water fish in India *. Noted for highly nutritive, recuperativ and medicinal properties, they generally fetch a high price. They are predatory in habits and thrive in natural weedy waters of a semi-marshy nature. There is no well-organised cultivation of these species.

MURREL CULTURE.

The predaceous, quick-growing and widely distributed murrels, Ophicephalus marulius and O. striatus are highly esteemed as food fishes, particularly in peninsular India. O. marulius is known to breed only in rivers from where fry and fingerlings are collected and stocked in irrigation wells and weedy waters in certain districts of Madras. O. striatus breeds in ponds.

EXOTIC AND TRANSPLANTED FISH.

Introduction of exoitic food fishes and acclimatisation of fast-growing salt water species to fresh water have been attempted with considerable success in some parts of India. Notable instances of exotic fishes in India are the following:-

1. Rainbow Trout, Salmo irrideus, introduced into Ootacamund, Madras, in 1867 from Europe.
2. English Carp, Carassius carassius, introduced into Ootacamund, Madras, in 1874, from Europe.
3. Tench, Tinca tinca, introduced into Ootacamund, Madras, in 1874, from Europe.
4. Brown Trout, Salmo fario, introduced into Kashmir and Kulu Valley (Punjab) from Europe.
5. Gourami, Osphronemus gorami, introduced into Madras, in 1926, from Mauritius and Java.
6. European Carp, Cyprinus carpio, introduced into Ootacamund, Madras, in 1939, from Ceylon.

The English Carp, the Tench and the European Carp have taken well to the upland waters of the Nilgiris. Recent experiments have shown that all these

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* Rept. Market. Fish. India, Mktg. ser. No.52, 1946, New Delhi.

...rms can be reared at lower elevations as well. The English Carp and ...ch have bred at the Sunkesula Fish Farm, and the European Carp has shown ...ellent growth in the Chetput Fish Farm, Madras. The latter has recently been ...troduced into Bombay and Uttar Pradesh. The Trout, confined to the hill ...eams of the Nilgiris, Kashmir and the Punjab is only a game fish and at present ...little fishery value. Gourami has also adapted remarkably to the new environ...nt and owing to its relatively large size, capacity to breed in ponds, hardihood ...flesh of excellent flavour, has become a popular fish for pond culture in ...ras. It has since been introduced into Bombay, Bengal, Orissa and different ...ts of penisular India.

Regional transplantation of Catla from the Godavari and the Kistna to the ...very and of Rohu from Bengal and Orissa to Madras has also been carried out ...h success.

Experiments for acclimatising salt water food fishes to fresh water have ...n carried out, notably in Madras, during the last decade. Fingerlings of ...tal species of Mullets (Mugil cephalus, M. waigiensis, M. troschelii, M. seheli, ...), the Milk-fish (Chanos chanos), the Tarpon (Megalops cyprinoides), the ...ti (Lates calcarifer) and the Indian Salmon (Polynemus tetradactylus) have ... successfully acclimatised to fresh water. The Milk-fish and the Bekti grow ...remely well in fresh water.

CONSERVATION.

Capture and destruction of brood fish and juveniles in large quantities ...commonly indulged in all over the country and are largely responsible for ...impoverishment of some of the freshwater fisheries. The necessity for ...ective legislation had been felt as early as 1897, when, at the instance of ...ais Day, the Indian Fisheries Act IV was passed. States like the Punjab, ... and some others have also adopted further legislative measures to suit ...l conditions. It appears that as a result of the enforcement of these ...ures a certain degree of conservation has been effected in these States. ...connection with the projects for the construction of large river dams, fish ...ys near Hirakud and the Damodar Valley are being carried out with the ...ct of conservation of the fisheries of these rivers.

The effects on fisheries of the toxic effluents discharged into rivers ... the different industrial and sewage works in the country are getting

increasingly menacing . The Kulti sewage outfall near Calcutta and the efflu from the quinine factory at Mungpoo, Bengal, the Mettur Chemical works, Madra and Cement and paper factories at Dalmia Nagar in Bihar are better known insti Investigations in connection with the effluents of Dalmianagar factories have been started at the Central Inland Fisheries Research Station.

6

PRINCIPAL ESTUARINE FISHERIES. *

Introduction.

The long coast line of India has numerous estuaries and brackish-water lakes of backwaters rich in fishes. On the East Coast the estuaries of the Rivers Ganges, Mahanadi, Godavari, Kistna and Cauvery and the brackishwater lakes of Chilka and Pulicat and on the West Coast the estuaries of the Narbada and the Tapti and the backwaters of Travancore-Cochin are the most important. The total brackishwater area could be roughly computed as about 3000 sq. miles. In the absence of any reliable statistics or estimates of fish catches from the estuarine waters, a very approximate idea of the yield can be formed only by the fairly accurate figures available for the Chilka Lake. This lagoon, with a mean area of about 400 sq. miles, produces a total of about 88,000 maunds of fish a year, giving an average yield of about 27 lbs per acre. +

Principal types of Estuarine Waters.

The estuarine waters may be grouped under two main divisions, viz., open estuaries and embanked brackishwaters. The first consists of typical estuaries or river mouths, brackishwater lakes and backwaters. The open estuaries may be 'perennial', as those of the Gangetic delta where there is flow of water from above, all the year round, or 'seasonal', as the mouths of many rivers that dry up during the summer months. The large brackishwater lake of Chilka and the backwaters of Travancore-Cochin have always connection with the sea, while most of the smaller coastal lakes and backwaters get isolated from the sea by a narrow sand bar.

The second type of estuarine waters, viz., embanked brackishwaters, are confined areas of estuaries, lakes and backwaters reclaimed or in the course of reclamation for agricultural purposes. In certain areas under cultivation, fish form a subsidiary but substantial crop, as during the off season in the paddy fields adjoining the Travancore-Cochin backwaters. In Bengal, embanked fisheries are mainly in areas under reclamation, and utilisation of lowlying land for piscicultural purposes is made only to a very limited extent.

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* The term is applied to denote brackishwater fisheries in general.
+ All statistics of fresh fish from Chilka Lake mentioned in the Chapter are collected by the Orissa Fisheries Department.

Principal groups of fishes.

The fishes (sensu lato) constituting the estuarine fisheries are mostly marine species which can tolerate considerable variations in salinity. Broadly speaking, the most important among them are the clupeids like herrings, anchovies and sprats, mullets, catfishes, jew fishes, thread-fins, perches and prawns. Among fishes of lesser importance may be mentioned the half beaks, gar fishes, Bombay-duck, silver-bellies, eels, sharks and rays, flatfishes, oysters and li shells, etc. Even mackerals and pomfrets are sometimes caught in the lower reaches of some estuaries. While most of the important fishes mentioned are distributed in all the estuarine waters, the clupeid Hilsa is rare or absent i the southern region of the West Coast. Similarly the Bombay-duck (Harpadon nehereus) is absent in the whole of the Southern region of peninsular India (Hora 1934).

Clupeids. There are several clupeids in the estuarine areas among which the most important are Hilsa ilisha (Ham), Nematolosa nasus (Bloch), Anchoviel spp., Thrissocles spp., Pellona spp., Anadontostoma chacunda (Ham.), Setipinna spp. etc. Of these the Indian Shad Hilsa is of the highest value. The mud Sh Nematolosa nasus, affords a regular fishery in the Chilka and in bulk the catch are as large as those of Hilsa. Anchovies and sprats are also caught in large quantities for local consumption.

Hilsa ilisha has more or less similar migratory habits as the American shad Alosa sapidissima and the European shad Alosa alosa. The fish is caught in large numbers in the Bengal-Orissa region and in the lower stretches of the la rivers on the east coast of peninsular India, in the Narbada and the Tapti on t West Coast, and in some of the smaller estuaries and creeks on the Kathiawar C A regular Hilsa fishery exists in the Chilka Lake all round the year. Though t main fishery is in the flooded rivers after the monsoon rains, * in the estuar of the Ganges and the Mahanadi, Hilsa fishing is continued during the winter an summer months also. In the Sundar bans, large numbers of young Hilsa known as Jatka or Hilsa-koira about 5 to 8 inches in length, are caught during the winte months in the neighbourhood of Saugor Island at the mouth of the Hooghly (Hora Nair 1940).

The methods employed for catching Hilsa are varied. It is caught in

* In the Indus the ascent of the fish is in summer when the river is in flood by the melting snow.

'Bangla jal', gill nets, seine nets, drift nets and bag nets+. In the Mahanadi estuary after the winter months, Hilsa moves about in great shoals; and large scale fishing is conducted by a combined operation of an 'armada' of 25 to 100 boats with a complement of about 200 to 500 men with nets stretching from bank to bank combing a long stretch of the river. The catch during one operation may be as large as hundreds of maunds, depending on the size of the shoal. Most of these catches are salted and sun-dried on account of the difficulties of transport. The product, despite its poor quality, finds a ready market in the interior parts of the State.

Mullets. Statistics of mullet catches from the brackishwater areas are not separately available, but according to the Report on the Marketing of Fish in India the quantity of marketable surplus of mullets from fresh and brackish waters is estimated at 380,000 maunds, and from the sea at 166,000 maunds. Figures available for Chilka show that the mullets constitute 10 to 16% of the total catch of fishes (including prawns).

About 26 species of mullets are recorded from the estuarine waters and of these Mugil corsula (Ham.), which is restricted to the Gangetic and Mahanadi systems, is the only species found both in the fresh and brackish waters. The largest species along our coast is Mugil cephalus (Forsk.), which has wide distribution in all the tropical and sub-tropical waters. It is not generally found above the Midnapore Coast in the Sundarbans area.

The migration of the mullet fry into brackishwater areas is taken advantage of for utilizing it for fish farming and its toleration to variations in salinity makes it ideal for the purpose. Mullets form an important crop in the Bhasa-bhada fisheries of Bengal and, together with prawns, in the paddy fields connected with the backwaters on the Malabar Coast. The mullet farm at Narakkal in Cochin is the first example of a successful saltwater fish farm in India.

Mullets are usually caught in stake nets, gill nets and seine nets and in shallow areas by cast nets. In fresh condition they are tasty but spoilage sets in soon in hot climate. A considerable quantity is salted and dried or sun dried, depending on the size of the fish. The small trade in fish-roe that existed in the Chilka and Mahanadi areas is now declining.

+The particulars of the above nets and methods of operation are given in the Report on the Marketing of Fish in India, 1946, Delhi.

Catfishes. Despite the fact that the Catfishes do not come under the category of prime estuarine fishes, like the Bekti, Hilsa, Pearlspot, or thread fins, they exceed any of the above in the bulk of the total catches. Their comparati abundance and cheapness bring them within the buying capacity of the poorer classes. A very large portion of the catches goes into local consumption and the marketable surplus does not, therefore, give a correct indication of the actual yield.

The most important among the estuarine Catfishes are Arius spp., Osteogeniosus militaris (L), Pangasius pangasius (Cuv. & Val.) and Mystus spp. The largest catches in Bengal-Orissa region are made from November to March. Arius spp. and Osteogeniosus militaris collect together in large numbers for breeding, and being sluggish in their movements at this time are caught in larg quantities.

During the glut season and in places where transport or marketing facilities are not available the surplus quantity is salted and dried or sun-dried according to the size of the fish.

Perches. Among the estuarine perches, the species that is of the greatest economic importance is Lates calcarifer (Bloch). This is a high class fish and fetches the highest price in the city markets. The pearl spot, Etroplus suratensis (Bloch), which is indigenous to the coastal backwaters and estuarie of South India, is of considerable local importance. The fry of this fish is used now for stocking both freshwaters and brackishwaters. Among the other estuarine perches are Epinephelus tauvina (Forsk), Lutjanus spp., Etroplus maculatus (Bloch), Ambassis spp., Therapon spp., and Otolithus spp. All, except Etroplus, come to the estuarine waters from the sea for food and growth, thus affording a valuable fishery.

Thread fins. The most important species is the so called Indian Salmon, Eleutheronema tetradactylum (Shaw). It is widely distributed along the Indian Coast and the young are found in the lower reaches of the estuaries where they probably come up from the sea for food. It is caught, along with mullets, clupeids and other fishes, in seine nets and drag nets. The other species are Polynemus indicus Shaw., which is an occasional visitor from the sea, and Polynemus paradiseus L., the distribution of which in India is restricted to the Bengal-Orissa region. The latter is found in fair abundance in the estuari

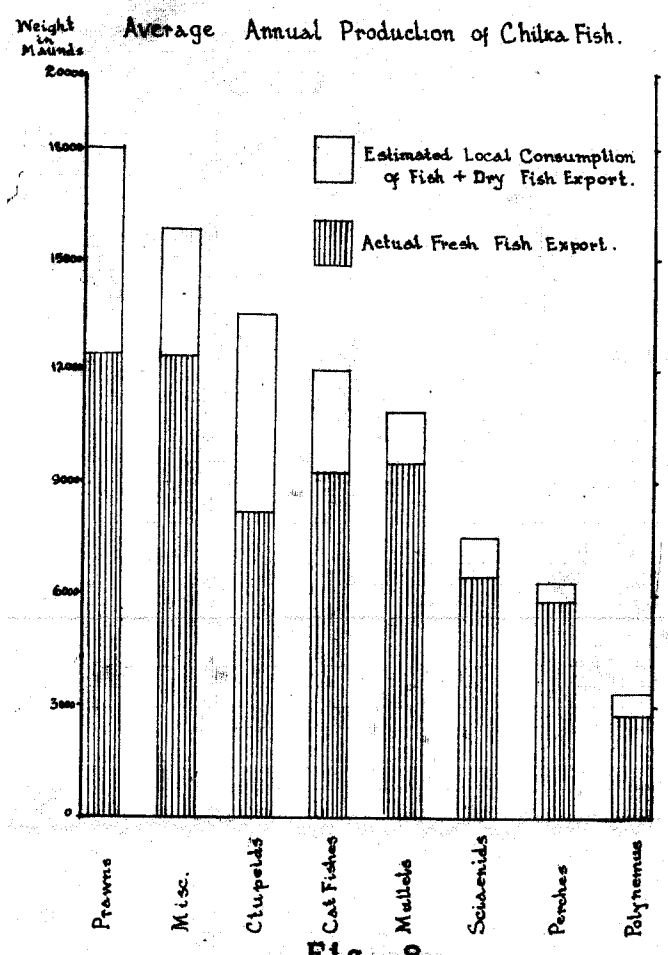
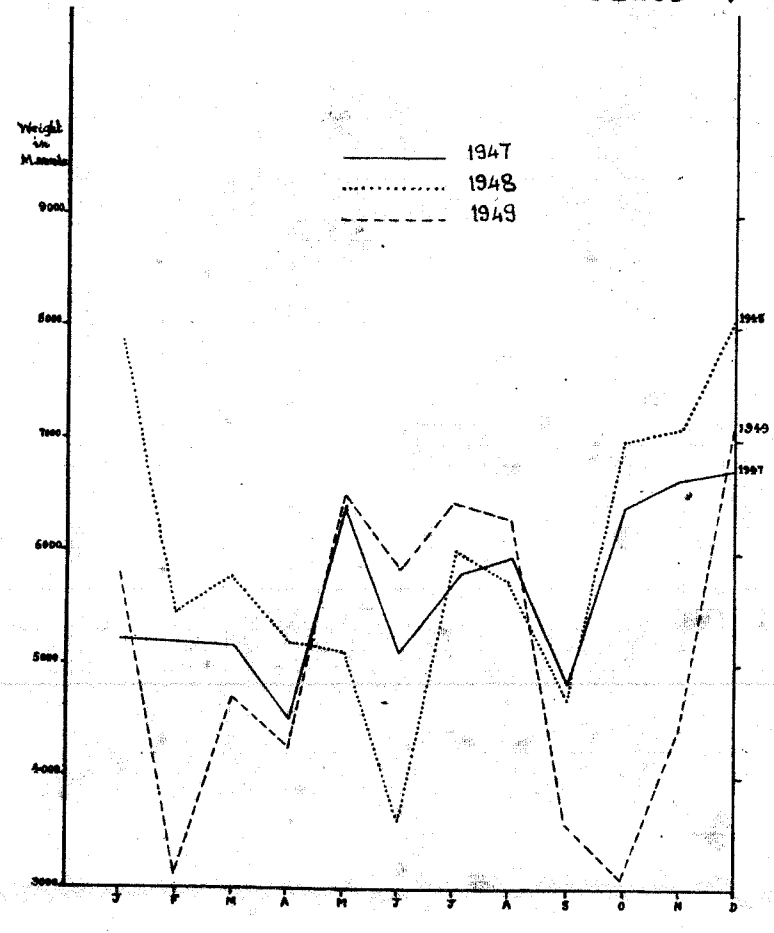


Fig. 8



Graph 1. Total Fresh Fish Exports From Chilka Lake. During The years 1947, 1948 & 1949.

Fig. 7

nd in the Hooghly it ascends up to about 150 miles from the sea for breeding, rom about April to June, when it is caught in large numbers.

Prawns and crabs- Prawns and shrimps constitute a very valuable fishery n estuarine waters (Chopra 1939) and as a group the catches in certain areas ay be more than those of any other single group of fishes. The most important re the Penaeids and the Palaemonids, of which the former are more predominant han the latter in the estuaries. A very lucrative industry of cured and dried rawns exists in the Malabar Coast (Panikkar 1935). The crabs form a subsidiary rustacean crop in the estuarine areas (Chopra 1939) and are usually consumed ocally. Prawn and crab and Molluscan fisheries are dealt with separately in his Hand-book.

Fisheries of the open brackishwaters-Chilka Lake.

In the absence of regular statistics of catches of fish from the open stuarine waters, the figures available for the Chilka Lake,* which are reliable re given below. The fish exports from the lake, which are controlled by the overnment of Orissa, represent more than three fourths of the total catches. e monthly totals of exports for 1947, 1948 and 1949 are shown in Text Fig. 7. esh fish exported from the lake averages about 67,000 maunds per year and king into account the dry fish exported to outside centres, the marketable rplus of fish from Chilka comes to nearly 80,000 maunds. In view of the poor al demand and low buying capacity of the people, the local consumption is imated at 10% of the above figure. giving a total production of 88,000 maunds year for the lake. Text Figure 8. indicates the average annual production the proportion of exports of the principal varieties of fish.

All the varieties with a catch of less than 1000 maunds are included r "miscellaneous" in the graphs and of these the most important are Gerres Ambassis sp., Hemirhamphus gaimardi (Cav & Val.), Tylosurus Strongylurus Hass), Therapon spp., Sillago sihama (Forsk), Glossogobius giuris (Ham), ops cyprinoides (Brouss) etc. A very small quantity of freshwater fishes consist of species that stray into the western and northern sections of

* general description of the Lake and its fish fauna see Memoirs of the ian Museum Vol. V. It is a shallow brackishwater lake with an area of 350 sq.miles in summer and 450 sq.miles during the rainy season. A annel 14 miles connects it to the sea. The lake receives the waters , one of the deltaic branches of the Mahanadi in addition to several local streams. The water in the lake is practically fresh when it is flooded condition.

the lake during the monsoon floods are included in the catches. These are l
than 1% of the total catch and consist mainly of carps, murrels and some fre
water cat-fishes. Most of these are consumed locally.

Fisheries of the Embanked Brackishwaters

Though India has a very extensive coast line, it has no marine or bra
water fish farms comparable to those in Java or in the Philippines. In the
estuarine areas of Bengal and in the backwaters of Travancore-Cochin, bracki
water fish-farming is, however, carried on to some extent.

In the Sundarbans in Bengal these are known as the Bhasa-badha fisher
and have been described by Hora and Nair (1944). Due to the action of the ti
the beds of many of the rivers and creeks in the estuarine areas of Bengal g
gradually silted up and in due course such areas are reclaimed for agricultu
purposes by constructing bunds to keep away floods and tidal water. Some port
of such reclaimed areas are too low for cultivation and these are usually
utilised for fish farming. Many of the reclaimed areas are provided with an
additional outer bund and the low-lying land in between is used for pisciculi
purposes. Water is let in during high tide through improvised or permanent
sluice gates and the in-flowing water brings a variety of fishes with it. Th
is no selective admission and mullets, prawns, perches, Scianenids, thread fi
Gobiids etc. come in. In the channel, inside the sluice gate, split bamboo
screens, shaped like an inverted V, are fixed in such a way that while they
allow admission of fish during high tide, escape of any fish when the water
recedes is not possible. Connected with the V shaped screens are box-like t
into which the larger fish collect and the useful varieties from them are
transferred to the stocking ponds.

During the summer months, when water is low in the river, some of the
shallow bheries are dewatered or dry up. During the monsoon months when the
salinity is low, water is let in and along with it fry also come in. Fishing
is generally done in winter when the fishes have grown to a marketable size.
In the perennial bheries the fish grow to a large size. The Bekti (Lates
calcarifer), Mugil tade (Forsk), and Mugil parsia (Ham.) and prawns are the
chief fishes obtained from such fisheries.

Embanked brackishwater fisheries of the Malabar coast, especially thos
of prawns, have been described by Panikkar (1939). There are extensive

low-lying paddy fields, known as pokkali fields, adjacent to the northern section of the Travancore-Cochin backwaters. Cultivation in these fields is restricted to a single crop from July to September due to the high salinity of the adjacent water during the rest of the year. After the harvest, the bunds are strengthened and wooden sluice gates are put up with adjustable planks to regulate the flow of water to and fro from the backwater. Water is let in during the high tide from October onwards and the incoming water brings along with it a large number of young Penaeid prawns, 2 to 3 inches in length, and fish fry. During low tide, if necessary, screens of closely-knit twigs are kept inside the sluice gates to prevent the escape of prawns and fishes. The stocking operations are continued for one to two months and no special manuring is done. There is a gradual rise in the salinity of the water up to the advent of the next moonsoon rains. Fishing commences from the end of December, by which time the prawns are grown to about 3 to 5 inches in length. This is done at low tide with the aid of bag nets, scoop nets and drag nets. Over 80% of the crop consists of prawns and the rest of mullets, pearlspot and orange chromide etc. The major portion of the catch is cured and exported to various places in India and to Burma and Ceylon.

There are few mullet farms on the Malabar Coast except for the one at Narakkal, near Cochin, and the experimental ponds at Ayiramthengu near Kayamkulam. The former has been described by Pillay (1948). It was originally a swampy waste but has now been converted into a fine mulletry consisting of several ponds with earthen bunds and provided with wooden sluice gates with adjustable planks and split bamboo gratings for regulating the flow of water. In summer the water level goes down considerably resulting in an increase in salinity and temperature. Some deep ditches have been dug in the ponds to serve as 'shelter' for the fishes. The necessary mullet fry is let in, along with the tide, during the monsoon months from the adjoining backwater and the additional quantities required are collected mechanically by nets and transferred to the ponds. Growth is very rapid and Mugil cephalus, which constitutes over 75 per cent of the stock, attains a length of about 1½ feet in a year. The other fishes consist mainly of Chanos, Etroplus, Polynemus, Therapon and prawns. In 1948, the yield from the 11 acres of the farm was about 10,000 lbs of fish giving an average of about 900 lbs per acre.

7

Principal Marine Fisheries.

1. SARDINE FISHERY

The clupeoids, which constitute about a third of the marine fish caught in India, are chiefly represented in Indian waters by the sardines (Sardinella), anchovies (Thrissocles), whitebait (Anchoviella), Rainbow sardine (Dussumieria), White sardine (Kowala), etc. Of these the sardines, represented by nine species constitute an important fishery along the west and South East Coasts of India. A few species like S. longiceps, S.fimbriata, S.gibbosa, and S.albella occurin large shoals.

From very early times, the oil sardine, S.longiceps, has ranked as a very valuable commercial fish owing to its food value and industrial uses. It is known to occur off the Coasts of Arabia, Iran, Pakistan, Ceylon, Andamans, Java and Bali Straits, but is restricted in its distribution in India to the West Coast and very rarely along the East Coast. Large shoals of the species a known so far only from the Kanara and Malabar Coasts. The fishery starts immediately after the commencement of the South West Monsoon, and lasts from August to March, the September-December portion being the best period for the fishery. The nets used in the sardine fishery are the seines, including the large shore seines, and the gilling nets.

Statistics of oil sardine landings and its by-products available from th beginning of this century show an irregular fluctuation in abundance at interva ranging from two to six years up to the 1941-42 season, after which the fishery has proved to be a complete failure. These fluctuations have made this fishery very undependable, with consequent disastrous effects on the oil and guano indu tries which flourished during the years of plenty. An improvement in the fishery was, however, noticed during the 1949-50 season. The fluctuations in t oil sardine fishery have been attributed to various causes but the significant ones, apart from the adverse factors influencing the rate of survival and recruitment to the stock, appear to be the indiscriminate caputre of shoals of small-sized immature sardines, during the years of abundance and of the 3-year old active spawners during the short spawning period. Considering the restric shoaling of the oil sardine along the West Coast and also its short life-span 3-4 years, unlike that of allied forms of other countries, the disastrous effe

* For production of marine fish in terms of percentages, according to commerci important groups, reference is invited to figure 4 facing page 41.

of indiscriminate destruction of immature fish and the spawners become obvious. Legislative measures were introduced in 1943 to prohibit the capture of oil sardines during the spawning period of August and September and of the immature fish below 15 cms. This legislation was in force for 4 years but was not continued owing to practical difficulties experienced in its enforcement.

The oil sardine fishery appears to have some influence on the other fisheries of the West Coast, notably that of the mackerel. The records of landings of these two fishes show inverse trends of variations, a good year for the one is generally coincident with an unsuccessful fishery for the other.

The oil sardine is esteemed as a very valuable food fish but since it putrefies quickly, only limited quantities are used for consumption, the major portion being cured with salt. Canning of oil sardines was successfully done for many years by a private canner at Mahe, and a State Cannery was subsequently opened in 1914 at Chaliyam near the mouth of the Beypore river. The canning of oil sardines in different sauces suited to Indian tastes, was tried in the State cannery and the products were in demand both in and outside India. Difficulties experienced during the post-war years necessitated the closing of the factory in 1933.

During early times, the oil sardines, along with other sardines, were used only for manuring coconut plantations and tobacco fields, but by the middle of the last century when there was scarcity of animal oils, attention was directed to the oil sardines for the extraction of its oil. This was done in a primitive and crude way by allowing the fish to putrefy in dug-out canoes. The high price prevalent at that time sustained this industry up to the end of the century, when it declined owing to the erratic appearance of oil sardines along the coast. An improved method of oil and guano manufacture by boiling the sardines in cauldrons over fire and pressing them in coir mat bags in indigenous screw presses was introduced in 1908 and produced oil of good quality and guano of good manurial value. This success led to the opening of a number of small factories along the 240 mile coast of South Kanara and Malabar and the peak figure of 647 factories, with an output of 32,000 tons of guano and 12,000 tons of oil was reached during the 1922-23 season. Malpractices in the manufacture of oil and guano, together with the capricious nature of the fishery in subsequent years and its complete failure during the last decade, has resulted in the closing down of almost all

the factories.

The crude oil was used locally as a preservative for boats. The bet quality oil obtained by the improved method was found to compare favourably the Menhaden or the Japanese sardine oil and was used in the leather, jute a steel industries, in arsenals and as base for good quality insecticides. Fo a century the oil was also exported to Great Britain, Germany, Turkey and ot countries.

The high nitrogen and phosphate contents of sardine guano have made it valuable manure, which was in demand in coffee, tea, coconut, suggar-cane an tobacco plantations and also exported to Colombo and Japan, Sardine fish-mea specially prepared in factories, was also in demand with livestock owners.

The fishery of sardine, S.fimbriata, has come to the fore in recent ye This is a smaller sardine, the commercial size ranging from 10-15 cms. The f of this sardine also is subject to fluctuations. Very heavy catches are usua obtained from September to January mixed with S. albella, another common sard of the West Coast. This sardine is less valuable as a source of oil and the surplus is largely used in the fish manure industry. It is also caught in fa large quantities on the East Coast, along with another sardine, S.gibbosa, wh is more common in the Palk Strait.

2. MACKEREL FISHERY

The mackerel is an important commercial fish of the west coast of Indi According to the available statistics, mackerels and perches constitute as muc as 21.7% of the total fish production of India. The Indian mackerel is compar tively smaller than the European species, measuring eight to ten inches in le and weighing about five to the pound. Day has recorded three species of macke from the seas of India. These are Scomber microlepidotus Ruppell, Scomber brachysoma Bleeker, and Scomber janesaba Bleeker.

The mackerel Scomber microlepidotus, considered synonymous with Rastrel kanagurta Russell, is the only commercially important species and is caught al the west coast of India from Ratnagiri in Bombay State to Cape Comorin in the South. On the east coast, the northern limit of the occurrence of this specie is as far as Ganjam.

The fishing season for mackerel on the west coast is from October to January and may sometimes extend to as late as March. The shoals subsequently

break, decrease in number towards April and disappear for a short period of a month or so. On the east of Ceylon they appear in November and December, but the fishery is at its height in December. On the Madras coast, the season is in two periods, namely July to October on the Andhra coast and from September to April on the Coramandel area.

The important mackerel fishing areas on the west coast can be divided into four zones according to the different types of boats and nets employed to suit the physical characters of the coast-line. These areas from north to south are:- (1) Konkan - from Rajeewade in the Ratnagiri District to the mouth of Terkhol creek (i.e. to the northern boundary of Goa); (2) North Canara - from Majali on the southern boundary of Goa to Bhatkal, near the southernmost coastal limit of the Bombay State; (3) South Canara - from the southern boundary of the Bombay State to the mouth of Baliapatam river near Cannanore and (4) Malabar - from Cannanore in the north to the southern part of Travancore. The chief mackerel fishing centres on the west coast are - Ratnagiri, Malavan, Karwar, Malpe, Tellichery, Calicut and Cochin. Except for the sporadic occurrence of mackerel, there is no regular fishery of this fish on the East Coast.

The different types of boats and nets operated in different mackerel fishing areas are classified according to their places of operation. Though the fishing methods are efficient, the field of operation is restricted to a range of two to five miles from the shore.

WEST COAST.

Fishing area	Type of boat.	Type of net	Vernacular name.
Konkan area	Pandi; Hodi (Both are provided with an out-rigger equipment)	Shore Seine	Rampan net
		Drift net	Pettle bale
		Cast net	Pag
North Canara area	Pandi; Doni (Similar to above with outrigger)	Shore seine	i. Rampan net ii. Yendi or Payawada.
		Drift net	Patta bale
		Cast net	Pag
South Canara area	Pandi (with outrigger) Dugout canoes	Shore seine Drift net Cast net	Rampan net Patte balai Deb balai
Malabar area	Dugout canoes.	Seine net.	1. Odam vala, also called Peru vala & Paithu vala.
		Gillingnet.	ii. Aiyla kolivala Aiyla chala vala

On account of transport difficulties only a small portion of the mackerel catch is consumed in a fresh state, the bulk of the catch being cured. The introduction of Carrier launches has, however, removed the transport difficulty to some extent and at present there is a fleet of 40 to 50 launches, owned by private companies or individuals, engaged in supplying mackerel from Malavan and Karwar waters in Bombay markets.

The principal methods of curing mackerel on the west coast are:

1. Dry process: (Mackerel gutted)

   i. Mackerel slit on the abdomen, gutted and gills removed.
   ii. Mona process-Without slitting open the abdomen, but pulling out the guts and gills through the mouth.
   iii. Fish split on abdomen, flattened and Visoera removed.

2. Wet process (without gutting)

3. Tamarind process or the Colombo method.

That some of the methods employed at present in the mackerel fishery are very efficient can be judged from the use of the Rampan net. Very few other shore seines in the world have such a capacity to catch large shoals of fish in inshore waters. In 1949, in one operation alone 25,00,000 mackerel were hauled at Chendyie, a fishing centre 5 miles to the south of Karwar. On account of the small size of the boats, the field of operation is, however, greatly restricted and the fishermen have to wait for the mackerel shoals to come to inshore waters. Extension of the range of operations by mechanisation, coupled with the use of some of the existing and new types of nets, appears to be necessary for improvement of the mackerel fishery. The experiment of the Central Government Pilot Deep Sea Station to operate two power vessels with Purse seines from Karwar during the current mackerel season will probably yield interesting results.

3. SHARK AND RAY FISHERIES AND SHARK LIVER OIL

Several varieties of commercially important species of sharks and dog fishes of the genera Galeocerdo, Carcharinus, Hypoprion, Scoliodon, Sphyrna, Chiloscyllium, Stegostoma and Ginglymostoma are found abundantly in the coastal waters of India. Rays and skates such as Trygon, Hypolophus, Aetobatis, Pteroplatea, Myliobatis, Rhinoptera, Pristis, Rhinobatus and Rhynchobatus also constitute a considerable part of the commercial catches on both the coasts. Most of the species of the west coast are largely identical with or closely allied to those of the east coast of India. Sharks are available through out the year but the main season of the fishery generally extends from July to Mar

on the west coast and May to January on the east coast, in waters ranging in depth from 25 to 30 fathoms. Rays are shallow water forms and their optimum catch is secured from depths of 10-15 fathoms, though they may occur in fair numbers up to 25 fathoms.

In the Arabian Sea, principally adjacent to Calicut, Tellicherry, Mangalore, Karwar and Bombay, the species of Scoliodon, Carcharinus, Sphyrna and Galeocerdo are seasonally abundant and support an important shark fishery. All these species are valued for food and oil extraction. On the east coast the principal species exploited for their liver are G.tigrinus, C.melanopterus, S. blochii, S.malleus and P.cuspidatus. As yet commercial shark fisheries on a large scale have not extended to the north section of the east coast.

The majority of the species migrate to shallow waters for breeding and the early stages and young forms have been taken from 3 to 4 fathoms. Present knowledge in regard to their life-history, rate of growth, age at sexual maturity, breeding grounds and breeding season is very meagre. Comprehensive investigations have been started at the Central Marine Fisheries Research Station to elucidate these factors for all the species of sharks and rays of our coasts.

The chief areas where extensive shark fishing is carried on are (1) Kathiawar, (2) Bombay, Kanara, Malabar and Travancore coasts, (3) Southern and Northern section of east coast of Madras, and (4) West Bengal. The largest commercial catches are landed at Kodinar, Veraval, Bombay, Karwar, Mangalore, Tellicherry, Calicut and Trivandrum on the west coast and at Tuticorin, Adirampatnam, Point Calimere, Nagapattinam, Kakinada, Musilipatam, Visakapatnam and Contai on the East coast.

The gear commonly used for shark fishing are the long lines and hooks, and different kinds of drift nets, ray nets, entangling nets, wall nets and all kinds of large nets, when fishing for small and medium sized varieties of sharks. For larger sharks a more specialised type of gear is preferred, like the revolving chain hook, which has shown the possibility of establishing a valuable commercial fishery for large species of oil-yielding sharks on the Indian coast. The craft used are the large plank-built boats on the Bombay coast, the dug-out canoes on the Malabar and Travancore coast, the catamaran on the Coromandal coast and plank-built boats on the northern section of the Madras coast.

The most important aspect of the exploitation of the Elasmobranchs is the extraction of oils form their livers. In India, manufacture of medicinal fish

liver oils, based on shark and saw fish livers, was in existence as early as 1852. In recent years the extraction of shark liver oil on a commercial basis has been taken up by the Madras Government, followed by other maritime States, like Bombay, Travancore and Bengal. Before the last war, India imported about 1,65,000 lbs of cod liver oil every year. Locally produced shark liver oil has since been accepted by the medical profession as a suitable substitute for cod-liver oil. Experiments show that many of our sharks are the best and cheapest source of vitamin A in concentrated form. Other advantages are the comparative largeness of their liver and the more copious yield of oil.

The principal species of sharks that constitute the shark fishery for the livers, mentioned in the order of their importance with reference to oil yield and vitamin A potency are:- (1) Galeocerdo tigrinus, (2) C.melanopterus, (3) C. gangaticus, (4) Sphyrna blochii and S.malleus, (5) P.cuspidatus, (6) C.menisorrah, C.limbatus, S. palasorrah and S.walbeehmi. With the exception of a few species like G.rayneri and C.tricuspidatus, the sharks found in Indian waters are generally rich in vitamin A content. Great variation have been noticed in the vitamin A content of the livers of different species, according to age, sex, season and breeding condition. The vitamin A potency has been shown to vary between 24,000 and 10,000 I.U. of vitamin A per gram of oil but the average value is 12,000 I.U. per gram. In comparison with cod liver oil, vitamin D potency is rather low.

No reliable statistics are available regarding the annual production of shark liver oil in the country. An output of a million and half pounds has been roughly computed against the total requirement of 28 million pounds per year. At present the annual catch of elasmobranchs does not exceed 20,000 tons. To meet the shark-liver oil requirements, a 20-fold increase in our shark fishery is necessary. But sharks which afford this valuable oil are mostly viviparous. Though the problem of overfishing is not of immediate importance, so far as sharks are concerned the viviparous habits producing a limited number of young at a time, together with long periods of gestation which set a natural limit on their multiplication, emphasise the need for judicious exploitation.

The Governments of Madras, Bombay and Travancore-Cochin have evolved different techniques for the preparation of the liver oil which are marketed by their fisheries departments. In addition to production on large commercial

scale, extraction also is carried on by fishermen and private agencies as a cottage industry. The crude oil received from the private agencies is collected by the fisheries departments, and after dehydration and clarification, the oil is blended with vegetable oil to standard strength of vitamin A. Vitamin concentrates under the trade name 'Adamin', and blended and standardised product with vitamin A potency of 1500 I.U. and a vitamin D potency of 100 I.U. per gram are put on the market by the Madras Government. Pure and unblended brand of high potency oil under the trade name 'Sharliverol' is marketed in Travancore.

A comparatively small portion of the sharks & rays caught are consumed fresh as food locally, the bulk are filleted, saltcured and sun-dried. Though sharks and rays are popular as food in Madras and some parts of Bombay States there is not much demand for these varieties of fish except by the poorer classes. Considerable quantities are used for making fish meal and fish manure. At present cured sharks are largely exported to Ceylon. Fins of sharks and saw fishes are also commercially valuable and are in great demand in China and other eastern countries, exports being mainly from Bombay, Madras and Nagapattinam.

4. Bombay Duck Fishery.

The Bombay duck fishery in India is more or less localised to the Bombay coast from Ratnagiri in the south to Broach in the north and consists exclusively of one species, namely Harpodon nehereus. This is a medium sized fish attaining a maximum length of 33 cms. or so. It is also found to some extent on the West Bengal, Orissa and Coromandal coasts. The total catch of Bombay duck in India during 1949-50 has been estimated at about 7,250 tons (i.e. about 2% of the total marine fish produced in India). More than 90% of the produce comes from the Bombay coast and the rest from the East coast of India.

The fishing for Bombay duck begins towards the end of September just after the south-west monsoon and remains in full swing upto the end of January. The fishing is mostly done by means of bagnet locally known as "Dol" operated at a distance of about 4-5 miles from the shore. Nearly 80% of the total catch is sun-dried. A part of the catch is also sold in the fresh state at nearby places. The species is carnivorous, its main food consists of prawns. It seems to be a migratory fish, since it moves away from the shore sometime in February-March and reappears in big shoals in October. The fish is probably a continuous

breeder, with two peak spawning seasons. The spawning appears to be in off-shore waters as eggs and larvae have not been obtained in the inshore area.

5. Ribbon Fish Fishery

The ribbon fishes or hairtails, belonging to the family Trichiuridae, are represented in the Indian waters by three species, Trichiurus haumela, T.savala and T.muticus. These shoaling fish form an important fishery on the Madras Coast and adjoining areas.

In Indian waters the three species shoal separately at different place On the East Coast, T. haumela predominates in the catches at Madras. T. sava is reported to be more common near Kakinada and in the fishing centres of Orissa, while T. muticus is the most common species in the south near the Gul of Manaar and Palk Strait. T. haumela and T. savala predominate respectively in the southern part of the West Coast, between Cape Comorin and Malpe, and i the northern part, comprising the Konkan and the Bombay coasts. These fishes appear along the coastal waters between the months of June and October with t peak occurrences in different months.

Observations so far made at the Central Marine Fisheries Research Stat indicate that Ribbonfishes spawn in the off-shore waters just before they app along the coastal regions from the month of June or July and that their spawn period is restricted to a short time once a year.

Although ribbon fishes afford only a seasonal fishery, they form a major part of the fish landings along both the East and West Coasts of India constituting up to 40-45% of the total landings during the peak periods. Bei soft and ribbon shaped, they are easily sundried with salt. The common meth of capture along the East Coast are by means of seine nets, locally known as Vella valai, Pedda valai, Iraga valai, Alivi vali, (Kovallu valai) and Madi va (shore seine) and along the West Coast with Paithu vala, Pachu vala, Thalava vala (used exclusively for catching ribbon fishes), Veechu vala (small meshe cast net operated from a canoe), Peru vala (shore seine) and Rampani nets.

8

MISCELLANEOUS FISHERIES.

1. CRUSTACEAN FISHERIES.

Among the commercially important crustaceans of India, prawns undoubtedly occupy the first place in virtue of the magnitude and value of the fishery they support. According to available statistics, they form 10% and 7.5% respectively of the total fish catch from the sea and fresh water. About two-fifths of the total production of marine crustaceans come from the state of Travancore-Cochin; Bengal contributes approximately 30% and the remainder is produced by the other maritime states like Orissa, Madras and Bombay.

PRAWNS

With the exception of a couple of species of Leander (family Palaemonidae), which are fished in fairly large numbers on the Bombay coast and in the Gangetic delta, all the marine prawns belong to the Penaeid group (family Penaeidae). The more important species are : Penaeus carinatus, P. indicus, Metapenaeus monoceros, M. affinis, M. dobsoni, M. brevicornis and Parapenaeopsis stylifera. All of them, except the last, have the habit of migrating into estuaries and backwaters in the early post-larval phase of their life-history and, after a period of growth extending over several months, go back into the sea where they become sexually mature and breed. The rich prawn fisheries of these waters owe their existence to this habit.

P. carinatus is the largest species, growing to a length of 10". An individual of this size may weigh well over 5 oz. Though it is found all along the east and west coasts of India, it is seldom fished in large numbers. P. indicus is a slightly smaller species, reaching a length of about 8". It is one of the most important commercial species and is caught in considerable numbers from the sea as well as from the estuaries and backwaters.

All the 4 species of Metapenaeus are much smaller, the largest, M. monoceros and M. affinia, rarely exceeding 6". M. monoceros is adapted for life in water of comparatively very low salinity and is therefore quite common at the mouths of streams and is brackish-water lakes like the Chilka and Pulicat lakes and the backwaters of Malabar. M. brevicornis is reported to be the most common Peneid of Bengal, large numbers of them occurring in paddy fields situated in low lying

areas. M.dosoni is found along both coasts of India and if probably the most important species concerned in the annual prawn fishery of the backwaters of Travancore-Cochin.

Parapenaeopsis stylifera is a non-migratory Penaeid growing to about 4½" in length. It is fished in large numbers along the Malabar coast from November to May; but is scarce during the rest of the year probably because of the comparatively low salinity of the coastal waters.

The fresh-water prawns are mostly species of Palaemon and are found all over the country. Some like P. carcinus, P. idae, P. malcolmsoni, etc. enter brackish water in certain parts of the year, apparently for breeding.

Prawn fishing is mostly done in shallow water, employing various kinds of nets like the boat-seine, wall net, cast net, drag net etc. Large quantities of prawns are caught by means of long conical nets supported on pairs of stakes (Stake nets) in the backwaters and estuaries of the South-West Coast where this is one of the most important methods used for large-scale prawn fishing. It is however, unsuited to areas which are not subject to tidal action. Several hundreds of acres of paddy fields bordering the backwaters and connected canals of the northern half of the Travancore-Cochin State have very valuable prawn fishing grounds. Only one crop is raised in these fields and after it is harvested water from the backwaters and canals, carrying large numbers of prawns, is let into them every day at high tide. Sluices are provided and by closing them at low tide water is prevented from flowing back. Fishing is restricted to a few days in a fortnight when the tides are strong and is done by fixing short conical nets to the sluices and allowing the water to flow out through them during ebb tide. December to April is the season of this fishery.

In the Chilka lake, the Oriya fishermen capture large numbers of prawns by a ring of traps placed at the end of a fence about 50' in length. The efficiency of this device depends on the habit of the prawns of moving along the shore at night. The fence leads them into the enclosure formed by the traps.

Large quantities of prawns are dried, semidried or smoked. There is a considerable export of processed prawns to foreign countries chiefly to Burma.

CRABS.

The commercially important species of marine crabs are Scylla serrata, Neptunus pelagicus and N. sanguinolentus. The first is mostly fished from brackish water, while the other two are caught from the sea also. They occur alo

along with prawns and fish, in the catches obtained with the nets generally in use, though a few are caught by other devices also. Considerable numbers of the two species of Neptunus are caught from the sea along the South-West coast from February to May, while Scylla is fished from estuaries and backwaters in June, July and August soon after the monsoon has started. The largest catches of crabs on the Bombay coast are reported to be from August to October, and, in Madras, the best season is from March to June. In addition to these marine crabs, species of the fresh-water crab Paratelphusa are also caught for human consumption.

LOBSTERS.

Two species of spiny lobster Panulirus polyphagus and P. ornatus and the squat-nosed lobster Thenus orientalis are commercially valuable. The last is rare along the West Coast of the peninsula; but on the east coast, especially from Point Calimere to Cuddalore, they occur in abundance at depths ranging from 10-30 fathoms. The spiny lobsters are caught in fair numbers on the Bombay coast from November to March, using special traps (lobster pots) or by nets like the wall net.

SHRIMPS.

Species of the genus Acetes, which rarely exceed an inch in length, occur in countless numbers in certain months in the coastal waters, when they are caught and marketed.

2. MOLLUSCAN FISHERIES.

The entire littoral and sublittoral zones of the east and west coasts, the innumerable reefs, creeks and gulfs, and the multitude of small and large estuaries and backwaters abound in a rich molluscan fauna, whose potentialities as a source of food and as raw materials of considerable value in commerce and industry, have not yet been fully exploited in this country. In India molluscans are utilized as food mostly by the poorer classes of people.

PEARL FISHERIES.

The true pearl oysters in the Indian waters are Pinctada vulgaris, P. chemnitzi, P. margaritifera, P. anomioides and P. atropurpurea, of which the first named species forms large beds of great commercial value in the Gulf of Manaar, Gulf of Kutch and also Palk Bay. The pearls produced in them have been well-known, from times immemorial, as oriental pearls. The pearl-banks, or

'paars' upon which the oysters live, are situated in 10 to 12 fathoms of water upto about 12 miles from the shore. In the Gulf of Manaar and the Gulf of Kutch the bottom of the pearl-banks is either rocky or formed of dead coral with encrustations of sand, whereas in Palk Bay it is composed of muddy sand. The oysters grow to a size of about 3½ x 4 inches and live not beyond five years. the Gulf of Manaar and Palk Bay they are fished by divers. In Kutch the beds are reached when they are fully exposed during low-water spring tides. Exploitation of pearl fisheries is conducted under state supervision. Millions of oysters used to be fished from the pearl-banks off Tuticorin coast, but at the present time the banks are barren.Even in the past, productive years have been followed by long intervals of little or no yield. The last fishery that was held off the Tuticorin coast was in 1926. Owing to the high expenditure incurred for the inspection of the banks, and to make arrangements for conducting the pearl fishery the loss to the State is enormous if the fishery is not productive. To assure a continuous yield of oysters, measures for the conservation of this fishery are essential.

CHANK FISHERIES.

The chank, Xancus pyrum, is restricted in its distribution to the Indian waters, and a closely allied race, which is sometimes regarded as a distinct species, occurs in the Andaman waters. Chanks are gregarious in habit and occur in large numbers on the muddy sand bottom up to about seven fathoms. They are fished by diving in the Tinnevelly, Ramnad, South Arcot and Tanjore Districts of the Madras State on the east coast, and in Travancore and Kathiawar on the west coast. The chank shells are largely used in the manufacture of bangles, an industry thriving in Dacca (East Pakistan). The rare sinistral shell is priced very high as it is believed to bring good fortune to its possessor. Five thousand rupees is not too much for a sinistral shell of good shape, size and quality.

EDIBLE SHELLFISH FISHERIES.

Oysters, clams, mussels, cockles and a few gastropods and cephalopods are used as food throughout the country. Of the edible oysters, the most important are the backwater oyster, ostrea madrasensis, which abounds in all the estuaries and backwaters of the east and west coasts, the rock oyster, O. cucullata, which is marine and occurrs on rocks all along the entire coast, and the disc oyster O.discoides, of the littoral zone of Sind and Bombay coasts. That the oyster is an excellent article of food has not been realised in this country, and here

yster culture is not practised. The Indian backwater oyster lends itself idmirably to culture on a large scale.

The green sea mussel, Mytilus viridis, occurs along the Madras, Malabar, anara, Cochin and North Travancore coasts. In Cannanore, Tellicherry and Mahe arge quantities are sold in the markets.

The clams, Meretrix meretrix, M. casta, M.ovum and Velorita cochinensis form ast beds in the estuaries and backwaters of the country and are of considerable ood value. Another edible bivalve in the backwaters is Arca granosa. The cockle lam, Circe gibba, of the mud flats in the shallow waters of Kundagal point near amban and of Palk Bay near Mandapam and Rameswaram, where it occasionally occurs n thickly populated beds, is extensively fished by the local population. Donax uneatus, and D. scortum from the wave-beaten sandy beaches all over the coast, esodesma (Paphia) glabratum from the intertidal zones of the islands of the Gulf f Manaar, species of Tridacna from the reefs, Cardium, Solen and Tapes from the ittoral zones are some of the other bivalves occasionally used as food whenever hey occur in large numbers. Of the fresh water bivalves, only the mussel finds avour with some as an article of food.

Of the marine gastropods, Xancus pyrum, Pterocera lambis, Oliva gibbosa, urbo marmoratus, Thais bufo, Thais rudolphi, Umbonium vestiarium, Tonna dolium nd species of Melongena, Natica and Strombus are utilized as food. The meat is sually extracted out of the shells after boiling the animals and used in curries; n the chanks it is removed with a knife in the fresh condition, sliced and dried or future use. The land snails are not known to be eaten in this country, and f the fresh water gastropods only the apple snail, Pila globosa, is utilized for his purpose.

Among the cephalopods, the squids of the genus Loligo, the cuttlefish Sepia, nd the devil-fish Octopus are of value as food, more particularly in the Ramnad istrict of the Madras State where they occur in abundance in the Palk Bay.

LIME FISHERIES.

In the coastal districts where limestone deposits are rare, the only sources f lime are the corals and shells of molluscs, of which the latter yield the best ıality of lime used in the construction and upkeep of buildings and other masonry)rks. From the estuaries and backwaters, considerable quantities of shells are ıthered of which the major part is composed of Venerid bivalves and Cerethidea.

A small amount of shell is collected from the surf-beaten sandy beaches of the entire coast. By far the bulk of the shells comes from the sub-fossil deposit as in the Pulicat lake near Madras, Surla near Ichapur, Vembanad lake in Travancore, and Tuticorin. The deposits occur in thick layers several feet be the surface and consist of a variety of shells, such as Xancus, Rapana, Murex, Cerethidia, Natica, Umbonium, Thais, Tonna, Arca, Cardita, Placenta, Meretrix, Pectunculus etc.

3. SEAWEEDS.

The Sunderbans, the Chilka Lake, the deltas of Godavari and Kistna, the rocky shore of Vizagapatam, Pulicat Lake, the rocks of Mahabalipuram, the estua of other southern rivers, the relatively calm Palk Bay, the turbulent Gulf of Manaar with islands fringed by coral reefs and many other areas in India are ri in algal growth. Many of the dominant species are brown or red algae of consid able economic value.

During World War II, agar was needed for medical and public health work, the cutting off of imports from Japan gave the impetus for marchalling our agarophyte resources. Thus in 1940, agar was for the first time processed in India simultaneously at the Labortatory of the Scientific and Industrial Resear Board, Delhi, and by the Department of Research of Travancore. The results were encouraging, considering how difficult it was, then to obtain filter-aids, free plants, and other machinery for the purpose. When peace returned, imports of ag came from the United Kingdom where agar had been made on a commercial scale duri the war; more recently imports from Japan have restarted, but the supply of agar is still insufficient, for Japan is now using the major portion of the output fo food purposes.

Research on the resouces of agarophytes in India, carried out at the Centr Marine Fisheries Research Station, Mandapam, has brought to light the fact that Gelidium micropterum which had been overlooked in previous work on agar manufact is a very valuable source. This seaweed is prolific on the coral reefs on the Pamban area and is probably found on all other coral reefs near the Indian shore and in the Laccadives and Andaman Islands. In the Pamban area fifteen other species of red algae, including Gracilaria have been shown to be sources of agar

The weight of fresh Gracilaria that could be collected from the Chilka Lak during the year 1946 was estimated to be 100 tons. The total annual tonnage of

all the agar-yielding species of the Pamban area also is roughly calculated at 100. The total resource of India may possibly be 3000 tons, which represents 12 tons of agar or about one-third the tonnage imported from Japan in 1937. The estuarine species of Gracilaria and Hypnea will give additional tonnage, and, further, they can be artificially propagated.

Work on the brown seaweed, Sargassum, shows that the Coromandel Coast, Travancore and the Kathiawar Coast have considerable resources of the seaweed, that of the last (taking into account only the seaweeds cast up on the shore) being roughly estimated at 100 tons per annum.

Experiments on algin extraction from the brown seaweeds are in progress at the laboratory of the Madras Government Fisheries Department at Krusadai I., in the Gulf of Manaar. Experiments on seaweeds as fertilizer, conducted by the same department, showed that Sargassum, Turbinaria and Gracilaria, composted with fish offal and shark-liver oil sediments for three months, yielded an "above average" fertilizer.

In Japan the relatively crude gel of Gracilaria and other agarophytes is extracted and used in various foods. G. lichenoides and G. crassa are occasionally used on the Coromandel Coast also in food preparations. An abundance of vitamins has been demonstrated in Porphyra, a red alga eaten especially in Japan and China but also found in considerable quantities in certain parts of our coast.

Part III - Research

9

PROBLEMS OF FRESHWATER FISHERIES.

Since the freshwater fisheries of India already yield a large crop, both in respect of bulk and value, the solution of its various problems is bound to ensure a substantial improvement in the matter of food production. The available statistics do not show the enormous quantity of fish caught from small streams, ponds etc., scattered all over the country, which is mostly consumed locally. Though the marketable surplus of freshwater fish in India was estimated in 1948 at 29% of the total production of 142.1 lakh maunds, its value was Rs.92.7 million, against Rs.86.8 million of the remaining 71% of marine and estuarine production.

The inland waters of India, excluding Andamans and Nicobars, fall mainly into the following five geographical systems, as shown in the accompanying map.

i. The Ganga system, one of the greatest river systems in the world, drains the southern slopes of the central Himalayas and covers the Uttar Pradesh West Bengal and portions of Bihar and Madhya Bharat. The rivers of this system have a combined length of about 5000 miles + and a catchment area of about 3.75 lakhs of square miles, with a rainfall ranging from about 25" to 77" (average 43") and an average annual run-off of about 20" and 397 million acre feet. Lying between the Indus and the Brahmaputra system, it embraces various types of freshwater habitats from the icy-cold Himalayan streams to the warm waters of the plains. There are numerous lakes and ponds and jheels both perennial and seasonal, some at high elevations like the Kumaon lakes. This system contains the richest freshwater fish fauna in India, ranging from the mahseers and loaches of the hill streams to the culturable carps, prawns and other fishes of the plains.

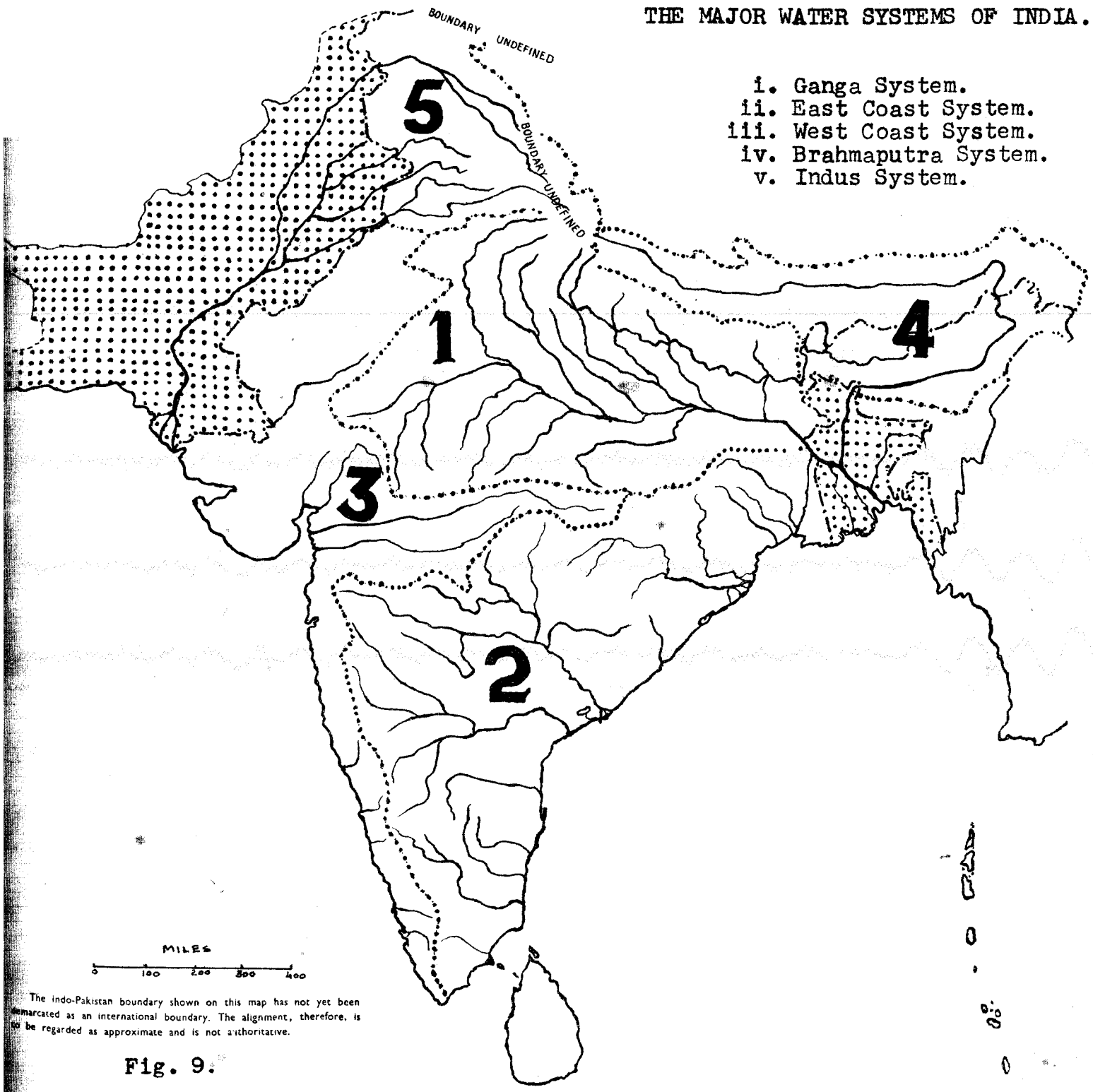
ii. The East Coast System drains the whole peninsular India east of the Western Ghats and the Southern Section of the Mahadeo Hills and Maikala Range of Central India and the Chota Nagpur Hill range, right up to the branching of the Bhagirathi (Hooghly) from the Ganges. The rivers of this area, excluding those shorter than 200 miles, are about 6400 miles in total length. The total catchment area of the region is about 4.7 lakhs of square miles and the rainfal

+ These figures have been kindly furnished by the Central Waterpower, Irrigatio and Navigation Commission.

Plate 8

THE MAJOR WATER SYSTEMS OF INDIA.

i. Ganga System.
ii. East Coast System.
iii. West Coast System.
iv. Brahmaputra System.
v. Indus System.



The Indo-Pakistan boundary shown on this map has not yet been demarcated as an international boundary. The alignment, therefore, is to be regarded as approximate and is not authoritative.

Fig. 9.

The freshwater fisheries proper relate mostly to the perennial and seasonal inland waters above the tidal influence of salinity. Rich and varied in nature, they comprise chiefly the major carps such as Catla, Labeo, Cirrhina, Barbus etc., Catfishes like Wallago, Silonia, Mystus, Pangasius, Bagarius, Callichrous, Eutropichthys, Rita, etc., air breathers like Ophicephalus, Anabas, Heteropneustes, Clarias, etc. featherbacks such as Notopterus, certain euryhaline fishes like Hilsa, Setipinna, Mugil, Etroplus etc. freshwater prawn Paleamon, and a few exotic and miscellaneous species including eels, minor carps etc. The problems of the freshwater fisheries of India are typical of an industry that is very old and has yet remained restricted to certain traditional practices. These problems fall under two categories, viz., those relating to conserving, enhancing and harvesting more fully the natural fish corps in rivers, canals, lakes, reservoirs etc., and those dealing with fish farming in smaller confined waters.

NATURAL CROP.

Conservancy.- Conservancy measures based on certain general observations have been attempted in some parts of India as in the Godavari and the Cauvery, including the Nilgiri waters, in Madras; the Kabbani, the Thunga, the Palar and the Cauvery in Mysore; the Beas, the Ravi and the Sutlej in the Punjab and the High Range waters in Travancore-Cochin. Some of these attempts have succeeded to a certain extent, but they have not been really effective, as our knowledge about the actual nature and extent of crop fluctuations, possible depletion and the species biology, with special reference to the breeding habits and the migratory movements of the fishes, is still incomplete. Further, in addition to biological information, particularly about the movements of fishes between their natural habitats and the restricted summer pools, dam aprons and other areas of congregation, collection of a large mass of accurate statistical data about various aspects of freshwater fisheries is necessary before suitable measures of conservancy can be formulated. Some efforts at gathering inland fishery statistics have begun to be made by some of the State fishery departments and the Central Ministry of Agriculture, but on account of the magnitude of the task, the widely scattered nature of the crop and the paucity of collecting personnel, progress so far achieved is somewhat meagre.

Protection of the freshwater fisheries from the effects of pollution due to industrial waste and Municipal sewage is another measure of conservancy

which has not yet received due attention in India. With increasing industrialisation of the country, this problem has begun to assume a serious proportion. A special Committee of the Indian Council of Agricultural Research appointed in 1944 recommended that definite data be collected on (i) the location of the centres of pollution, (ii) the factors responsible for pollution and (iii) the effects of such pollution on the fisheries of the area. Some information on the first of these has now been gathered from different State Departments. Distilleries, paper mills, textile mills, sugar mills, cement factories, iron and steel works, cinchona factories, glue works etc. are reported to be the major sources of pollution through industrial waste in a large number of States. The range of pollution, the injurious principles involved and the extent of their adverse effects on the fisheries have all to be studied, at least in the more important cases, before any remedial measures can be formulated. The possible transmission of diseases through the agency of fish affected by sewage is another problem requiring investigation.

The effects of dams on fisheries is a subject which has gained special importance with the formulation of several multi-purpose river projects in India. For fishery requirements, the need for the provision of fish passes, lifts etc., in the construction of the dams and wiers, clearance of boulders and tree trunks from the prospective reservoir beds, adjustments in the manipulation of sluices and regulators, etc. has to be carefully examined. In this connection a thorough knowledge of the feeding and breeding movements of at least the more important fishes in the area, their leaping capacity, the hydro-dynamics in the region, the value of the fishery resource of the river system likely to be affected by the dam, the economics involved and a host of other problems is necessary. Preliminary biological investigations in connection with the Hirakud and Damodar Valley projects have been started by the Central Inland Fisheries Research Station.

Enhancing.- In addition to enriching the natural crop by protective measures, it can also be enhanced by regional stocking as has been proved by the introduction and establishment of the Catla from its sources in the north into the Cauvery system and of the exotic forms such the Mirror Carp and the Trout in the Nilgiris, etc. Recent observations on the occurence of the Mrigal and the Rohu in some of the peninsular waters have indicated the possibility of the extension of these fishes in the waters of the south.

Efforts at augmenting the fluviatile crop through artificial hatcheries has not revealed any tangible results in the case of Hilsa. Artificial hatching of major carps on a large scale has not been successful so far, but minor carps have been found to respond well to articicial propagation. At present the work of any importance in this line is virtually confined to the trout, which is cultured for sport.

Regional manuring in streams and lakes has not been practised in India, with the exception of stray attempts at dumping bones and corals in the Nilgiri rivers with a view to increasing the calcium content of those upland waters.

Fuller harvesting. Apart from certain regions of the hillstreams and other riverine areas which may not be easily accessible, many deep inland waters are a problem for the fishermen. Weedy waters and those with submerged boulders and dead tree trunks are particularly difficult to fish. Deep water fishing experiments with modifications in local implements, like the night line and the introduction of new implements, such as the Rangoon net, Oosavalai, etc. have led to some increase in catch. Effective fishing methods have, however, still to be devised for the different kinds of deep and difficult inland waters with due reference to the substratum, depth, contour, flow, weedage and the fish species concerned.

FISH FARMING.

Seed. - The supply of fish seed obtained from the small number of known riverine fry collection grounds and 'bundh' type of tanks is inadequate to meet the seed demand which is rapidly increasing with the expansion of fish culture among public and private bodies. As a result of the partition of the country, the majority of fish seed collection grounds are now in East Pakistan, and the seed problem has become so acute in India, that the price of spawn rose to Rs.502/- per kunka + in 1950. Bengal and the adjoining areas are practically the only part of India where a regular fish seed trade has existed from ancient days. Of late, efforts have been made to discover and exploit local sources of seed in other States also, specially in Orissa, Madras, Bihar, U.P. and Delhi. In the Bengal area, the practice is to collect eggs and larvae of major carps from rivers and to some extent from 'Bundhs' and transport them to

+ Measure employed in West Bengal and some other States, generally containing approximately 1,00,000 spawn.

stocking tanks and other waters, usually after a period of care in nurseries. Considerable quantities of spawn, fry and fingerlings are now exported from Bengal to meet the requirements of other States like Madhya Pradesh, Bhopal, Hyderabad, Bombay and Tripura. In places like Madras and Orissa, fingerlings are collected instead of, or in addition to, fry.

Unfortunately, some of the methods employed in the seed trade are exceedingly wasteful; sometimes the majority of the seeds perish in the course of the operations. As much as 95.7% mortality was reported last year from the Zobra Farm in Orissa. An analytical study of the existing practices and a series of laboratory and field experiments have revealed that this high mortality is the cumulative effect of faulty methods of collection, conditioning, transporting and stocking etc. By the application of suitable methods, it has been possible to reduce the mortality by nearly half.

Transport of fish seed and seedlings has become a problem of immediate importance, especially since distant States have begun to indent for fish seed on West Bengal and other seed yielding areas. Aeration in the "Thuma" type of live fish transport truck is satisfactory for short distance road transport, but is expensive both in capital cost and running charges. A cheap and handy adaptation of this type of aeration has been successfully worked out in Orissa. Transport by air and rail over long distances has been attempted at Barrackpore, and over ten lakhs of fry have been thus despatched during the last season from Calcutta to Madhya Pradesh, Bhopal, Hyderabad, Tripura and Bombay. While sealed oxygen containers have been found to be of considerable help in reducing mortality during transport, the technique has to be perfected, so as to ensure maximum survival and economy in long range transport.

Side by side with improvements in the methods of collection and transport, etc. of fish seed, sources of seed supply have to be greatly extended in order to cater to the increasing requirements of stocking. While, through survey work, new fields are gradually being added to the collection grounds of spawn, fry and fingerlings, the essential conditions of spawning are still imperfectly known. After the necessary conditions for spawning in the actual spawning grounds have been fully understood, it may become feasible to construct breeding 'bundhs' for augmenting seed production.

The use of saltwater fish seed for culture in freshwaters has been tried

in some parts, but still remains to be systematised. The cultural possibilities of saltwater fishes like Pearlspot, Chanos and Mullet in freshwater have yet to be taken full advantage of and their farming requirements worked out in detail. As mullets have been found to stand direct transfer to water that is nearly fresh, their extensive seed grounds in the coastal areas need to be fully exploited.

Another problem relating to fish seed is the recognition and separation of seeds of various species. Not only have seeds of predaceous fishes and of uneconomic forms to be eliminated, but the different culturable species should also be distinguished in their early stages and segregated for selective stocking in proper combinations. While considerable amount of information on the distinguishing characters of young stages of our fishes is available, a simple and reliable key for the use of the fish farmer in the field is an urgent necessity. Some experiments in timed skimming of seeds in lots, as commonly done in China, carried out at Barrackpore have indicated the possibilities of segregating different species with reference to their different oxygen requirements and other hydrological needs.

Survey of Cultivable Waters.- An essential step towards the extension of fish culture in the country is to take proper stock of all our actually and potentially productive waters. Statistical information on the cultivable waters of India is at present meagre, though efforts at systematic survey of inland waters have begun to be made in a number of States, notably Madras and Orissa, where elaborate forms for collecting the necessary physical, hydrobiological and other data are being used. The Fisheries Statistics Committee of the Central Ministry of Agriculture has devised standard forms and suggested means for carrying out a general survey of this nature on a uniform basis throughout the country.

Preparation of waters.- A good deal of general information has become available on the factors of aquatic productivity and fishery requirements in ponds, but the optimum conditions to be promoted and maintained in each kind of water, with regard to its hydrological factors have still to be worked out. In farming practice, very little is done towards the preparation of waters before stocking, nor is much attention paid to the maintenance of suitable conditions after stocking. Predatory fishes are generally netted out prior to

stocking and a small quantity of organic manure is sometimes added to promote plankton growth.

Stocking. - As a number of species of major carps are generally stocked together, the proper combinations of suitable species and their desirable densities are matters of considerable importance. Though certain combinations and proportions are already in vogue and a few others have been suggested by some workers, there is great need for experimentation in this direction.

Pond upkeep. - While a piece of water is usually over-stocked to begin with, the crop is regulated by timely thinning out as the fishes grow in size, and by introducing fresh juvenile stocks whenever necessary. This regulation of numbers requires much discretion, as on that depends the possibility of obtaining yearly more than one harvest, especially from perennial waters.

One of the most vital problems of pond upkeep is that of fish food, and care is needed to maintain the aquatic food chain continuous. Though in West Bengal and some other States, adequate nutrition is provided for the crop directly and indirectly by the selective use of farmyard refuse and other organic manures, in many other parts of the country no manuring is done. Chemical fertilizers are seldom used, though experiments on their use in different doses and combinations, in connection with brackish water farming are being tried in Travancore.

The potentialities of sewage and night soil as aquatic manure and fish food, which have been well proved in China and have also been indicated by encouraging results in stray attempts in India, have yet to be tried on a large scale in this country.

10

PROBLEMS OF MARINE AND ESTUARINE FISHERIES

Introduction

The problems confronting the marine fishery investigator in India are mainly those inherently connected with the geographical and oceanographical features of the Indian coast, the physiological conditions prevailing in the tropical seas as against the temperate zones and the rich and varied nature of the tropical marine fauna. The ultimate aim of all fishery research is to find means of increasing the available supplies of fish. The gap between the collection of scientific data on fisheries on the one hand and their application to direct practical use is unfortunately large; the procedures of fact-finding and implementation are slow and often unimpressive in proportion to the vastness of the problem. Organized attempts at scientific studies on Indian marine fisheries date only from 1947, although investigators at several centres, notably Madras, have worked on subjects of local interest. On most aspects of Indian marine and estuarine fisheries, scientific information is deficient or non-existent, excepting a knowledge of the predominent species that comprise the catches.

Fisheries of East & West Coasts.

The fisheries of the West and East Coasts of India are strikingly different as judged by the yield of the narrow inshore belt, not exceeding 5-7 miles from the shore, which is all that is fished at present. About two-thirds of the total landing comes from the West Coast, where the water masses are of an oceanic character and are influenced by the Bottom Antarctic Drift as well as by the Somali Current which moves northwards from the coast of East Africa and sweeps round at the head of the Arabian Sea and moves down along the West Coast of India. It seems likely that the productiveness of the West Coast fisheries is brought about by the nutrient salts carried by these currents and the upwelling of coastal waters under the influence of the strong South-West Monsoon Winds. The East Coast of India, on the other hand, with the numerous large rivers opening into the Bay of Bengal and with the large number of tidal creeks, salt marshes, inlets and the two large coastal lakes, the Pulicat and Chilka, with feeble monsoon winds and less pronounced oceanic circulation, presents conditions which are very different. The marine and

estuarine fisheries are consequently different in composition from those of the West Coast.

Principal Fisheries of the different coastal zones.

West Coast. Notwithstanding the broad demarcation mentioned above, the fisheries of either coast are not uniform in character throughout the length of each coast. This could be seen from the following enumeration of the chief bio-geographical zones as understood from the fisheries point of view. Starting from the North Western part of India, the Coast of Kathiawar has, in common with the Pakistan coast, an extremely valuable fishery of Scienids or Ghols, which appear in large numbers at certain seasons of the year, considerable landings of Polynemids or Rawas, Clupeids and sharks and rays. The Gulf of Cambay and the strip of the coast north of Bombay share many features with the Kathiawar Coast, but owing to the influence of the Narbada and Tapti there is a development of the estuarine fisheries as well and, further down, the fishery for Bombay Duck, Harpodon nehereus, is well marked. Both the Ghol and Bombay Duck are not pelagic in the sense we understand the mackerel and sardine fisheries which are best developed to the south of Bombay. The Konkan Coast is noted for the mackerel, Rastrelliger kanagurta, enormous shoals of which appear during the October-January period. Mackerel is a most important fishery throughout the West Coast of India from the Konkan to the Travancore Coast, but shoals are not encountered to the south of Quilon. On the Kanara and Malabar Coasts, the mackerel, although important, is partly eclipsed by the Clupeoids- more particularly the oil-sardine of Malabar Sardinella longiceps, and the related forms Sardinella fimbriata, Kowala thoracata, and species of anchovies. Several Carangids, Cynoglossids (Cynoglossus semifasciatus), sharks and rays also contribute to the high annual yield of the Malabar Coast. Polynemids and pomfrets are found in considerable numbers throughout the West Coast. The prawn fisheries, composed of Penaeids are also well developed in the coastal belts of Malabar, Bombay and Travancore-Cochin. The general features of the Malabar Coast, with a rich productive season during the period September-February and a lean season during the following months ending in total inactivity during the monsoon months, June to August, are in evidence up to about fifty miles north of the Cape Comorin the southernmost point of India.

The pelagic fisheries composed of sardine and mackerel disappear in the Comorin area but their place is taken by midpelagic or demersal species, mostly perches (species of Serranus, Lethrinus), pomfrets (Stromateus spp.), the butter fish (Lactarius lactarius), sharks, rays and species of Cybium in considerable numbers. The Wadge Bank near the Cape is one of the richest fishing grounds for percoid fishes and may well prove to be a lucrative trawling ground like some of the waters off Ceylon.

East Coast. The Cape area has much in common with the East Coast between the Cape and Point Calimere, where the fisheries are composed of numerous species, each contributing to a small scale fishery consisting of Silver Bellies (Leiognathus spp.), pomfrets (Stromateus spp.) and Carangids (Caranx spp.). The waters of Palk Bay and Gulf of Manaar have considerable yields of Belone and Hemirhamphus and the smaller Clupeoids Dorosoma, Stolephorus, Dussumeria and Sardinella and the large Clupeid Chirocentrus dorab. High yields are noticeable in this area of numerous perches of the genera Lethrinus, Serranus and species of Cybium. The waters between Tuticorin and Point Calimere are noteworthy in the possession of extensive chank beds, which yield a lucrative and unique fishery, as also the pearl cyster in the Tuticorin area. The Palk Bay is a valuable fishing ground with considerable resources in leiognathids, elasmobranchs, cybiids, clupeids, and carangids but the fisheries do not appear at present to be exploited adequately. From Point Calimere to Adirampatnam there are good grounds for sharks and rays and, during June to August, shoals of flying fishes appear off the coast of Nagapattinam and Cuddalore. In the same area there are also unexploited fishing grounds for perches and the lobste Thenus. From Madras to Vishakapatnam, the biggest shoaling fishery is that of the hair-tails or species of Trichiurus. This important area on the East Coast is also noted for Cybium, Leiognathus and Lactarius. The Andhra Coast appear to have numerous valuable grounds for shark fishing, especially to the south of Kakinada with considerable yields also in Engraulis, Pellona and Stromateus. Between Godavari and Ganges, there are numerous small-scale fisheries, the predominent forms being species of Pellona, Sardinella, Engraulis and Stolepho with subsidiary fisheries of species of Arius and Cybium. On West Bengal and Orissa Coasts, Hilsa also appear in large numbers.

The most noteworthy feature of the East Coast marine fisheries seems to be the absence of large shoals of mackerel and sardine, although small numbers of them are noticed; their place seem to be taken by the less valuable clupeoids, horse mackerels and leiognathids.

It will be obvious from this survey that the fisheries of the East Coast, which now yield only about a third of the total, are more diversified in character than those of the West. It is probable that the smaller output is correlated to socio-economic factors- not least of which is that the West Coast fisherman is a better seaman and that conditions of transport and utilization are not as well developed as in Malabar. While the West Coast will be suitable for industrial exploitation of fewer fisheries like the clupeids, mackerel and prawns, the East Coast would, if developed, substantially increase the supplies of sea fish for consumption in the fresh state.

Estuarine Fisheries.

Euryhaline groups of fishes are of great importance throughout India but more on the Eastern Sector. The mullets, which include numerous species of Mugil, are essentially coastal forms which are highly adaptable and are often found in estuaries; the bulk of the fisheries of the Chilka Lake is contributed by mullets. These, and the well known Clupeid Hilsa and the percoid Bhekti (Lates calcarifer) are of great value in the Deltaic system of the Ganges-Brahmaputra, as well as at the mouths of Godavari and Kistna. There are several other clupeoids which thrive in the estuarine waters of the Ganges. The estuarine regions, backwaters and the coastal lakes also provide nurseries for the quick growth of young prawns of the Penaeid group, giving high yields in the Pulicat, Collair and Chilka Lakes and in the Sundarbans area of Bengal. Crab fisheries, mainly consisting of Scylla serrata, and Neptunus spp. are also valuable in estuaries and lakes.

Special Problems of Tropical Fisheries.

Fisheries Science having developed largely on the basis of work carried out in countries where the winter and summer periods in the sea are sharply demarcated, many of the well known tools of research utilize the effects on fishes of the dormant period when growth is arrested owing to inactivity of absence of food organisms. It remains to be established as to what extent credence could be placed on growth rings observed on scales and otoliths in

tropical waters. Similarly, owing to the high, and uniform temperature, fairly steady supply of food throughout the year, extended spawning periods and high rate of growth, it is with considerable difficulty that year classes could be separated and the rate of annual recruitment to stocks determined as a guide to the estimation of total populations. These factors, combined with the fact that in several fisheries instead of a single fish, many closely related species are involved, which even the trained systematist often finds difficult to separate in the younger and juvenile stages, have created problems not encountered in the colder seas. At the present time, an appreciable part of research effort has to be directed to the development of suitable procedures to tackle the problems presented, in addition to the framing and studying of individual problems. The taxonomist, whose interest is in species, will find a wealth of material in the rich fauna of India, but it has added difficulties to the fishery worker. Investigations on plankton, analysis of bottom fauna and evaluation of organic production in the sea are all rendered difficult by the multiplicity of organisms, both plant and animal. Correct understanding of populations contributing to fisheries, as to whether they are widely distributed or local, would help a great deal in deciding whether there is any danger of overfishing; any measures for the conservation of fisheries, that may be necessary, can only be based on full knowledge of the biology of the fishes involved. In all this work we have made only a beginning.

Scientific Exploratory Fishing.

In India, the development of marine fisheries at the present time is primarily one of increased exploitation of the resources already existing in nature. But it has to be made sure that such expansion of effort will not adversely affect the stock as has occurred in many parts of the world. Our idea of these resources at present is purely based on the fishing carried out in the inshore waters, where there are already complaints in certain areas that there has been large scale diminution in stock, but it is not now known whether such fluctuations are natural or produced by intense local activity. To begin with, existing production has to be closely studied in relation to the effort expended so as to formulate ideas regarding regions which could be more intensively fished than at present even by the extended use of indigenous

year. There is every reason to believe that the present inshore stock of several fisheries is coextensive with regions at present untapped. One of the urgent needs is to carry out exploratory fishing in the areas immediately outside the present zones of fishing, eventually leading to the charting of the fishing grounds, so that commercial ventures could rely on the availability of fishes in definite areas at definite times of the year. This is all the more necessary since the bulk of the commercial species are pelagic and seasonal. Full knowledge of their distribution, movements, factors governing the movement of shoals and estimates of abundance of their populations are essential so that organisations started for large-scale exploitation will not be faced with lack of adequate supplies, but will be able to follow a working plan which would reduce periods of inactivity to the bare minimum. This is particularly so with forms which promise to develop into large-scale industries like the sardines, the mackerel, and the prawns, all of which are fished in quantities far in excess of local demands and at the same time can give satisfactory canned products.

High Sea Fisheries.

The discovery and utilization of high sea fisheries, like the tuna and the swordfish, will contribute substantially to increased production as shown by the history of these fisheries in the Pacific. Small tunnies, probably species of Euthynnus, are landed in several places in both East and West Coasts of India, more particularly on the Malabar and Travancore coasts. A few hundred miles away, around the Laccadives and Maldives, large populations of tuna are believed to exist and are partially utilized. Nothing is at present known accurately of the different species, races and populations that contribute to this fishery.

Untapped Resources.

The discovery of untapped off-shore resources will be of practical benefit only when means of utilizing them by efficient mechanized methods of capturing and bringing them ashore in good condition are available. But information on habits and movements of fishes along the coast would be useful for increased exploitation even with the existing gear by the introduction of untried methods which will tap a usually untouched ground in any area or by the application of

existing methods in what is normally off-seasons for fishing owing to frailness of craft. Introduction of small scale mechanized craft, which would enable these variations on the existing methods to be practised without considerable capital outlay, may be expected to augment the supplies considerably in addition to throwing new light on the biology and habits of these numerous species. This type of work appears particularly necessary for the east coast of India where there is urgent need for a close study of the fisheries now considered as only of small-scale importance.

Hydrology.

Our knowledge of the water masses of the Indian coasts and their movements is extremely meagre and, at present, it is not possible to correlate these with the fisheries. Extensive studies on the hydrology of the Indian Ocean would help in the study of both on-shore and off-shore fisheries but this is a line of work which cannot extensively be carried out without research vessels. Data relating to coastal waters at Mandapam and Calicut are now being obtained and it is hoped to extend this work to many other regions of the Indian coast through the cooperation of the Naval Vessels patrolling Indian seas.

Plankton Productivity.

It is widely held that the productivity of tropical seas is low as compared with the temperate waters owing to the low percentage of available nutrient salts which supports only a poor plankton. The data obtained for coastal waters indicate reasonably high values of phosphates and nitrates with well marked seasonal variations contributing to diatom-maxima and occasionally to unusual increase in organisms inimical to fisheries like Trichodesmium and Noctiluca. The inshore waters, at any rate, could be expected to support a rich plankton contributing to productive fisheries and it seems probably that areas of high biological productivity exist in both the Bay of Bengal and the Arabian Sea, opposite the mouths of large rivers bringing into the sea large volumes of fresh water and with it both in organic and organic nutriments. Similarly, it may be expected that valuable fishing grounds exist in areas of oceanic or coastal upwelling or vertical mixing which bring nutrient-laden waters to the surface.

The low productivity usually attributed to tropical waters probably needs re-examination as has been pointed out by a few recent workers, because the

distinction which is based on standing crops of plankton is more apparent than real if the rate of organic turn-over for the whole year is taken into account. An integrated programme of plankton and hydrological investigation in relation to fisheries becomes necessary as also the aspects of plankton studies to correlate the presence of certain organisms as indicative of factors influencing the fisheries. Researches in this connection have already been initiated.

In many estuarine fishes, like Hilsa, the fisheries problems are complicated by factors affecting the physiology of species during the various stages of life history, probably affecting their migratory movements. The main points connected with estuarine fisheries are dealt with in another Chapter.

Marine Fish Farming.

Increased fish production through marine fish farming, utilizing the fallow coastal lagoons and salt marshes, is a distinct possibility that deserves study. The earliest phase in such practices is the utilization of marine fry for stocking the coastal areas, captured by simple trapping during favourable tides and employed in the prawn cultivation in the paddy fields of Travancore-Cochin. The next stage in development is the collection of fry from the sea in such seasons as are favourable and stocking them in coastal waters until they are grown to appreciable sizes and are ready for the market. It is on these lines that the culture of Chanos chanos is developing. The practice of collecting favourable fry and stocking them could, with advantage, be extended to the penaeid prawns, more especially to species of Metapenaeus which survive diminution in salinity much more than the related Penaeus indicus and P.carinatus, equally suitable for cultural purposes. Many Mullets could likewise be employed, but more details of species and degrees of tolerance are badly needed. Success in fish farming operations depends upon the correct selection of species to suit the peculiar physical and chemical conditions under which farming is carried out. The chief factors concerned appear to be temperature and salinity and the species chosen should be both euryhaline and eurythermal. In Chanos chanos, these characters are fortunately combined but a great limiting factor in this species is the dependence on naturally occurring fry for stocking purposes, which are available only in certain seasons in restricted areas of the coast. Further exploration of sea fry resources for stocking is an urgent necessity. In the matter of marine fish farming a clear

picture of the fauna and flora of the coastal areas and the physiology of the organisms would be of great value.

11

MARINE FISHERY PROBLEMS OF THE WEST COAST

INTRODUCTION.

The marine fisheries of the West Coast are among the most important in India. A large proportion of the population is either directly engaged in fishing operations or employed in one of the subsidiary industries. Any visitor to the coastal area, especially to the rural parts, will be struck by its intense fishing activity. Yet, judged from modern standards, the fishery is in a very backward condition and there is great scope for stepping up fish production along the coast if suitable measures are undertaken.

RESOURCE.

The West Coast fishery has a coastline of about 1,500 miles from Cape Comorin to the north of Kutch and the fishable area on the continental shelf up to the 100-fathom line may be roughly estimated at 65,000 square miles. The continental shelf slopes gradually outwards and is much wider than that on the East Coast. The fisheries along this coast vary considerably from region to region in respect of the species of fishes, their relative abundance, the physical nature of the sea, nature of sea bottom and in the fishing methods practised. On these considerations, the West Coast fishery may be broadly divided into three zones: (1) Travancore Zone, from Cape Comorin to Cochin (about 200 miles), (2) Malabar - Kanara Zone, from Cochin to Malvan (about 350 miles) and (3) Bombay Zone, from Malvan to the north of Kutch (about 950 miles). The sea along the Travancore and Bombay coasts, being open sea, is comparatively rough while that along the Malabar-Kanara coast, which is a part of the Laccadive sea, is calm, except during the south west monsoon months. The fishery of the Malabar-Kanara zone is comparatively more productive than those of the other two zones. The richness of this fishery is mainly due to the presence in this area of two commercially important shoaling species, the oil sardine and the mackerel. The oil sardine, which once formed a very rich fishery along this coast, has been practically non-existent as a commercial fishery for the past few years. There are, however, signs of its recovery indicating the recurrence of its cycle of abundance. The deficiency caused by the failure of the oil sardine

fishery has been made good by increased yields from the mackerel fishery.

PRESENT POSITION OF THE FISHERIES AND THE FISHING INDUSTRY.

Though the West Coast fisheries are vast and rich, the present level of fish production is low. The fishing operations are at the level of a cottage industry, as fishing effort is confined to a very narrow strip of the sea, from the shore to about 10-fathom line, a distance of only 5 to 6 miles. Fishing in the inshore area is well organised and has practically reached maximum efficiency consistent with the craft and gear used. The practice of the fishermen has been to wait for the fishes to come to the inshore area and not to go after fish shoals in the open sea. Both the catamaran of the S. Travancore Coast and the dug-out canoe of the Malabar-Kanara Coast are small, light boats which are operated with oars and sails. There is hardly any working space on them and they are unsuited for staying out on the sea for more than a few hours. Each of these boats requires six to seven persons to operate it and often much time and energy are spent in rowing it to and from the fishing ground. On the Bombay Coast, the fishermen go a little farther in larger Ratnagiri boats to conduct drift-net fishing. In Malabar, long line fishing is done to some extent for sharks, rays and catfishes in 16 to 20 fathom area whenever the winds are favourable.

Several types of nets - boat seines, shore seines, large drift nets, gill nets and cast nets - are used along the coast. In Malabar particularly there is a special net for almost every type of fish. These are quite efficient for small-scale fishing and well suited in relation to the crafts used. The fishermen are robust, hardy and possess a good knowledge of the fishes, the fishery conditions and the seasonal changes in the physical conditions of the area of the sea where they fish. Economically they are better off than those on the East Coast, but most of them are indebted to the capitalist money-lender who generally owns the boats and who keeps them under his control by a system of advance payments.

About 50 to 60 per cent of the fish caught is utilized in fresh condition and the rest is sundried, salted and sometimes converted into manure. All along the coast there is a ramification of distributional organisation for the supply of fish to markets for a distance of about 10 miles from the

coast. The method of curing varies from place to place. The fish salted and dried in the Fish Curing Yards of the Madras and Bombay States are known to be of better quality than that cured by fishermen outside the Yards. During the months of October and November, when fishing is good, a number of instances of large scale fish spoilage have been noticed. This is partly on account of the inability of the fishermen to handle large quantities of fish and partly due to the north-east monsoon rains hampering the sundrying of fish. Efficient shore organisations for the handling, assembly, transportation and marketing of fishes are generally absent.

In recent years efforts have been made by the Madras and Bombay Governments to improve the socio-economic conditions of the fishermen and to organise the fishing industry. A large number of fishery schools, fishermen's co-operative societies and fish curing yards have been established along the coast. There are at present about 50 carrier launches in Bombay transporting fresh fish from the far off fishing grounds to the Bombay markets. This has greatly stimulated the production of fish in that State. The Government of Madras have under execution, with financial assistance from the Central Government, a number of schemes for distribution of yarn, sail cloth and timber for boat building among fishermen at subsidized rates, building of small sized, suitably designed power vessels for fishing operations and for sale of salt in the Fish Curing Yards at cheap price in order to bring about improvement in the curing of fish. Two cold storage plants, one at Calicut and the other at Mangalore are being constructed.

CAUSES OF BACKWARD CONDITION OF THE FISHERIES.

The chief causes of the backwardness of the West Coast fisheries, as already indicated, are the low socio-economic condition of the fishermen, their lack of initiative and ability to organise large-scale production and to effect efficient distribution of fish and fish products, weakness of their fishing effort and their inability to cope with situations arising out of abrupt fluctuations in the fisheries.

Many of the important fishing centres along the coast are more or less isolated from the mainland. There are not many road communications in the coastal areas. Even the few roads that are there are cut every few miles by a number of rivers and streams which have to be crossed by ferries with

the result that it takes a long time to transport fish even a few miles. Further, there are no easy communications between the narrow strip of the low lying coastal area and the mainland of the Peninsula as the two are separated by the Western Ghats from Bombay to the southern end of the Peninsula. Railway communications are almost absent along the coast except over a short distance in Malabar and South Kanara districts. The better organization of the fishing industry in these districts is in a large measure due to the railway communication there. Lack of adequate communications in the coastal areas is a serious hindrance to the quick transportation of fish to the interior markets.

PREREQUISITES FOR EFFECTIVE PLANNING.

An accurate knowledge of the different species of fishes which support our fisheries, their periodical migrations, and concentrations in different areas of the sea, their growth and behaviour, spawning areas and seasons, their relation to the environmental factors and the fluctuations of the fisheries and their causes, and of the statistical data on the extent of fish catches and their composition along different parts of the coast and the craft and gear used and their measure of catching ability, is very essential for a rational planning of fisheries development. In India, marine fishery research and fishery statistics have received very little attention in the past, except by the Madras Fisheries Department who have been collecting valuable data for many years. There are at present two Sub-Stations of the Central Marine Fisheries Research Station, at Calicut and Karwar, engaged in investigating fishery problems of this coast. The research staff of these Sub-Stations have for the past two years collected some valuable information on the biology of certain food fishes and prawns and their relation to the biological and physico-chemical conditions under which they live.

SCOPE FOR FUTURE DEVELOPMENT.

There is considerable scope for stepping up fish production on the West Coast, if suitable measures are adopted. In addition to the sea, the vast backwaters and salt water lakes in Travancore can be made to yield large quantities of fish and prawn, by treating them with fertilizers and stocking them with suitable species. While the present fishing effort is effective for exploitation of a limited area of the fishery, it is unsuited for large

scale production of fish.

Any attempt at greater production of fish can be effected only by the mechanization of the fishing operations and their extension into the offshore area. One of the urgent and essential needs for greater exploitation is to build suitably designed small power boats. The deep-sea fishing experiments conducted by the Madras Fisheries Department with such vessels point out that fishing is good up to 30-fathom area and that, under suitable conditions, it can be made a commercial proposition. A modest estimate of the requirement of such boats on the West Coast would be 500 and it should be possible to reach this number within a few years. The fishing nets that are now being used are well designed and can be enlarged and improved to suit the needs of fishing with motor vessels. The results so far obtained in trawling experiments with large trawlers in different parts of our seas, the absence of precise knowledge of the offshore fisheries beyond 30-fathom area and the present economic set up of the fishing industry seem to suggest that small motor vessels are likely to be successful for commercial fishing operations over large parts of the West Coast.

12

FISHERY STATISTICS.

The collection of accurate fishery statistics for the whole of India is a necessary pre-requisite for a proper scientific plan of exploitation and development of marine and inland fisheries. Until very recently, different constituent States were collecting some statistics without any central agency to rationalise the methods of collection and to give a co-ordinated and integrated picture of various aspects of fisheries for India as a whole. Recently, a Technical Committee on the co-ordination of Fisheries Statistics was appointed by the Government of India to examine the existing fishery statistics and to recommend suitable forms and annexures and the methods of collection of such statistics. The committee has published its report and the different institutions of the Central and the State Governments are making efforts to implement these recommendations.

The fishing industry in India is still in a primitive stage and is in the hands of a large number of illiterate fishermen. The degree of development and organization of the industry vary from State to State. Hence it is clear that any single method of collection of statistics may not be applicable to the whole country but at the same time multiplicity of methods in compilation has to be avoided.

The various types of statistics required to be collected in the present stage of development of Indian fisheries fall into the following categories:-

(1) Potentialities, including a survey of resources, personnel engaged and equipment possessed by them.

(2) Production, including catches and manufactured products.

(3) Utilisation, demand and supply, including processed fish, market arrivals, trade and prices.

(4) Biometrical data including population studies, growth rate, migration etc.

MARINE FISHERIES

The data relating to potentialities are such as could be obtained by complete census only. The Report on the Marketing of Fish, in the Agricultural marketing series No.52, contains information relating to approximate number of vessels used for sea fishing and the number of persons

engaged. The 1931 census report gives an estimate of persons engaged in fishing. Besides, the State Government of Madras collects some statistics on fishermen employed, fish curers, fishermen families, fishing villages and boats. In 1948-49, the Survey Section of the Central Marine Fisheries Research Station made a preliminary effort to collect statistics relating to the number of marine fishing villages, total fishing population, the number of different types of boats and nets. Excepting for Kathiawar coast, the data are complete and are given in the appendix.

The data relating to production are very meagre. Through the agencies of fish curing yards, the State Government of Madras collects data relating to landings of fish but it is difficult to assess the relative accuracy of such data. The great length of the coastline dotted with innumerable fishing villages and the illiteracy of the fishermen rule out of consideration the possibility of complete enumeration of fish landings in India. The only method that can be suitably employed is the technique of random sampling. The Indian Council of Agricultural Research has recently undertaken a pilot survey along the Malabar coast with the object of studying the possibility of applying this method for estimating the total catch of marine fish and for studying the seasonal variations in the catches of important kinds of fishes. The tentative plan is one of systematic sampling in time with the landing boat as a unit of sampling. The Central Marine Fisheries Research Station is also trying, since the beginning of 1949, to estimate the total landings of fish and the distribution of different varieties of fishes by the sampling method at some important fishing centres on both the East and West coasts of India. In this case the boat-net combination has been chosen as a sampling unit. It will thus be seen that at present, data on fish production are not available for any year for the whole of India but concerted efforts are being made to perfect a reliable method to obtain such data for each year with a sufficient degree of accuracy.

The statistics of utilization include prices and market arrivals in addition to data on cured, processed and canned fish. Exports and imports of fish also fall within this category. Both sampling and complete enumeration technique can be employed in the collection of data in this field. The Marketing Report gives approximate figures of imports and exports of fish and

fish products. As part of the general import and export trade statistics collected through the agencies of the Customs Department and published by the Department of Commercial Intelligence and Statistics, quantities and values of imports and exports of fish are available for a series of years. These statistics are fairly complete. The Directorate of Economics and Statistics in the Ministry of Agriculture in their monthly journal Agricultural Situation in India publishes the weekly wholesale prices of important varieties of fish prevailing at Bombay and Calcutta and retail prices at Calcutta and Madras.

The fourth category of data required relates to studies into the biological factors of fisheries involving continuous biometric analysis for a period of time. These factors include the rate of growth, age-determination mortality, food habits, gonad conditions, spawning habits etc. These require continued observations for a number of years. The appropriate statistical techniques have to be worked out before they are finally applied for a correct interpretation of the data. Workers of the Central Marine Fisheries Research Station and some of the State Government Departments dealing with fisheries are now engaged in collecting such data with regard to different commercial species of fishes.

INLAND FISHERIES.

The scattered nature of the inland waters throughout the length and breadth of the country renders the task of collection of inland fisheries statistics extremely difficult. It is essential that, in the first stage, statistics relating to potentialities should be collected by the complete enumeration method. Excepting for the piecemeal efforts of certain State Governments, no concerted efforts have been made so far in this direction. Once this is done, suitable sampling processes should be evolved to estimate the production side of the fisheries. The position relating to statistics of utilization is the same as on the marine side. The biometrical side of the inland fisheries is being tackled by the Central Inland Fisheries Research Station and Fisheries Departments of some of the State Governments.

TABLE SHOWING STATISTICS OF MARINE FISHING VILLAGES, FISHING POPULATION, BOATS, NETS ETC.

Zones.	Number of fishing villages.	Total fishermen population	Types of boats			Types of nets					Computed landings of fish in tons in 1949.
			Catamarans	Boats	Canoes	Shore-seines or in-shore drag-nets	Fixed or stationary nets	Bag nets or boat-seines	Drift and gill-nets	Other Miscellaneous types	
1. West Bengal and Orissa	127	33,640	2,391	792	-	1,257	3,092	4,079	4,341	2,224	18,842
2. Andhra coast (from south of Gopalpur to north of Visakhapatnam)	139	83,404	9,034	850	-	887	-	4,617	20,763	-	54,273
3. Andhra coast (from Visakhapatnam to Masulipatam)	145	28,885	5,995	5,442	-	560	13,530	3,027	11,635	1,036	24,426
4. Andhra coast (south of Masulipatam to north of Pulicat lake)	108	8,870	2,578	474	-	217	-	1,452	2,697	-	1,308
5. Coromandel coast (Pulicat lake to Cuddalore)	123	51,329	7,874	543	336	535	-	4,700	473	-	12,685
6. Coromandel coast (south of Cuddalore to Devipattanam)	55	9,136	2,086	353	-	-	833	327	5,029	650	11,850
7. Palk Bay and Gulf of Mannar (south of Devipattanam to North of Cape Comorin)	55	35,268	1,502	482	228	1,282	-	353	10,283	-	2,600
8. Travancore, Cochin and South Malabar (Cape Comorin to Ponnani R.)	45	1,59,248	982	-	13,387	-	-	12,948	5,712	3,094	48,659
9. Malabar and South Kanara (north of Ponnani.R.to Mangalore)	108	85,115	-	36	6,468	7	-	6,205	3,875	5,063	85,512
10. Kanara, Karwar & Konkan coast (north of Mangalore to south of Ratnagiri)	145	85,057	-	2,670	4,349	-	-	33,815	75,501	35,768	72,840
11. Bombay and Gujarat (Ratnagiri to Broach)	183	1,61,945	-	3,949	562	2,119	11,109	763	41,840	13,628	48,447
12. Kathiawar coast (North of Broach)	-	-	-	-	-	-	-	-	-	-	-
Total	1,231	7,41,899	32,442	15,571	25,330	6,864	28,564	72,886	1,82,169	61,463	3,81,442

the logs are pegged to one another with wooden pieces. The cost varies from Rs.150-300.

(b) Visakhapatnam type - This is larger than the former, being from 15' to 21' in length and is made with heavy wood. The hull consists of two halves lashed together at each end, when in use. Each half is a long log bearing a wash board sewn upon the outer edge and a wooden plank fixed to the side to give it the shape of a boat. In large ones about 24' long, a median log with a pointed stem-piece tied and not pegged is sometimes added in between the two halves of the hull. The cost is about Rs.400-700.

(c) Coromandel type - This type consists of a variable number of carefully shaped logs of definite relative proportions, lashed together in a certain order. To these are added a number of accessory pieces in the shape of stem parts and rowing rails. There are various sub-types, of which special mention may be made of Kola maram or flying fish catamaran, used in Tanjore district north of Point Calimere during June-August at 20-25 miles from the shore for flying fish fisheries. It consists of seven logs with an accessory one lashed upon the star board and costs about Rs.1,000.

(d) Boat-catamaran - It is in use from Mukkur in Ramnad district to Cape Comorin on the East coast and from Cape Comorin to Colachel on the West coast. It consists of three logs fitted in such a way that the median one, which is stouter than the rest, fits keelwise at a lower level than the other two. The logs are held in position at either end by a transverse two-horned block of wood, to which the logs are lashed by means of rope. The length varies from 18' - 25 and the cost from Rs.500-1,000.

(e) Raft - This is a small catamaran of primitive form and consists of four to five logs tied together in raft fashion and used on the West coast between Colachel and Quilon.

Masula boat . Next to catamaran, this boat is much employed for fishing with inshore drag nets along the East coast. The geographical distribution is from Orissa southwards to Point Calimere on the East coast, with a break in a small strip from Kakinada to Masulipatam. This is a non-rigid boat, constructed with planks only, without ribs or frames, so as to stand the severe knocking of the surfs. The planks are sewn together with

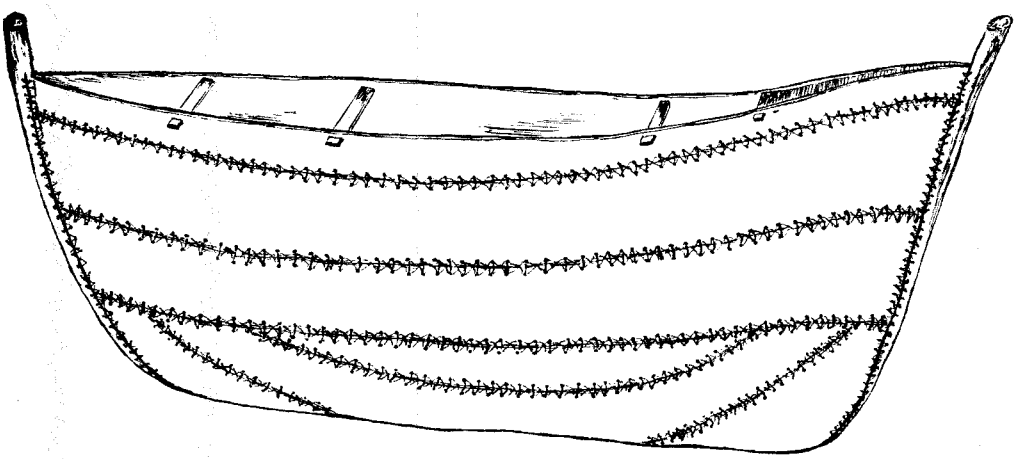
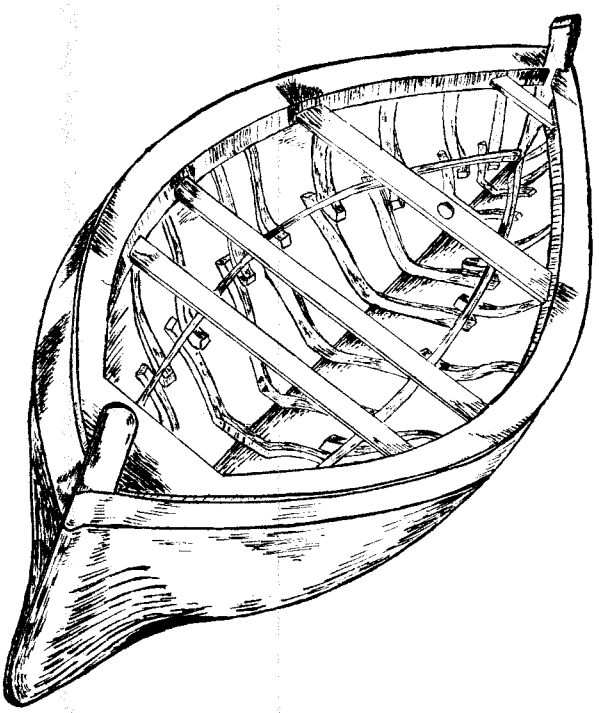


Fig.10. Padava - a Masula boat of Telegu coast.



g.11. Dinghi - a carvel built boat of North Orissa.

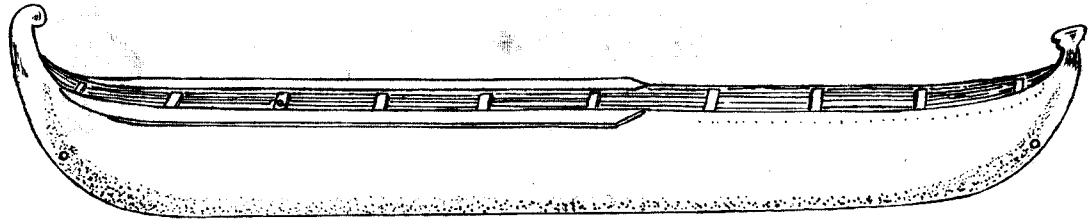
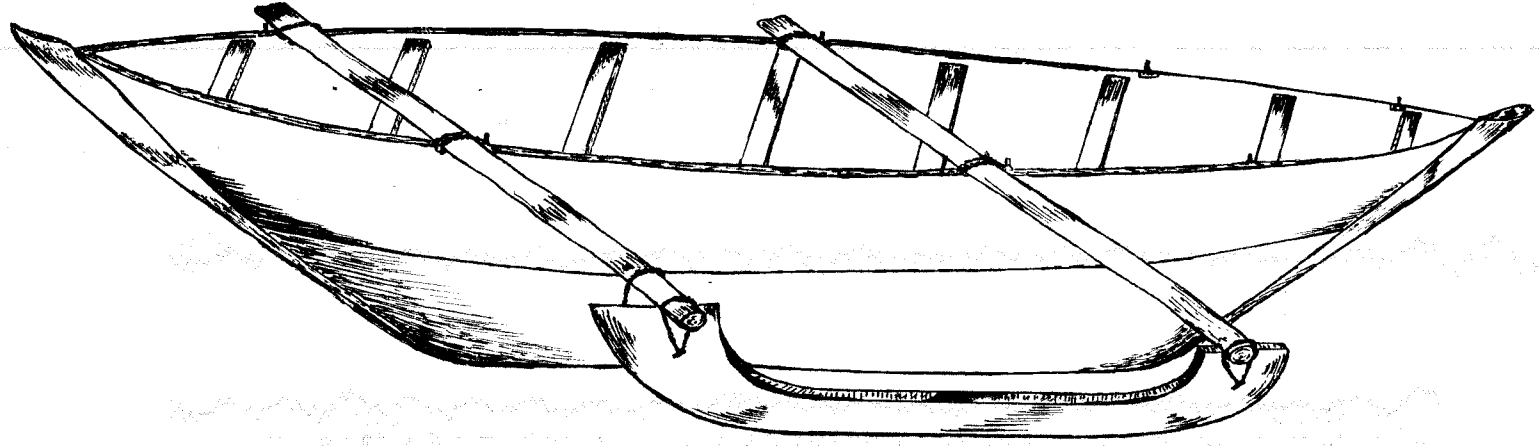


Fig. 12. Odam - a dugout canoe of Malabar.



coir rope and the inter-spaces between them are filled in with dry straw. In Orissa these boats are called Bar boats, on Telegu coast Padava and on Coromandel coast Padagu. There are various sizes, the biggest one being 37' in length and others varying between 15' and 30'. The cost is about Rs.250-450. In the strip between Kakinada and Masulipatam, a boat of the same design as Masula boat but rigid in type is used. This has strong ribs inside as a frame and on it wooden planks are nailed water-tight. Three or four wooden planks are fixed across the boat to accommodate crew for rowing. Its size is generally 30' x 5' x 3' and it has a displacement of 3 tons and costs Rs.750.

Other types - Besides the above two main types of craft, a few other types, suitable for particular regional waters, are also seen on the East coast. The Dinghi and Nauka of West Bengal and North Orissa are carvel built boats, the latter with a dimension of 42' x 10½' x 5' is more spacious than the former. The Tuticorin type of boat, about 36' x 6' x 3' in size and also carvel built, is used at Tuticorin, Pirmakayal and Tharuvakulam. The Pattiya of North Orissa is a clinker built boat. The Muthupet type of boat in use at Ramnad and Tanjore districts is a flat bottomed boat with an average dimension of 37' x 5' x 3'. The Shoe dhonie of Telegu coast between Kakinada and Masulipatam is a peculiar type of boat, so called because of its shape like a shoe.

Craft of the West coast.

Dugout canoes - As the name implies, the canoe is made by scooping out material from a large log of wood. The keel portion is left thicker than the sides. There are various sizes of dugouts with a displacement of about 3-5 tons. They are mainly operated on the West coast from Colachel in the south to Kathiawar in the north and also in some parts of Ramnad and Tanjore districts on the East coast.

The largest sized dugouts, known as Odams or Vanchi, are 32' to 40' in length and are used for operating large boat-seines on the Travancore-Cochin and Malabar coasts. The cost is about Rs.1,000. Canoes, measuring from 28'-32' and called Thonies, are generally used for gill and drift net fishing in addition to small boat-seine operations in the same waters. It costs about Rs.700. The smallest dugout 25'-28' in length and called Beputhoni is used

for long lines. It costs Rs.500-600. The Patta valla thonie of South Kanara and Pagar of Karwar and Ratnagiri districts are variations of the above canoes, with no ribs like the others, but having at regular intervals a ridge of wood to give strength.

Plank-built canoes- These are essentially dugout canoes, except that they have some planks stitched on to the sides. There are several local variations. Chemboke or Thanga vallam is a flat-bottomed plank-built canoe with dimensions 30' x 2½' x 2'. It costs about Rs.600 and is used for the operation of small boat-seines and drift nets in Travancore-Cochin State north of Quilon. The same type is also seen north of Bombay and in Kathiawar. The Ghol-bala boat of South Kanara is also similar but is used for operating bag net. The Rampani boat of Malabar, Karwar and Konkan coasts, used with outrigger arrangement,is a built-up canoe with a narrow keel and the upper planks spreading out more. Its dimensions are about 50' x 6' x 9' and costs about Rs.2,500. Plank-built canoes, with narrow keel but planks built up in the fashion of Chemboke and used with outrigger, are found in large number between Bhatkal and Majali.

Built-up-boats - These are plank-built boats,built in the carvel fashion. In between two planks, cotton soaked with glue is packed to make the boat watertight. This type is used on the West coast from the Ratnagiri district northwards. There are several variations of this type according to differences in the keel, stem or stern. The Ratnagiri type, having a displacement of 15 tons, has a pointed bow,straight but narrow keel,and low gunwale. The Bassein type locally called Machwa has a broad hull,pointed bow, straight keel with gunwale not so high. The Satpati type, popularly called Galbat and having a displacement capacity of 5 to 30 tons,has a medium pointed bow,broad beam,straight keel and high gunwale. The Broach type is a flat bottomed boat used in the inshore waters and estuaries.

Tackle

Though the fishing implements are of various types, they can be conveniently classified under the following broad groups :-

(1) Fixed or Stationary nets.

(2) Bag nets and Boat-seines.

(3) Shore-seines and inshore drag nets.

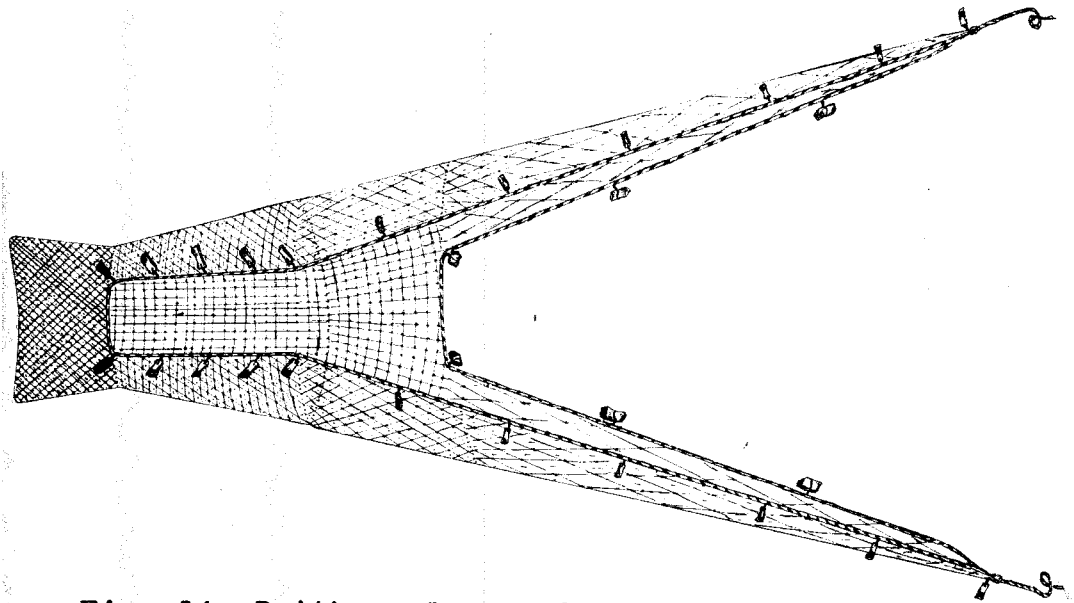


Fig. 14. Paithu vala - a boat-seine of Malabar.

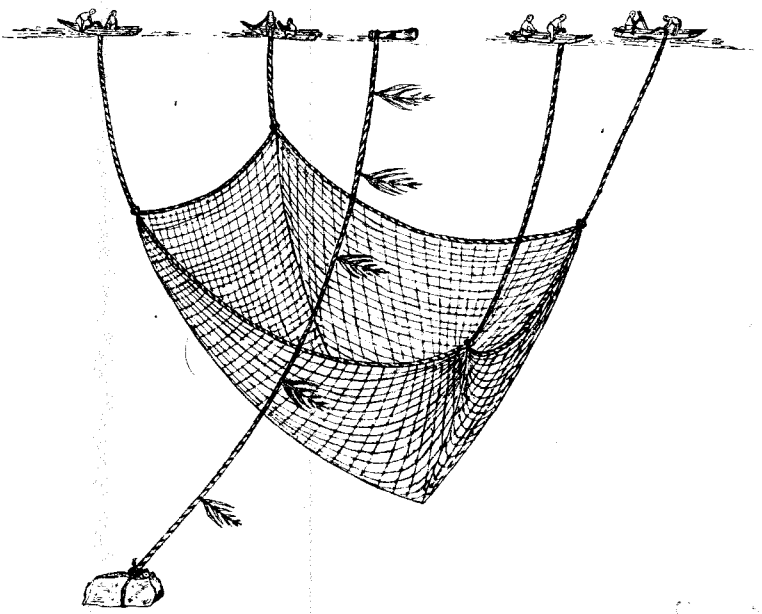


Fig. 15. Mada valai - a bag-net of Coromandel coast (After Hornell)

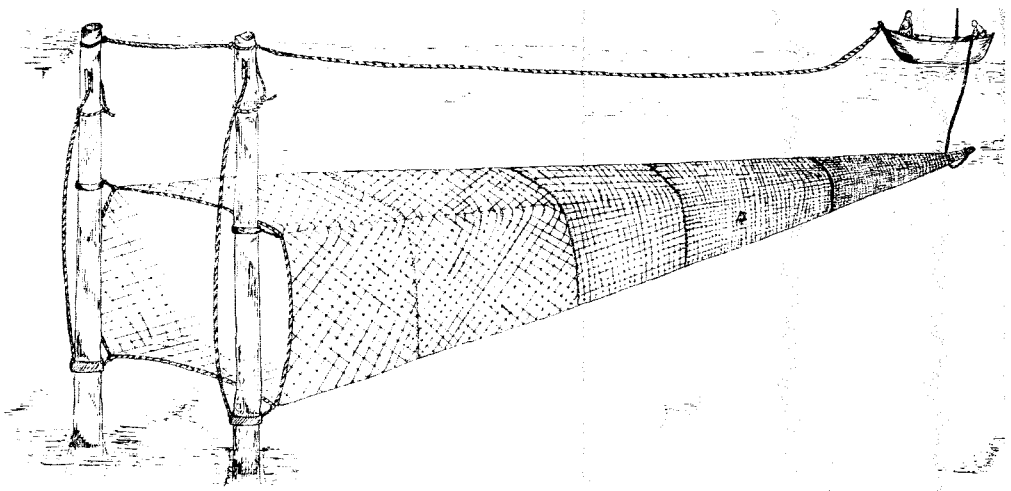


Fig. 16. Dol - a bag-net of Bombay coast.

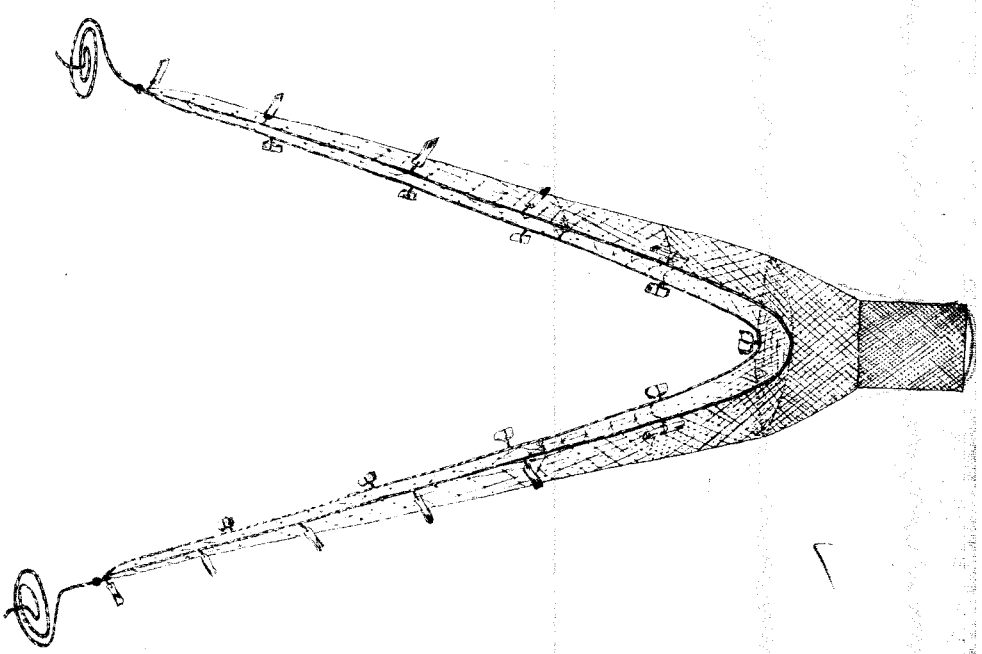


Fig. 17. Pedda vala - a shore-seine of Telegu coast

(4) Drift nets and gill nets.

(5) Cast nets

(6) Long lines and Hand lines

(7) Miscellaneous

The small nets are generally made of cotton and the bigger ones of hemp. Long lines used for sea fishing are made of cotton. The nets are prepared by hand and are commonly preserved by treating them with a bark decoction. In some parts of India, specially Bengal and Orissa ,coal tar is used for preserving the nets.

Some important types of nets under each group are briefly described below :-

1. Fixed or Stationary nets - These are mostly rectangular in shape with different sizes but in some cases they are conical. The Panch Kathia kool jal, Panch kathia ber jal and Behundi or Ghurni jal of West Bengal and North Orissa are conical nets. The Bayd or Mal jal of West Bengal and North Orissa, the Barnada jal of North Orissa Kala valai of Tanjore District,Kalam katti valai of Gulf of Mannar, Konda vala , Thorku vala , Waghol jal and Bangda jal or Patta bala of Kanara coast and Jadi or Magh jal of Gujarat and Kathiawar coasts are rectangular nets of various sizes and meshes. The principle of operation of this type of net is that it is fixed in the tidal regions of inshore waters during the low tide periods with stakes or with floats and sinkers. The high tide water passes over the net ,but when the tide recedes, the fish that come with it are trapped in the net. Excepting the nets of the Kanara coast which are kept in vertical position by sinkers and tin floats, most others are fixed by stakes or poles. The Behundi or Ghurni jal is fixed in such a way that it turns round the pole with the change in direction of the tide and thus four collections of fish are made in a day with this net.In the Kala valai of Tanjore district, when the high tide comes, many fishes going against the current are gilled in the net. Main catches from these nets are sharks, rays, mullets and Engraulis, Pellona, Polynemus and Lates spp.

2. Bag nets and Boat-seines - In general , this type is a conical net with or without wings. The mesh usually increases from the bag portion towards the outer end of the flanks. The bag nets with long tapering flanks are Iraga or Thuri valai of Telegu or Coromandel coasts,and all the boat-seines of

Travancore-Cochin and Malabar coasts. Two catamarans or canoes operate such a net where the fishes are trapped in the bag portion. The Madasu vala, operated along Palk Bay, resembles the Iraga vala but the method of operation varies. Before the season starts, trees are planted in the sea bottom with cement bags and the fishes take shelter under these trees,from where the net operated from two canoes on dark nights collects the fishes. The Kola valai of Coromandel coast and Kadura vala of Andhra coast are also long-winged bag nets operated in the same way as Iraga vala but differing from it in having 100 wooden rods set at 2 feet intervals to keep the head and foot rope apart. The Mada or Mara valai of Coromandel coast is a shallow bag net with a square mouth and no wings. It is operated from four catamarans for catching pomfrets taking shelter under conconut leaves moored previously. The Eddavalai, Nida valai and Pindai valai are only variations of this net. The Dol net which is a big bag net fixed in the sea by stakes or buoys, is operated in Bombay and Gujarat waters where the currents are high enough to keep the net in a horizontal position.

3. Shore-seines and Inshore drag nets - Shore-seines and Inshore drag nets of two designs are in use in India. The first type contains a bag with two wings and is represented by the Ber jal of Orissa, Pedda and Alivi vala of Telegu coast, the Periya valai of Coromandel coast and Kara vala madi of the Gulf of Mannar. The other type includes the biggest shore-seine used in India, viz. Rampan net operated along Konkan and Malabar coast. This is a wall net of enormous length. Wooden floats and stone sinkers are attached to the head and foot ropes of the net respectively to keep the net in position. The method of operation is the same for both the types described above. One extremity of the net remains on the shore,while a boat carries the rest of the net and pays it out in a semicircular way and brings the other extremity to another point on the shore and then the two ends are slowly dragged by two parties of men. Mainly shoaling fishes like sardine, mackerel ,white bait etc. are caught in them.

4. Gill and Drift nets - These are wall-like nets either made of hemp or cotton of various sizes and meshes. The material, mesh and size differ according to the type of fish caught. Generally wooden floats and some sinkers are attached to the head and foot ropes of the net respectively.Drift

nets are generally intended to catch big varieties of fishes and are therefore made of strong material with large mesh. The operation of the net consists in paying the net in the fishing ground with one end of the net secured to the boat. Then the boat and the net are allowed to drift in the current and the tide. The fish while moving about are gilled or entangled in the net. After a few hours, the net is hauled up and the fish collected. Gill nets are generally made of cotton with comparatively smaller meshes. The net is paid out in the course of shoaling fishes which are eventually gilled. There are innumerable vernacular names of these two types of nets.

b. Cast net - Two chief varieties of cast nets are in use in India viz. (1) stringed cast net and (2) stringless cast net. The method of operation consists in throwing the net fully spread over a collection of fish which gets trapped as the circumference of the net closes due to the weights attached. All kinds of small fishes are caught in this net, which is extensively used all along the coast.

c. Long lines and hand lines.- Lines are generally made of cotton. Several hooks of numbers 1 to 3 are left hanging from the line with baits attached. A number of floats and sinkers are used at regular intervals to keep the line in a particular position. The line is generally operated only in the offshore waters for catching big fishes. Chain hooks are also used. The main catches are sharks, rays, perches, Arius, Lutjanas and Cybium. Sometimes in the Gulf of Manpar while the boat sails at a great speed, the baited line is allowed to trail behind. The hooked fishes thus got are Thynnus, Chorinemus, Caranx and Cybium.

d. Miscellaneous - Two kinds of tackle deserves special mention

Sangoo rope -- This consists of a long rope with chanks attached at regular intervals. Loligo and Sepia get into the chanks for shelter. It is used at Tuticorin.

Harpoon -- It is occasionally used for catching very large fish on the Malabar Coast.

14

POWER FISHING

Though India has extensive marine fishery resources, fishing is confined to only a narrow coastal belt, generally not more than 10 miles in width. This is mainly due to the fact that the indigenous craft and tackle used by the Indian fishermen is not suited for offshore and deep water fishing. As a result of this, the inshore waters are fished intensively - sometimes a little too intensively as on the Travancore coast - but the large potential resource in the offshore waters is left practically untouched. Commercial sea fisheries, like those responsible for the bulk of supply in many countries of Europe, America and in Japan, have not been developed at all in Indian waters.

For the exploitation of our offshore waters, it is necessary to extend the range of operations of our fishermen. Though some of the nets and other tackle used in India are eminently suited for inshore fishing, improvement of the existing gear and use of modern mechanised methods of fish capture are also essential. Range of operations can be extended, among others, by the use of powered vessels, mechanisation of the existing craft and towing of indigenous fishing boats to and from the fishing grounds. All these three methods are being employed to varying extent in different parts of India.

Attempts at fishing with mechanised vessels have been made since 1907 along the coasts of Bengal, Bombay and Madras. For this purpose, Steam Trawlers "Golden Crown", "William Carrick" and "Lady Goschen" were employed by the Governments of Bengal, Bombay and Madras, respectively. These vessels were, unfortunately, unsuited to conditions in Indian waters and at the very initial stage heavy expenditure had to be incurred in connection with their reconversion. In the absence of Indians trained in the methods of mechanised fishing, expensive European technical personnel had to be engaged. As no data regarding the location and extent of fishing grounds were available, the work done by these vessels was more or less of the nature of a survey. In view of the heavy expenditure involved and somewhat slender prospect of their proving an economic success, these trawling experiments were discontinued before very long.

In addition to the lack of information regarding the suitability of different types of vessels and gear under Indian conditions, of trained Indian personnel and data regarding fishing grounds etc., another great handicap to the development of offshore fishing is the absence of harbour facilities for berthing, repairs and maintenance of powered vessels. Except in three or four major Ports, these facilities are practically non-existent in India. A few commercial concerns started power fishing after the last war but have had to suspend their operations, partly for lack of adequate finances and partly on account of the difficulties referred to. The Government of India, therefore, came to the conclusion that before the State Governments or private enterprise could be expected to take up the development of marine fisheries, it was necessary that pilot offshore and deep-sea fishing in different areas should be carried out by a Central Government agency, for determining suitable types of craft and gear and methods of work, collecting essential data regarding fishing grounds and fishing seasons, training personnel and, in general, demonstrating the possibilities of commercial fishing in Indian offshore waters.

A Pilot Deep-Sea Fishing Station was set up in Bombay in 1946. As suitable fishing vessels were in very short supply in India and abroad at the end of the last war, the Basset Steam Trawler "Berar", which had become surplus to the needs of the Indian Navy, was acquired. After extensive alterations, this vessel started operations in January 1948 under the name of S.T. "Meena". The Skipper and other officers had to be recruited from Britain and some difficulty was experienced in the early stages even in the recruitment of crew. This vessel was in commission for 513 days, but on account of berthing difficulties partly due to congestion in the Bombay Port, was out at sea for 212 days only. In addition to doing charting and other exploratory work, mostly in waters north-north-west of Bombay, she was able to land 4,400 maunds of fish, giving a catch of 20 maunds per day's absence from Port.

S.T. "Meena" was a single-screw vessel, 153'-5" in length and with a net registered tonnage of 159.85 tons. An ice making and cold storage plant was installed on the ship. As the maintenance and operation costs of this large coal burning vessel were unduly high, she was decommissioned in June,1949.

The work that S.T. "Meena" had been doing, is being continued with two Dutch Motor Cutters, M.T. "Ashok" and M.T. "Pratap", and two Reekie Boats,

M.F.V. "Bumili" and M.F.V. "Champa". Each Cutter has an overall length/of 38'-4" and net registered tonnage of 23.44 tons. The Reekie Boats, which were built in the United Kingdom with Indian teak specially sent for the purpose, are 50' long and have net registered tonnage of 10.01 tons each. The diesel engines of the Cutters are of 240 B.H.P., while those of the Reekie Boats are of 100 B.H.P. One of the Cutters is provided with a small cold storage unit.

The Cutters and the Reekie Boats started operations in the winter of 1949-50. The catch of "Pratap" has averaged 22 maunds per day's absence from port while the corresponding figure for M.T. "Ashok" is 17 maunds. The catch of each of the Reekie Boats has averaged about 10 maunds per day.

The Two Dutch Cutters and the two Reekie Boats have mostly been working in the area that had been previously charted by the Steam Trawlers"William Carrick" and "Meena". In the current fishing season, however, fresh areas are being explored. It is proposed that one of the Cutters will operate in waters off the coast of Saurashtra, while the other will fish around the Angria Banks south-west of Bombay. As there is a very rich mackerel fishery off the coast of north Kanara, the two Reekie Boats will be operating off Karwar during a part of the current fishing season.

The Steam Trawler "Meena" and the Motor Trawlers "Ashok" and "Pratap" have mostly been operating the Peter Carey type of Otter Trawl. For the Cutters this type of gear has proved to be a bit too heavy and a smaller trawl, commonly known as the "Hoover" trawl, is now being experimented with. The Reekie Boats used the Danish Seines and Drift-nets during the last season, but, for various reasons, their results were not altogether satisfactory. During the current season, these Boats will be working with the Purse Seine for mackerel fishing and with other types of gear for other fisheries.

The composition of the catch landed by S.T. "Meena" and the Dutch Cutters shows that Sharks, Rays and Skates constitute a considerable proportion of the catch. Of the 4,400 maunds landed by "Meena", these bottom, and somewhat uneconomical, fishes constituted as much as 23.73 per cent. The percentage composition of the total catch of "Meena" is given below :-

Sharks.	-	2.41
Rays and Skates	-	21.32
Jew Fishes.	-	33.44
Threadfins.	-	16.16
Catfishes.	-	11.47
Eels.	-	8.27
Perches	-	2.36
Pomprets.	-	1.64
Miscellaneous	-	2.93

In order to train personnel for working on power vessels, the Government of India sent a batch of young Indians for six months' preliminary training to Grimsby in the United Kingdom. On returning to India, they were given two years' practical training on the "Meena" and other vessels of the Pilot Deep-Sea Fishing Station. Five of the trainees have successfully completed their course and are at present employed in responsible positions on these vessels, two as Second Officers (certified) on the Cutters, one as Bosun-in-charge of one of the Reekie Boats and the remaining two as Bosuns on the Cutters. One of the Second Officers was even in charge of one of the Cutters for some months. It is expected that these trained officers will be able to take full charge of the vessels in the very near future.

After a lapse of many years, the Government of West Bengal have again undertaken offshore fishing in the Bay of Bengal with two Danish Cutters. These vessels are manned by Danish crew, who are also training Indian Officers and deckhands. In addition to trawling, the Danish Cutters are undertaking surface and mid-water fishing with different kinds of nets and gear. The vessels have recently started operations and the results achieved by them are not yet available.

Other means for extending the range of fishing operations are being tried by the State Governments of Bombay, Travancore-Cochin and Madras. In Bombay a beginning has been made with the mechanisation of indigenous craft and a number of sailing boats have been fitted with motor engines. In Travancore-Cochin and in Madras, fishing boats, using indigenous nets and other tackle, are being towed to and from the offshore fishing grounds with the help of motor fishing vessels. This enables the fishing boats to go farther and fish longer and results in larger catches than previously. This has specially been the case in Travancore-Cochin, where 8 to 10 boats are taken out and the catch per boat per day has been nearly double the previous catch.

From what is stated above, it will be seen that, in spite of several serious handicaps, a beginning in power fishing on modern lines has been made in India. The results of the work carried out in this connection by the Governments of India and other States will be of interest not only to India but to many other countries of South East Asia also.

15

Refrigeration and Curing.

Refrigeration

Though ice is extensively employed for preserving fish, no information is available in regard to the quantity used in India for this purpose. The total production of ice in the country is at present about 10,000 tons per day, but a large portion of this is utilised for purposes other than fish preservation. Since the end of the last war, the number of ice factories and the supply of ice have been showing a gradual increase every year. In several parts of the country, private enterprise has put up ice plants near the fish assembly centres. The Government of India and the State Governments concerned have afforded special facilities for the erection of these plants. The Government of Bombay have sanctioned a five-year scheme for establishing one ice factory and one cold storage plant every year. When complete, these will be transferred to Fishermen's Co-operative Societies. The Government of Madras have also acquired three ice-plants.

Refrigeration and cold storage facilities for the preservation of fish are available to a very limited extent only in Bombay, Madras and West Bengal States.

The Government of West Bengal are undertaking the construction of a 100-foot Lighter fitted with a refrigerating plant with 10 tons freezing and 50 tons cold-storage capacity. It is proposed to use this Lighter as a mobile assembly centre for coastal and estuarine fisheries.

The Government of Madras are putting up two ice-cum-quick freezing plants for fish at Mangalore and Kozhikode. Each of these plants will daily produce four tons of ice and will have the storage capacity of 25 to 30 tons of chilled fish and 40 tons of frozen fish. It will freeze 4½ tons of fish per day by Carrier dry air blast method. The Government of India have also just completed the installation of an ice-cum-cold storage plant at Bombay. The ice plant will produce 20 tons of ice per day and have a storage capacity of 50 tons of chilled fish and 250 tons of frozen fish. The plant will freeze 15 tons of fish per day.

Private enterprise has also taken up the establishment of quick-freezing plants. A Prawn freezing plant has recently started operations in Cochin,

and a frozen-fish plant is soon to be installed at Trivandrum. A few smaller units are being erected at Surat, Malda etc. Some private firms are also reported to be putting up small "powder-ice" plants as this offers a decided advantage over crushed 'block ice' in the preservation of fish for short duration.

Fish Curing.

In the absence of adequate supplies of ice, facilities for cold storage and rapid transport, a large quantity of surplus catches from the sea is dried and cured all along the coast, usually under conditions that are not altogether hygeinic or economical. It is estimated that nearly 50% of marine fish catches are at present being processed, resulting in products that are often, of a poor quality. Curing of fresh water fish is not practiced on any large scale.

Different methods of fish curing are employed in different parts of the country. The main principle involved in almost all the methods is the removal of waters from fish muscle, partly by osmosis, as a result of the applications of salt, and partly by drying. The addition of indigenous preservatives and spices in the cure or pickle further enhances the keeping qualities of the preserved fish and provides an agreeable flavour. The following methods of fish curing are generally employed in different parts of India.

West Coast (Bombay)

1) Sun drying. The fish are dried on the beach on mats for 2-3 days with an occasional turning over. By far the largest quantities of fish are cured by this method. Comparatively small and lean kinds of fishes, like Bombay Duck, Ribbon fish and Prawns are cured in this way.

2) Salting and drying. Very small fish, like Silver Bellies, Soles etc. are salted without gutting. Medium sized fish, like Mackerel, Sardine, Seer and Pomphret, are gutted, slit open from the back and salted. Large fish, like Sharks, Rays and Skates, are gutted, slit open and deep incisions made in their flesh. These are packed in layers in a tub or cement tank with a sprinkling of salt in between each layer. The proportion of salt to fish is 1.6 to 1.8, depending on the size of fish. After 18 to 24 hours they are removed, washed in self-brine and dried in the sun for 2-3 days.

West Coast (Madras, Travancore-Cochin).

1) Sun drying. This method is employed for small and lean fishes like ribbon fish, soles and prawns.

2) Semi-drying. This is employed chiefly for prawns where the moisture content of the product is brought down from about 80% to 40% by an initial boiling in weak brine followed by deshelling and immersion in concentrated brine and then drying lightly.

3) Salting and drying. This method is similar to that employed in Bombay, but occasionally Malabar tamarind (Gorukapulli) is also employed while salting. This is said to enhance the quality of the cured product.

4) Ratnagiri method. This is employed at Malpe, mostly for curing Seer fish intended for Bombay markets. The Seer is gutted, split, incised and cleaned and salt in the proportion of 1:3 is employed for curing. The application of salt is made in three stages. On the first day half the total salt is used and well rubbed into the incisions and the fish are packed in rectangular heaps upto three feet high, on a cement floor. The next day, the fish are re-packed and a quarter of the salt is used for rubbing and repacking. On the third day, the remaining quantity of salt is used and the fish repacked. The stack is left undisturbed for a week or ten days and then sold in the market without any further drying.

5) Pickling or Colombo method. This is practiced only to a limited extent by Ceylonese fishermen who visit Cochin and other centres during mackerel fishing season and is employed mostly for mackerels. The fish are gutted, cleaned and rubbed with salt and packed in a wooden barrel in alternate layers of fish and salt. Malabar tamarind (Gorukapulli) is also mixed with salt. The barrel is packed to the brim and weighted down. After two or three days, shrinkage is observed and self-brine forms. This self-brine is drawn off through a hole at the bottom of the barrel which is again filled with more fish and brine of the same cure from other barrels. The bung hole is then tightly corked. These barrels of cured fish are exported to Ceylon.

6) Fish Pastes or 'Padda' fish of Malabar. This is mostly a domestic method of preservation. Vinegar, chillies, mustard, cumin seed, tamarind and turmeric are made into a paste in ghee or oil and the fish in slices is dipped into the paste, and after cooling packed in jars. Another type of domestic paste, called Mollei, is also prepared in Cochin.

7) Light or Madura curing is employed mostly for mackerels. The fish is salted slightly and dried in the sun but not so hard as in other methods. The cure is intentionally imperfect to suit the taste of the labour classes.

East Coast (Madras and Orissa).

1. Sun drying as described above.

2. Salt curing in pits is practised from Muthupet down to Tuticorin area. The fish are rubbed with salt and piled in pits, lined and covered with leaves. After a stipulated period the fish is removed and dried in the sun. A similar pit-curing method is also employed in Andhra area. The product is very inferior, but finds a ready market among the poor classes.

Smoking. No regular smoking of fish is done, though prawns of the Chilka Lake are smoked, more for the purpose of drying them than for curing.

East Coast (Bengal)

Pit curing with salt is employed as on Madras coast.

2) Sun drying. This method is also similar to that employed in other parts, but large fishes are cut into slices for easy drying. Smaller varieties are partially dried and then their entrails removed by squeesing or trampling. Drying process is again continued for about 10 days. Prawns are sun dried and shells are removed by beating them in gunny bags.

3) Fish pastes and fish in oil preparations are produced on a purely domestic scale.

From the above description of methods employed for curing fish in India, it will be observed that there is a wide range in the degree of drying and intensity of salting. As a rule, the quantity of salt used is inadequate and the product generally liable to insect attack and putrifaction.

In order to improve the quality of cured fish, the Governments of various maritime States have established fish curing yards at principal fish-assembly centres. In these yards facilities are provided for curing fish under hygeinic conditions. In order to induce the fishermen to bring their fish into the yards and cure it under proper supervision, duty-free salt was, until recently, supplied in these yards. With the abolition of salt duty in December, 1947 and the availability of salt in the local market at the same price at which it is supplied in the Government yards, the curing within the yards has been showing a steady decline. The Governments of Bombay and Madras are, however, reviving the supply of salt at concessional rates.

Fish curing yards were first established in Madras in 1874 and their number has been increasing ever since. In 1948, there were 187 fish curing yards along both the coasts of India. Of these, 163 were on the west coast and only 24 on the east coast. Of the west coast yards, 96 were operated by the Bombay Government, while 53 and 14 yards were under the charge of the Governments of Madras and Travancore-Cochin, respectively. All the 24 yards on the East Coast were in Madras State. The fish curing yards in Orissa which were previously managed by Government, have been handed over to fishermen's co-operative societies. Bombay has no yards north of Ratnagiri District and there are no fish curing yards in Saurashtra and Cutch.

From the available information, it appears that more than 26 lakhs maunds of fish is brought into fish curing yards every year, but considerable quantities are also cured outside the yards. Every effort is being made by the Government of India and the State Governments concerned to induce the fishermen to improve the quality of cured products, a large proportion of which is exported to Ceylon, Malaya and Burma.

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MARKETING OF FISH

Volume of Production.

The annual catch (excluding quantities taken by non-professional fishermen) was estimated in 1948 to be 142.1 lakh maunds (1169 million pounds), valued at nearly 179.5 million rupees. Of this quantity, nearly 71 per cent comprise sea and estuarine fish, valued at Rs.86.8 million against Rs.92.7 million for the remaining 29 per cent caught from fresh water resources. The supply greatly falls short of the potential demand. The shortage is increased by the wide variations which exist in the catch in different localities and in the catch from season to season. The seasonal fluctuation appears to be the greatest on the South West Coast of India where 3.4 per cent of the sea-fish catch is taken in May and 17.4 per cent in September. Fluctuation of this kind is characteristic of the fishery and has considerable effects on it in every way. There are geographic differences as well; for instance, of freshwater fish nearly 72 per cent were estimated to come from West Bengal, Bihar and Assam and of the sea fish 48.3 per cent from Madras coasts, 27 per cent from the United State of Travancore-Cochin and 5.5 per cent from West Bengal. However, in the absence of reliable statistics regarding production by units of time, of area (length of coastline and so forth), the number of boats and gear employed, the number of men who fish, etc. it is not possible to measure the amount of effort employed by Indian fishermen and compare this with the data available for other countries.

IMPORTS AND EXPORTS.

India imports annually an average of about 49400 cwts. of preserved and canned fish valued at Rs.1.8 million. This is, however, offset by exports of preserved fish averaging 567,000 cwt, valued at Rs.2.95 million. In addition, India also exports about 63,000 tons of fish manure. The bulk of the exports goes to Ceylon, Burma and the countries in the Far East. There appears to be good demand for the cheaper qualities of cured fish in the importing countries particularly from Indians who have settled down in them.

DISTRIBUTION OF THE CATCH.

There are three principal channels of disposal of the catch:fresh (which includes alive), dried and salted (with a wide range in the degree of drying and intensity of salting) and conversion to manure. Little care is taken of the fish between the points of capture and landing or, beyond the latter to the point of marketing or of processing. Ice is seldom carried in fishing vessels; even when carried, the quantity of ice taken is generally insufficient and methods of its use are careless. Gutting and cleaning are never done in the sea. There is a great prejudice in the country against buying gutted fish. In the conditions of extreme heat which prevail in the fishing areas of India and of the uncleanliness in the fishing vessels,the catch is some times landed in a poor or putrescent condition.

TRANSPORT.

From the point of landing the catch is transported by a variety of methods to the consumers, market, storage or processing point. The commonest method of transport is by the head-load employed for transport to retail markets or direct to consumers for roadside sale. The use of bicycles and other simple modes of transport has developed in some large fishing areas to supplement the head-load traffic. When motor roads are available,trucks are employed for the cartage of fish over long distances. Such transport ranges from cartage of baskets of fish in buses and public utilities, the use of special trucks for the carriage of baskets of fish and the fisherwomen by whom the fish is to be sold and in a few instances special insulated trucks. The railways are also used extensively for the carriage of fish from landing points to markets. Carrier vessels have been in use in the Bombay area for some years and also for river transport in West Bengal. On the whole, the transport facilities in India are not adequate in so far as the quantity which they can handle, the speed with which they carry the traffic and the means at their disposal for preserving the fish in good condition.

CONTAINERS.

The principal containers in use are baskets generally made of bamboo and a wide assortment of wooden boxes. Gunny bags, nets and matting are also used. Very little attention is paid to keep these containers clean and hygienic.

STORAGE

Storage facilities of a reasonable standard are now available only in the chief cities of India. Plants for quick-freezing and cold storage of fish at Bombay,Kozhikode and Mangalore under Government auspices and one at Trivandrum by a private company are now under erection.

PER CAPITA CONSUMPTION.

The average annual per capita consumption in 1948 was estimated to be 3.36 lb. The actual consumption in different tracts varies widely, the highest consumption being in the maritime tracts of the West Coast.

MARKETING OF FRESH FISH.

It is estimated that nearly 43 per cent of the total production is consumed as fresh fish. A small proportion of the catch is sold by the fishermen's family, who remove the catch in baskets of various sizes, frequently as head-loads,and take it direct to retail markets or otherwise dispose of it. But the bulk of the catch is taken over from the fishermen by middle-men who either sell direct to consumers in retail markets or convey it to markets where it is auctioned. Very often the auctioneer is himself a middleman. The bulk of the catch passes quickly from the fisherman's control because firstly, he is anxious to be rid of it and get cash and secondly on account of his financial arrangements with the middle-men. From the wholesale markets the catch is taken in baskets to retail markets. The "markets" are of an assorted nature. Invariably they are part of a general market building; sometimes it is an open space on the beach or on the river bank. Some markets in urban areas have facilities for displaying the fish. But most fish markets lack cleanliness.

AVAILABILITY OF ICE.

There are ice-making factories in principal towns, but their output is generally insufficient to meet even the existing undeveloped demand. The cost of ice is high. Facilities for delivering ice to fishermen in remote fishing centres are absolutely inadequate. Ice is practically beyond the buying capacity of individual fishermen. Only middlemen handle the trade in

"iced fish" and the quantity of ice used by them for packing the fish and the method of applying it, are often unsatisfactory.

PROCESSING.

The chief methods of processing are drying and salting,and conversion to manure. In 1948, it was estimated that 7.2 million maunds of fish (representing 49.3 per cent of the total production) was cured in India; the bulk of this was sea fish and most of it was sun-dried. The methods employed include wet and dry-salting and sun-drying and there are variations in the techniques employed in the different areas. Smoking is not favoured and canning of fish has not so far been undertaken on large scale. The preparation of dried and "semi-dried" prawns is an industry of considerable present and future importance. There are some minor industries such as manufacture of fish-oil, shark-fins, isinglass, etc. In 1949, nearly 6.6 per cent of the total catch was converted into manure.

There is general agreement that the methods employed for processing fish are not satisfactory in so far as efficiency or hygiene is concerned and that the products can be improved to increase their appeal and extent of demand.

Processed fish is generally marketed through wholesalers and commission agents in their own stores. Retail sales take place in retail markets.

PRICES.

The value of fish landed was estimated at Rs.12/10 per maund in 1948. This average comprises a wide diversity of prices in different areas depending on the water, species, season, facilities for marketing available locally,etc. Average price for freshwater fish is about three times that of sea fish. Between the producing centre and the consuming centre the wholesale price increases greatly depending upon the distance and other factors. This increase, to a large extent, depends upon the species also. The price spread in these cases consists of charges in despatching from one centre to another (freight, ice, packing materials, etc) and the commission agent's charges at the selling end.

ORGANIZATION.

The fishing industry in India, it has to be admitted,has neither a structure nor organization. Co-operatives have very little influence or voice in it; there are hardly any large companies. There are numerous fishermen who work alone,owing cast-nets or lines singly. From this simple unit, there is progressive increase in complexity,with numbers of men making use of boats and gear owned by a single person or a group of people and the catch (or the return obtained for the catch) shared among the workers and the owner of the gear in accordance with various practices or prior agreements. These practices are linked with arrangements for finance. The fishermen consequently receive a wide diversity of treatment. An organization to eliminate the middlemen should be in a position to render to the fishermen all the services that the middlemen now provide, besides additional facilities like cheap ice,transport, storage and so forth. The fishing industry in India may be said to consist of innumerable separate units operating with little regard for one another and virtually in competition in respect of fish to be caught, finance,supplies to be purchased and of market for the catch. Amelioration for this situation comes in the activities of State Governments and co-operatives.

The progress made by the Governments of Bombay, Madras and Orissa States for the improvements of the condition of fishermen in recent years are noteworthy.

Part V- Socio - economics

17

Fishermen's Co-operatives

General condition

According to the census Report of 1931, the fishing population constituted about 0.5 per cent of the population of India. On this basis,and not taking into account any change that may have occurred as a result of changes in the economic condition of the community, the present fishing population in the Indian Union may be estimated to be in the neighbourhood of 1.7 millions. The economic problems of fisherman, like those of the petty artisan and the small farmer, concern his methods of production, purchase of domestic and production requisites, provision of credit, and the sale of his produce. The crafts,gear and other equipments which he uses are primitive, inefficient and wasteful. The middlemen, to whom in many cases, his catch is sold in advance, generally supply him with his domestic and production requirements, and with other credit accommodation which he needs. He is, therefore,compelled, by the circumstances of his trade and living, to buy dear and sell cheap, and thus sinks irretrievably into debt. Belonging to an economically and socially backward community, ignorent and ill-educated, he has generally neither the will nor the means to organize himself for self-emancipation.

General progress of Fishermen Co-operatives

Co-operation makes very little effective appeal to the desperately poor, as also to the very rich. The one is too weak to successfully evoke any measure of self-help; the other is too strong economically to need any collective aid, and as the fishermen community in India belong, for the most part, to the former category, co-operation has not made any appreciable progress among them. Only in a few States, like Orissa, Bombay, Madras, Madhya Pradesh, West Bengal and Assam, has some attempt been made to organize them on co-operative lines. The progress made in these six states at the end of

the Co-operative year 1948-49 was as given below:

Progress of Fishermen Co-operatives

1948-49

State	No.of Societies	Membership	Share capital (In '000)	Total working capital (In '000)	Transactions Purchases (In lakhs)	Sales	Loans
1.Orissa	39	5,487	19	172	10.84	4.42	
2.Bombay	45	13,464	344	832	21.38	20.79	
3.Madras	178	17,582	205	488	16.22 (value of foodstuffs, yarn etc. distributed)	3.02 (estimated value of fresh water fish)	3.03
4.Madhya Pradesh	3	152	N.A.	10		0.05	0.16
5.W.Bengal	244	10,128	36	174	0.80	2.02	0.72
6.Assam	16	628	43	81	0.06	0.61	Nil.

Credit-Co-operatives

As in other fields, the first type of societies to be started for fishermen was mainly the credit co-operatives. Little attempt was made to pool, process and sell the member's catches. This was largely owing to the difficulties of accquiring fish curing yards, where salt could be had at concessional rates, limited availability of godowns, where the stock could be stored, absence of ice-plants and cold storage facilities, and inadequate transport arrangements for marketing fish in distant areas. There were in Madras 178 societies at the end of June, 1949, but most of these societies generally catered only to the credit needs of their members.

It has, however, been realised that credit by itself will not be a solution of the problem,and unless the fishermen are organized both for the purchase of their necessaries, as well as the sale of their catch,their economic condition will not materially improve. Increasing attempts are,

therefore, being made to link credit with purchase of requisites on the one hand and sale of the produce on the other.

Help in production and purchase.

One of the commonest ways in which the fishermen have become indebted is by having to purchase their necessities from unscruplous local merchants. Some of the societies, therefore, have, in addition to the supply of credit, undertaken the purchase and distribution of domestic requirements to the fishermen members. In Orissa, the Government have organized consumers' stores attached to each fish curing yard in the coastal villages. Seven such stores were functioning in 1949 with a membership of 2,070 and transactions amounting to Rs. 1.5 lakhs. These stores have been formed into a Union with working capital provided free of interest by the Government for a period of three years. The Union makes bulk purchases of the requirements of their members, distrubutes them and conducts inspections to ensure that the sales proceeds are duly returned. In Madras, some of the societies undertook the distribution of foodstuffs and other requirements to their members valued at Rs.16.22 lakhs in 1948-49. In Bombay, the societies sold foodgrains and other rationed articles and fishing gear of the value of Rs.20.78 lakhs in 1947-48. In Madhya Pradesh, two of the five societies which are actively functioning in the State, have undertaken the distribution of foodgrains, kerosene oil, sugar and other necessaries to the members.

Many of the societies are also actively helping the members in the purchase of their production requirements. In Bombay, the societies have undertaken the supply to their members at cheap rates of the raw materials required by them such as hemp, hook, tar, yarn, cloth for sail, etc, and also to educate them in the use of improved technique of fishing according to the instructions given from time to time by the Director of Fisheries. The Government have also given subsidies for the purchase of improved types of fishing boats fitted with oil engines for deep sea fishing. In Madhya Pradesh, the societies supply the members with yarn for repairing old nets and making new ones. In West Bengal, the Bidyadhari Spill Fishery Co-operative Society owns its own set of fishing appliances, which are hired to members.

Assistance in marketing.

The model bye-laws for fishermens Co-operative societies in all the States, inter-alia, contain provisions for the joint sale of the members produce. The principle of 'controlled credit', so successful in the field of agricultural credit, is being in a away extended to some of the fishermen's societies also. In the Ajanur Fishermen's Co-operative Society in South Canara, Madras, loans are granted by the society generally to only such of the members as undertake to sell their catches through the society. In Bombay and Orissa also the same method of linking up credit and marketing is being pursued in some of the societies. The Ajanur Society has also attempted to pool the members' catches and sell them either as fresh or cured fish or converted into manure through other co-operative sale societies.

It has, however, been found difficult for small primary societies of fishermen to purchase the heavy equipments needed by the industry, to keep them in a proper state of repair, to own curing yards, ice-plants and cold storage depots and to transport fish to distant ma rkets for sale. It has been felt that for all these purposes, it is necessary to organize the primary societies into unions which could provide the funds, purchase and distribute the equipments needed, supply necessary technical advice and undertake the processing and sale of fish. Such Unions have been formed in some of the States, like Orissa, where the Chilka Co-operative Union controls a substantial part of the fish trade of the Chilka Lake. Steps are also being taken in Bombay for the formation of federations of fishermen's primary societies,which would help the member societies in securing modern fishing appliances,and in transport and marketing of fish. Middlemen are also sought to be eliminated by the society establishing direct connections with purchasing centres, as is done by the Union in Orissa, or by entering into agreement with the merchants for settling the price for the season, as in Baroda. Fishermen-producers are thus endeavouring to exercise some control over wholesale prices. These co-operatives are also receiving active support from the State. Twines for sail cloth,yarn for net, fishing hooks, timber for boats, etc., are being supplied at cheap rates by government through the societies in Bombay. The societies are also being helped by loans and grants for the purchase of motor launches,fishing

boats, tackle, etc., and for meeting their administrative cost. With financial assistance of the Government of India and the States concerned, schemes have been sanctioned in Madras and West Bengal for the supply of fishing requisites at subsidised rates to fishermen through Co-operative Societies. The possibility of erecting cold storage plants is also being explored in some of the states like Bombay and Madras. In Bombay, some societies are endeavouring to put up ice-factories with the financial assistance of the Government.

Welfare activities.

In a community so backward in every respect, and depending ordinarily on such a precarious and narrow means of livelihood, it is hardly to be expected that self-help organizations will be able to find either the resoruces from among themselves, or the necessary personnel to undertake welfare work on anything like the scale required by the community. Such work like education, provision of housing, medical welfare,health and sanitation arrangements,and other ameliorative measures, have,therefore, to be undertaken by the State or other public bodies. One or two co-operatives have, however, done something in this direction also. The fish curing yards which were started under Government auspices in Orissa were later handed over to the co-operative stores and converted into centres for the welfare of fishermen. These centres have served very useful purpose in the distribution of daily necessaries to fishermen and providing places where meetings and other community activities of the fisherfolk could be held. Another Society in West Bengal, the Captain Bherry Fishery Society, is maintaining a primary school for imparting education to the boys of fishermen. Some of the fishermen co-operative societies started in Madras in the wake of the enforcement of prohibition in the State, have, in addition to granting small loans, undertaken recreational activities.

The working of the fishermen co-operative societies has shown the possibilities in this direction, and with more propaganda, careful planning and spread of education, there appears to be very good scope for the setting up of new societies and expanding the activities of those already in operation.

18

FISHING COMMUNITIES.

The fishing profession in India is mainly confined to the fishing communities living in villages scattered along the Indian Coasts, rivers and backwaters. As fish capture is almost entirely in their hands, any attempt to improve the fishing industry has to take into consideration the socio-economic conditions of the fishermen. At present the fishing population is illiterate and occupy a very low position in the social scale. Consequently, they are highly conservative and reluctant to adopt new ways and methods in their profession. They are heavily indebted to the middlemen who control the trade or to the capitalist who owns the boat and gear which they are allowed to use. These aspects have been briefly discussed in a previous chapter, but some details of the chief communities in the different parts of the country and their social anthropology are given below.

Over eight million of the population of India are returned as fishing communities, though large sections of these no longer follow this calling. While their hereditary profession was fishing, boating, sea-faring and allied occupations such as salt-making or selling chunam (burnt lime), they have gradually merged with other castes and professions. Being inured to hardships of the sea and of the coastal and riverine regions, they are naturally strong and sturdy in physique and easily take to other callings; most of them in Northern India and the Deccan have taken to the profession of water-carriers, porters, and palanquin bearers. Though fishermen in India have a very low status in the caste hierarchy, they have succeeded in raising their status by following other avocations, such as water carrying and domestic service. Thus the Kandu, Machi, Bhadbhunja and Bhatiara castes of cooks and domestic servants were originally of the fishing communities. Again the Kahar, Jhinvar and Dhimar of Northern India are fishermen, who have elevated themselves to a higher position as domestic servants and water carriers.

In South India, large numbers of the fishing communities have embraced Islam on the west coast and Christianity on the east coast, on account of their 'inferior' caste status, while those who are Hindus still occupy a low rank.

In many places where fishing could not support them, the communities

have taken to other pursuits such as hunting, fowling and the collection of forest produce as in the case of the Bedar, Boyi and Boya of the Deccan, and agriculture, weaving, and commerce as among the Kevat, Kahan, Haliya and Talabda of the North and the Canarese Kabberas and Tamil and Telugu Pallis of the south.

The Kahar, Machis and Bhois are the principal fishing castes of northern and western India. Most of them speak Marathi or Gujerati. Besides fishing, they follow other professions such as agriculture, trade, domestic service, and cooking. The Kahar have no endogamous divisions or exogamous septs. They allow polygyny. They usually cremate their dead. The Machis are both river and sea-fishers, boatmen, cultivators and labourers. They prohibit cross-cousin marriages.

The Mallah, Malo, Tiyar and Patni are the principal fishing communities of Bengal, Bihar and other eastern parts of the country. The Mallah include various fishing and boating castes. The Malo appear to be a tribal people with totemistic survivals. They are largely hinduized. They are Vaishnavites, practise clan exogamy and cremate their dead. The Tiyar include both fishers and cultivators. They have three hypergamous divisions; also have a tribal organisation. The Patni are a low caste of fishers and boatmen. They include traders and cultivators. They are Hindu Saivites and have exogamous septs.

The Besta, Boya and Palli are the principal Telugu fishing castes. The Besta are also porters and cooks. The Telugu Boya is probably identical in origin with the Canarese Bedar, though the former are fishers, porters and labourers while the latter are hunters, fowlers and nomads. The Pallis are the Telugu division of the Great Tamil Palli caste who are agriculturists. Both these divisions, however, claim to be superior and call themselves Vanni Kula Khatriyas, wear sacred threads, imitate Brahmins, prohibit meat-eating and widow re-marriage to raise themselves in the social scale.

The Kabbera or Ambiga and the Moger or Mogayar are the fishing castes of Canara. They are both fishermen and cultivators, the former speaking Canarese and the latter Tulu. The Kabbera have two endogamous divisions, the children of Gowri (Gowri makkala) and the children of Ganga (Gangi makkala) and each has exogamous septs. They are Vaishnavites. Th tali is tied by the Brahmin purohit during marriages. They have the Basavi system among them. The Moger or Mogayar are Tulu fishermen who have taken to other professions.

Their settlements are called Pattana, like those of the Tamil fishermen. They are superior to the Malabar fishermen or Mukkuvans. The Moger have exogamous septs with animal names. They are also matrilineal.

The Mukkuvans are the fishermen of Kerala. They are boatmen, palanquin bearers, cultivators and chunam sellers. They have hereditary chiefs called Arayans. They are matrilineal in the north and patrilineal in the south. Bhadrakali is their chief goddess. They work side by side with the Mappillas and are largely islamised. The women wear ornaments on the helix of the ear like Muslims. Some children were brought up as Muslims and married to Muslims for fulfilling vows. The Maharajah of Cochin on his coronation receives a bag of salt as a present from a Mukkuva chief.

The Sembadavans and Pattanavans are the chief Tamil fishing castes. The latter are sea fishers, and live in maritime villages. They are considered to be inferior to the former who are river fishers. Another caste of seafaring people in the South called the Savalaikarans are superior to Sembadavans. The Pattanavans are mainly Hindus though there are some sections who are Christians. They have a right to carry the idol during temple processions. The Sembadavans are in many places pujaris or priests of temples of mother goddesses in the villages.

During the early epochs when the Andhras, Pallavas, Cholas and Cheras were important maritime powers, the ancestors of the present fishing communities of the Indian coast provided the navigators who manned the large sea-going vessels, big enough, in some cases, to take a number of elephants. Later, when seafaring became a lost art, the fishermen lost their importance as navigators. During late medieval times, the Zamorin employed Arabs in his navy; even in other regions of Southern India, navigation and coastal trade passed into the hands of Muslims. But in the fishing communities of India today, we have the best recruiting ground for our navy and merchantmen.

REFERENCES.

Alcock, A.	1902	-	A Naturalist in Indian Seas - London.
Annendale, N., Kemp, S. and others.	1915-24	-	Fauna of the Chilka Lake. Mem. Ind. Mus. 5.
Bose, J.L., Karimullah & Siddiqui, S.	1943	-	Manufacture of Agar-agar in India. Jour. Sci. Ind. Res. (India), 11(2).
Chidambaram,K, & Menon, M.D.	1946	-	Investigation on the shark fishery of Madras Presidency. Madras Fish. Bull.
Chopra, B.N.	1939	-	Some food prawns and crabs of India and their fisheries. J. Bomb. Nat. Hist. Soc. 41 (2), pp 221-234.
,,	1943	-	Prawn Fisheries of India. Pres. Address, Zool. Sec., 30th Ind. Sci. Congr.
Day, F.	1873	-	Freshwater fish and fisheries of India and Burma. London.
,,	1878	-	Fishes of India. London.
,,	1889	-	Fauna of British India. London.
Devaneran, D.W, & Chidambaram, K.	1948	-	The common food fishes of the Madras Presidency, Madras Government Publication.
Gajjar,I.M. & Sreenivasiah,M.	1945	-	Economic utilization of sharks in India Curr. Sci. 14.
Government of India.	1941	-	Agricultural Marketing in India: Preliminary guide to Indian fish, Fisheries, methods of fishing and Curing. Mark. Ser. No. 24.
,, ,,	1946	-	Agricultural Marketing in India: Report on the marketing of fish in India. Mark. Ser. No.52.
,, ,,	1945	-	Report of the Fish Sub-Committee of Policy Committee No.5 on Agriculture, Forestry and Fisheries.
,, ,,	1950	-	Report of the Technical Committee - Co-ordination of Fisheries Statistics. Government of India, Ministry of Agriculture.
Gravely, F.H. (Ed. by.)	1927-37	-	Littoral fauna of Krusadai Is. in Gulf of Manaar, Bull. Madras Govt. Mus.,(Nat. Hist.) 1.
,,	1941-42.	-	Shells and other animal remains found on the Madras beach. Ibid .5.
Hora, S.L.	1934	-	Wanderings of the Bombay-Duck, Harpodon nehereus (Ham.Buch.), in Indian waters. J. Bomb. Nat. Hist. Soc. 37(3),pp 640-654.
Hora, S.L.	1938	-	Preliminary note on the spawning grounds and bionomics of the so called Indian shad, Hilsa ilisha (Ham.) in the Ganges. Rec. Ind. Mus. 40(2), 147-158.

Hora, S.L. & Nair, K.K.	1940	-	The Jatka fish of the East Bengal and its significance in the fishery of the so called Indian shad, Hilsa ilisha (Ham). Rec. Ind. Mus. 42(4), 553-565.
,, ,,	1944	-	Suggestions for the development of the salt-water Bheries of Bhasa-bhada Fisheries in the Sunderbans. Bengal Government Fish. Dev. Pamphlet No.1.
Hornell, J.	1911	-	Marine fish farming for India. Madras Fish. Bull. 6 (2).
,,	1914	-	The Sacred Chank of India. Ibid.7
,,	1922	-	The Indian Pearl Fisheries of the Gulf of Manaar and Palk Bay. Ibid. 16.
,,	1924	-	The fishing methods of the Madras Presidency Part I - The Coramandal Coast. Ibid. 18 (2).
,,	1938	-	Part II - The Malabar Coast. Ibid 27 (1).
,,	1946	-	Water Transport, origins and early evolution, Cambridge University Press.
,,	1949	-	The study of Indian Molluscs, Parts I, II & III. J. Bomb. Nat. Hist. Soc. 48 (2).
Job, T.J. & Chacko, P.I.	1947	-	Rearing of saltwater fishes in freshwaters of Madras. Ind. Ecol. 2 (1), 1-9.
John, C.C.	1935	-	Freshwater fish and fisheries of Travancore. J. Bomb. Nat. Hist. Soc. 38 (4), 702-733.
Kini. U.S. & Chidambaram, K.	1947	-	The liver oils of elasmobranch fish of South Indian Waters. Jour. Soc. Chem. Industry. 66.
Menon, K.S.	1931	-	A preliminary account of the Madras plankton. Rec. Ind. Mus. 33.
Nataraj, S.	1948	-	The prawns of Travancore. Univ. Trav. Dept. Res. Rep, 1939-1946, 282-285.
Nicholson, F.A.	1909	-	The Preservation and curing of fish. Madras. Fish. Bull. 3.
Panikkar, N.K.	1937	-	The prawn industry of the Malabar coast, J. Bomb. Nat. Hist. Soc. 39 (2), 343 - 353.
Panikkar, N.K. & Aiyar, R.G.	1937	-	The brackish water fauna of Madras. Proc. of Ind. Acad. Sci. (B) 6.
Prashad, B.	1944	-	Memorandum on the post-war development of fisheries. Govt. of India Press.
Prashad, B., Hora, S.L. & Nair, K.K.	1940	-	Observations on the seaward migration of the so-called Indian shad, Hilsa ilisha (Ham.), Rec. Ind. Mus. 42 (4), 529-552.
Pillay, T.V.R.	1948	-	A mullet farm in Cochin State, Ind. Farming 9 (3), 99-103.
Rao, H.S.	1941	-	Indian Shell fish and their fisheries. Sci & Cult. 7 (2), 69-78.
Rao, H.S. & Panikkar, N.K.	1949	-	A survey of the pelagic fisheries of the world, Proc. Indo-Pacific Fisheries Council. 1.

Samuel, M.	1944	-	Animal communities of the level-sea bottom of the Madras Coast. Jour. Madras. Univ. 15 (2).
Schott, G.	1935	-	Geographie des Indischen und Stillen Ozeans. Hamburg, Verlag von C. Boysen.

Scientific Reports of the John Murray Expedition, 1933-34.

British Museum (Natural History). 1935

Sewell,R.B.S.	1925-32	-	Geographic and Oceanographic research in Indian waters, Mem. of As: Soc. Bengal 9.(1-6)
,,	1937	-	Oceans round India, outline of the Field Sciences of India, Calcutta.
Weber, M. & De Beaufort, L.F.	1911-40	-	The fishes of the Indo-Australian Archipelago. 1-8.