CHANDRA KALA HORA MEMORIAL LECTURE

INTEGRATED RESEARCH AND DEVELOPMENT OF INDIAN FISHERIES

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After a brief review of the fishery wealth of India, the developments in the field of fisheries in this country during the past twenty-five years are reviewed. Against this background the main problems in fishery development in future are discussed. In the field of marine fisheries the country has to embark upon an integrated programme of marine exploration, research and development. Even though work has been going on for some time, the efforts to connect up these activities have been inadequate. Expansion of marine fisheries can take place only on sound knowledge of fish stock and oceanographic conditions. Crustacean fisheries, particularly the prawns, have soared in commercial importance but increased output can be sustained only by large scale culture. The developments in inland fisheries have shown substantial increase in per hectare yield but fish culture as an industry has yet to take root. Perhaps this will be possible only if the yield is sufficiently high and attractive; marginal increases in production alone cannot sustain a culture industry. Both inland marketing of fish and external trade still call for improvements; technological research is badly needed. Training and education in the field of fisheries require considerable organisational effort and one line of thought is the development of at least one fisheries university for the country, on the lines of the newly established Agricultural Universities, to which fisheries training institutes could be federated or affiliated.

My first duty is to thank the Indian National Science Academy for awarding the Chandra Kala Hora Medal to me, and to recall the memory of the distinguished donor. It wascmy privilege to have been closely associated with the late Dr. Hora during his assoiation with the Zoological Survey of India and the National Institute of Scienes.

Indian fisheries occupied an insignificant position in the national economy in the forties. Dr. Hora took a great deal of interest in focussing attention to this aspect of the national sector through his own work and writings. He himself was passionately devoted to the development of inland fisheries and pond culture, subjects on which he wrote and spoke extensively. For quite a few decades he was in the very forefront of scientists of India actively to propagate the cause of fisheries research and development. One of the primary aims for making this award has been to recognise work which has improved the lot of the fishermen. The Academy rightly considered a few years ago that the ultimate objective of betterment of the fishing community is reached through many fields of research as well as development and that it was most essential to have more broad-based criteria for recognising

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work in the field of fisheries. It is probably in this context that the Academy thought it appropriate to make this award to me as one most closely connected with the growth, research and development of the fisheries activities in India since 1946, when I was first called upon to organise fisheries research by the Union Ministry of Agriculture. My later association in this field as a scientist and as Director of the Central Marine Fisheries Research Institute at Mandapam and subsequently as Fisheries Development Adviser to the Government of India at the Ministry of Agriculture gave me the opportunity to build up organisations for the prosecution of research in marine and inland fisheries, to carry out certain researches in the field of aquatic resources, and to the fuller study of the problems of fisheries of the country as a whole. Thus came my efforts in establishing the Central Institute of Fisheries Technology for crafts, gear and processing research at Cochin and the Central Institute of Fisheries Education at Bombay for training fisheries officers which was preceded by an extensive study of the requirements of man-power in this area of activity at that time. These efforts also led to the establishment of the Central Institute of Fisheries Operatives at Cochin for the training of persons to catch and process fish, skills in the art of fishing and the connected techniques. It was also possible at that time to initiate a fisheries extension service under the Ministry, with quite a few centres established for the specific purpose of popularising fish cultural practices. A retrograde decision was taken by the Government in the early sixties to close down the extension centres or to transfer them to the States but I am told that steps are afoot to revive the extension services.

My association with the fisheries sector of national activity assumed a different complexion with my heading the Indian Programme of the International Indian Ocean Expedition and subsequently the National Institute of Oceanography because these activities were really the scientific realisation of the importance of the environment in the diagnosis, development and management of marine resources. Today we are all happy that there are quite a few hundred fisheries scientists and fisheries administrators working all over India on marine, estuarine and inland problems. While this substantial expansion in our scientific and developmental efforts gladden our hearts, it is also a good occasion for stock taking, to have a closer look at some of the problems, which would give us an insight into what the future holds for us and to see how we may obtain the best for the money, effort and man-power expended in this direction.

In achieving this growth of Indian fisheries during the last two decades, in some fields phenomenal and in others tardy, yet in the overall, a sizeable spurt in the national wealth, I should like to pay tribute to the efforts of some of the former Fellows of the Academy in addition to the late Dr. Hora whom I have already mentioned. They are the late Dr. Baini Prashad, who fought hard for the establishment of a deep-sea fishing effort in India; the late Dr. B. N. Chopra who laboured hard for a closely knit organizational set-up for fisheries and the late Dr. H. Sreenivasa Rao who did pioneering work for the establishment of the Marine Fisheries Institute. In the field of inland fisheries, some of our distinguished contributors, Dr. B. S. Bhimachar, Mr. Alikunhi and Dr. Kulkarni are continuing their efforts, while the research activities are expanding in marine and inland fisheries under the leadership of Dr. S. Z. Qasim and Dr. V. G. Jhingran respectively. The untimely death of

Dr. V. K. Pillai, Shri R. Jayaraman and Dr. M. P. Motwani has taken away from our midst three brilliant workers in fisheries technology, oceanography and inland fishery management at the prime of their lives.

The extent of fishery wealth

The Indian fishery wealth comes from the marine, estuarine and inland waters. Its landed value is most conservatively put at Rs. 150 crores per annum but its annual value in terms of the products is of the order of Rs. 350 crores of which it gives us much more as national income, accounting for an annual export trade of Rs. 58 crores and employing well over a million fishermen. The total yield is at present something like 1.8 million tonnes of which about 1.2 million tonnes are taken from the sea and the rest from the inland waters (Tables I–III).

TABLE I A

Annual landings of major fisheries (in tonnes)

Name of fishery	1967	1968	1969	1970	1971	1972*	Average
Oil sardine	256,326	301,641	174,249	226,997	208,982	125,413	215,601
Mackerel	29,445	21,703	91,837	139,206	184,811	124,171	98,529
Bombay duck	74,942	82,501	76,276	78,443	71,415	51,496	72,512
Prawns	94,422	101,436	106,097	121,691	149,968	159,756	122,228
Total of all marine fishes	891,888	934,611	913,630	1,085,607	1,154,844	974,456	992,506
Total of freshwater fishes	508,112	591,389	691,370	660,393	609,156	666,600†	621,170
Total of all fishes	1,400,000	1,526,000	1,605,000	1,746,000	1,845,000	1,641,056	1,627,176

*Provisional †Approximate

In terms of annual total production we are considered among the first few nations producing over a million tonnes. It is well known, however, that the operations are primarily coastal, labour-intensive using frail craft with fishing operations which are of an artisanal nature, including a large amount of effort for subsistence only. The radical change which has taken place during the last thirty years has been in the mechanisation of the fishing boats of which there are some 15,000 at present. The last few years have seen the emergence of indigenous trawlers and fishing by the use of larger boats which could go far out into the sea. The indigenous trawler building capacity is being developed. The incentive given by the lucrative foreign markets for prawns, commercially called shrimps, has given a great fillip to the fishing industry in many parts of India. At present several hundreds of boats are operated from the sea fishing centres all over the Indian coasts, although large scale concentration of effort has been mainly on the coasts of the Kerala State.

TABLE I B

The composition of total marine fish landings in India during 1970–1972 (*in tonnes*)

Sl. No.	Name of fish	1970	1971	1972*
1.	Elasmobranchs	44,048	42,061	45,225
2.	Eel	6,983	4,130	4,430
3.	Catfishes	50,631	49,197	41,161
4.	*Chirocentrus*	91,58	9,996	9,848
5. (a)	Oil sardine	2,26,997	2,08,982	1,25,413
(b)	Lesser sardines	55,220	63,775	42,489
(c)	*Hilsa ilisha*	1,050	1,855	1,393
(d)	Other *Hilsa*	9,492	10,500	12,298
(e)	*Anchoviella*	24,400	19,509	18,517
(f)	*Thrissocles*	14,087	10,929	11,102
(g)	Other clupeids	26,439	29,462	28,659
6. (a)	*Harpodon nehereus*	78,443	71,415	51,496
(b)	*Saurida & Saurus*	2,813	3,759	4,460
7	*Hemirhamphus & Belone*	1,814	993	681
8.	Flying fish	2,844	9,185	1,412
9.	Perches	13,913	13,077	14,450
10.	Red mullets	2,118	3,836	5,892
11.	Polynemids	7,168	7,464	7,051
12.	Sciaenids	41,903	36,518	39,099
13.	Ribbon fish	26,984	45,336	36,275
14. (a)	*Caranx*	18,412	21,474	26,869
(b)	*Chorinemus*	2,120	2,126	2,928
(c)	*Trachynotus*	143	17	2
(d)	Other carangids	966	523	319
(e)	*Coryphaena*	254	60	223
(f)	*Elacate*	518	347	397
15. (a)	*Leiognathus*	49,275	32,591	32,503
(b)	*Gazza*	154	32	76
16.	*Lactarius*	4,697	5,511	6,632
17.	Pomfrets	17,589	21,831	18,940
18.	Mackerel	1,39,206	1,84,815	1,24,171
19.	Seer fish	13,410	18,433	21,211
20.	Tunnies	3,015	5,835	5,990
21.	*Sphyraena*	1,530	1,278	2,358
22.	*Mugil*	2,428	3,727	1,523
23.	*Bregmaceros*	2,196	4,345	5,488
24.	Soles	13,364	11,112	9,346
25. (a)	Penaeid Prawns	89,857	73,320	74,268
(b)	Non-Penaeid Prawns	31,834	76,648	85,488
(c)	Other Crustaceans	10,832	9,592	11,541
26.	Cephalopods	1,184	1,561	991
27.	Miscellaneous	36,118	37,665	41,841
		10,85,607	11,54,822	9,74.456

(CMFRI, 1973)

*Provisional

TABLE II

Statewise annual marine fish landings in India during 1961–72 (*in tonnes*)

State	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
West Bengal & Orissa	9,151	8,387	11,176	10,642	12,244	10,041	19,318	30,658	22,879	31,403	27,255	14,203
Andhra	54,966	60,521	64,913	71,727	76,477	80,087	76,054	77,429	77,526	74,459	83,289	83,870
Tamil Nadu	123,593	111,622	109,602	131,309	99,018	134,779	152,497	154,400	151,876	149,106	160,214	155,264
Pondicherry	–	–	–	–	7,011	12,762	8,017	8,151	10,637	10,624	10,453	8,980
Kerala	268,624	192,470	203,242	317,974	339,173	346,744	364,129	345,301	294,787	392,880	445,605	291,959
Mysore	18,113	45,128	39,176	104,218	68,476	65,630	49,185	87,822	75,793	115,205	103,978	83,457
Goa	452	–	–	–	17,186	24,600	12,460	18,888	27,559	20,736	21,000	39,980
Maharashtra	116,225	127,956	124,587	130,603	131,907	134,339	133,302	123,916	168,720	192,361	216,340	219,138
Gujarat	91,442	97,827	102,040	92,882	80,590	80,339	75,633	86,585	82,248	89,027	84,941	75,846
Andamans & Nicobar	131	155	159	148	224	330	410	341	412	500	547	569
Laccadives	872	178	589	79	471	660	883	1,120	1,193	1,165	1,200	1,190
Total	683,569	644,244	655,484	859,582	832,777	890,311	891,888	934,611	913,630	1,077,466	1,154,822	974,456

TABLE III

Primary fishery statistics (marine fisheries) and percentage proportion of fish landings in maritime states and union territories

Name of the State	Approx.. length of coast-line (km)	No. of fishing villages	No. of landing centres	Percentage catch of each State to the total all India catch
West Bengal & Orissa	680	182	45	2.36
Andhra	970	321	253	7.22
Tamil Nadu (incl. Pondicherry)	960	363	361	14.78
Kerala	560	279	213	38.58
Mysore	270	131	98	9.00
Goa	110	–	–	1.82
Maharashtra	600	265	179	18.73
Gujarat	1,500	256	107	7.36
Andamans	–	–	–	0.05
Laccadives	–	–	–	0.10
Total	5,650	1,797	1,256	100.00

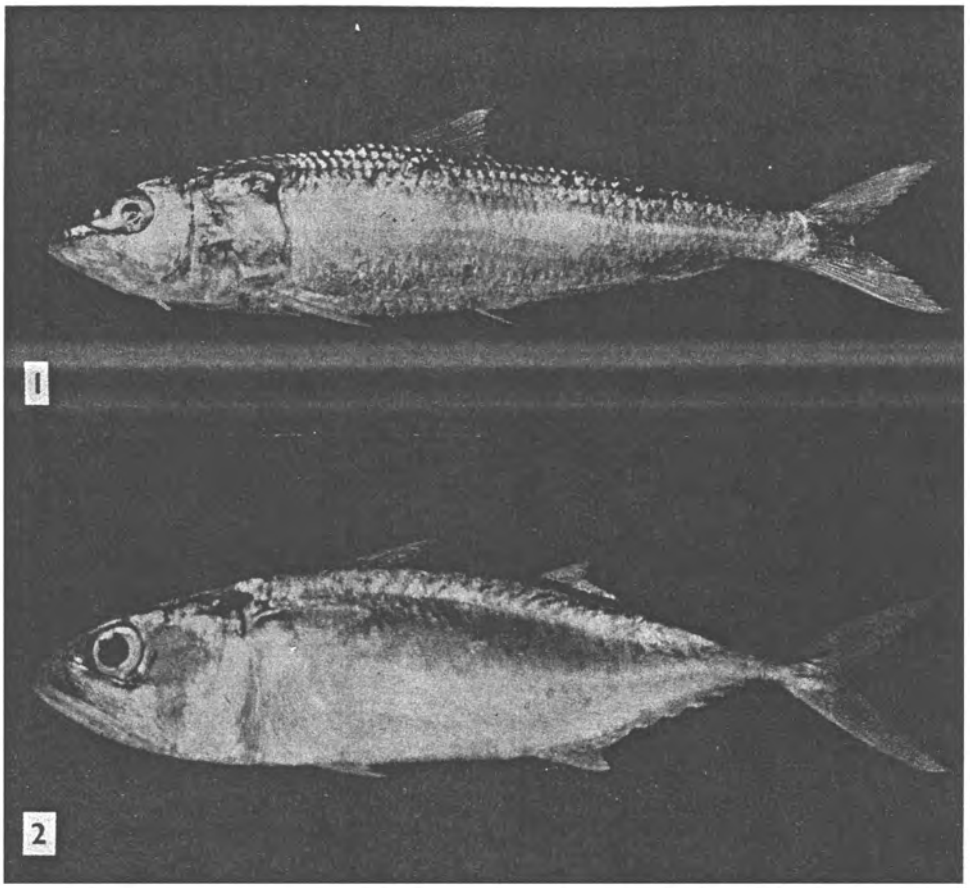
(CMFRI 1972)

It is often asked whether substantial increase in marine fishing can be sustained from the Indian coasts. To gain an understanding of this it is necessary to give a brief mention of our principal marine stocks.

Of the pelagic fish groups the Clupeids form nearly a third of the total marine fish landings of India. The most important among them is *Sardinella longiceps*, the oil sardine of Malabar (Fig. 1), the fishery of which extends from Quilon to Ratnagiri on the west coast. Very marked are the annual fluctuations, the outputs varying from a few thousand tonnes to over 200,000 tonnes in different years in the past two decades. The lesser sardines represented by several species, like *Sardinella fimbriata* constitute about 5 per cent to the annual landings. Other clupeioids as the Anchovies, etc. are in fair abundance in the fish landings along both the coasts. The utilization of the oil sardines is not merely for food, but also for its body oil used as a lubricant for machinery, for tanning leather and as a repellant in preservation of wooden hulls of boats against the attacks of drilling molluscs.

Among the Scombroid fishes, the Indian mackerel, *Rastrelliger kanagurta* (Fig. 2) also occurs in the same zone as the oil sardine along the west coast, but unlike the latter it supports fisheries of fair magnitude along the east coast also, between Tamil Nadu and Orissa. In the past two decades the annual outputs varied between 3 per cent to about 20 per cent of the total landings. There are two other species of *Rastrelliger* also occurring along the Indian coasts, they being *R. brachysoma* and *R. faughni.*

The oil sardines and the mackerel are plankton feeders, the former mostly utilizing the phytoplankton and the latter zooplankton. Their fisheries are seasonal coinciding with the periods when the shoals strike the coastal waters. Their migratory movements are little understood, but in the off seasons both the species are



FIGS. 1–2. 1; The oil sardine *Sardinella longiceps*; 2, The Indian mackerel *Rastrelliger kanagurta*.

obtained occasionally by types of gear operated at varying depths below the surface waters.

The ribbon-fish fisheries constituted by several species of Trichiuridae contribute much to the landings along Tamil Nadu, Kerala and Andhra coasts. The Bombay duck fishery supported by a single species *Harpodon nehereus* contributes to about 10 per cent of marine fish landings. Much of the catch comes from Maharashtra and Gujarat and a minor portion from Andhra and Orissa coasts.

Among the demersal fish catches from trawls are a large number of percoids, sciaenids, polynemids, catfishes, soles, elasmobranchs and silverbellies. Some of these are high class quality fishes which are much in demand in the local markets. While they are in fair abundance all along the shelf region, their concentrations are the highest along north of Bombay up to the Gulf of Kutch. In general, the catch per hour returns in trawling operations are far higher on the west coast than along the east coast.

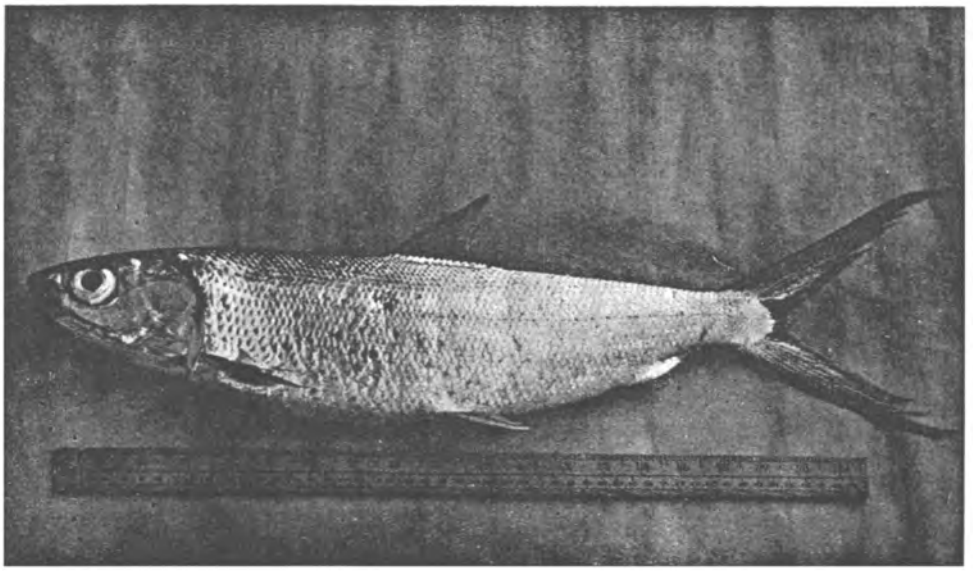


FIG. 3. The milk fish *Chanos chanos*

The crustacean stocks are comprised by penaeid and nonpenaeid prawns together forming over 95 per cent of the total crustacean landings and the rest composed of other crustaceans viz., lobsters, crabs, etc. Owing to the ever-increasing demand by foreign markets, the crustacean fisheries have come into great prominence. Penaeid prawns rank the highest in the export trade, *Penaeus monodon Penaeus indicus, Metapenaeus dobsonii* and *M. affinis* being important in the freezing and canning industry. The giant shrimp *Macrobrachium rosenbergii* and some of the lobster species are much sought after, though quantitatively less available. The annual crustacean catch is about 10 per cent of the marine landings. The shrimp beds off Cochin are comparable with any of the well-known productive beds of the world. The deep sea lobster and prawn beds discovered a few years ago off Cochin are as yet little exploited for export trade (Figs. 6 to 8).

The oceanic pelagic fishery resources remain unexploited by India. Exploratory surveys have indicated abundance of tunas, other fishes and cephalopods in the nearby oceanic regions to our coasts. The Indian Ocean resources outside the territorial waters are exploited by certain other nations even to the point of exhaustion of the available stocks of some of the species.

The molluscan resources are vast but their utilisation is negligible except in the case of pearl oysters and chanks which are harvested when available, under Governmental supervision. In respect of the edible oysters, clams and mussels no data on the extent of their utilisation are available. These shell-fishes are gathered by coastal populations for their domestic use and nowhere in India are organised fisheries for them. As most species lend themselves to cultivation the scope for increasing production is immense, by selecting suitable species and culturing them

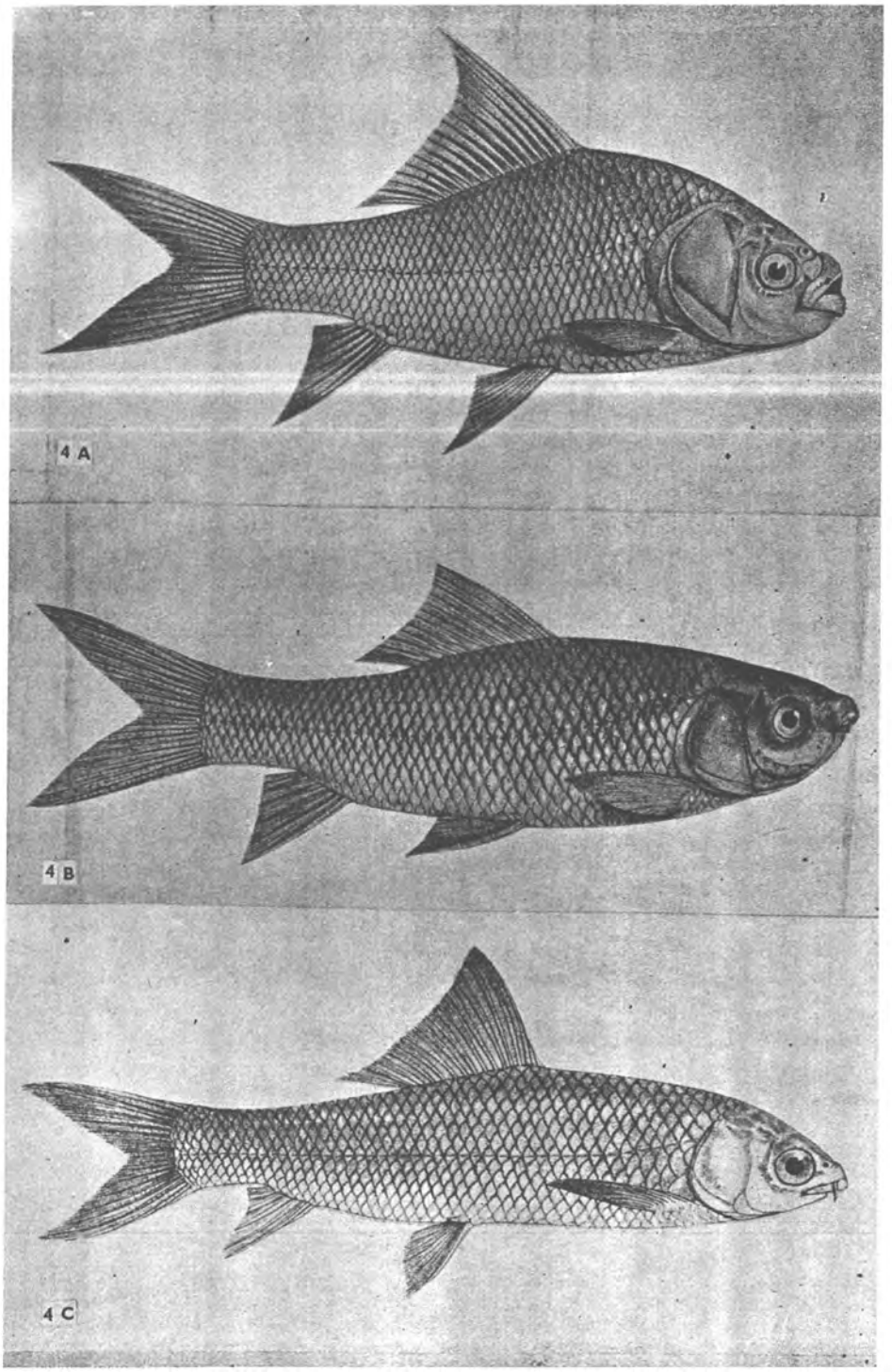


FIG. 4. A–C. Indian major carps. A, *Catla catla;* B, *Labeo rohita;* C, *Cirrhina mrigala*

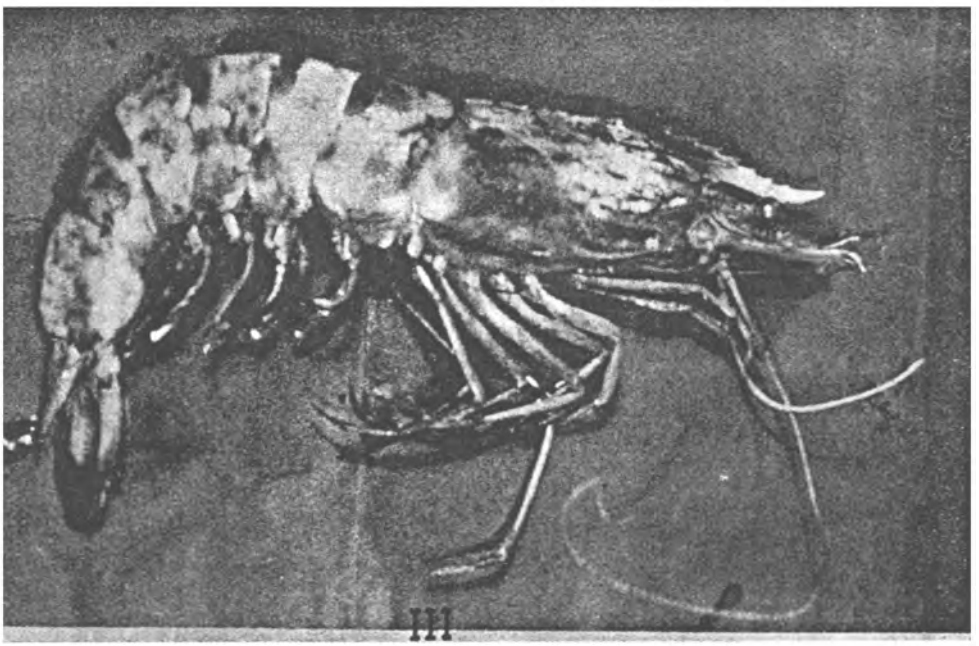


FIG. 5. The jumbo tiger prawn *Penaeus monodon*

on scientific lines. A good deal of biological information on cultivable species is available, but this has not yet been put to use on an industrial basis.

The importance of utilizing the vast shallow salt water lagoons for aquaculture is well recognised. Collection of Chanos (Fig. 3) fry and fingerlings from coastal areas and stocking them in freshwater ponds has been in vogue in several parts of the country, but culture of the species in salt water lagoons has not advanced here beyond experimental level. Seaweed culture of utilisable agar-yielding varieties has been visualised but not so far taken up on an industrial basis. A good many fish, molluscan and algal species could profitably be reared or cultured in lowlying coastal lagoons, backwaters and similar habitats if only we overcome certain biotechnical and economic obstacles.

It is quite evident from the present trend of research that the yield from these fisheries could be raised many times more than what is now known and it is one of the principal directions in which new research and exploration have to help. In addition, many new fisheries have to be located and their extent assessed. In this additional resources have to come many species of trawl fish, extension of fisheries for tuna and skipjack and newer seasons and new locations even for some of our well known fishes.

The world fish catch from the oceans at present amounts to something like 70 million tonnes per annum and there have been many justifiable speculations of the total landing of sea fish possible from the world oceans. It is worthwhile to note the phenomenal increase in sea fish catches during the past three decades, but it

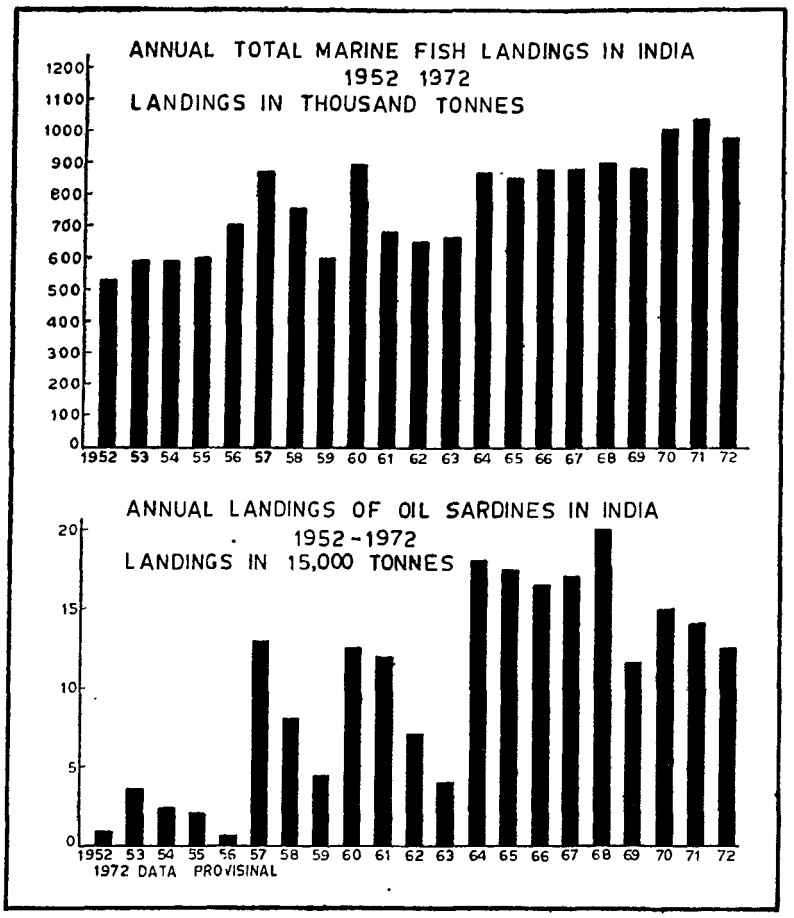


FIG. 6

is equally interesting that this increase has taken place in the major fishing areas of the world already exploited, such as the Northern Atlantic and Northern Pacific. Of the 70 million tonnes, the contribution made by the Indian Ocean, today is 2.5 to 3 million tonnes per annum but it has been estimated that the production from this ocean could be increased many times even with the use of existing technology. I made an estimate at the close of the International Indian Ocean Expedition that Indian Ocean could contribute about 20 million tonnes per annum and more accurate figures have now been worked out by Prasad and colleagues who place the Indian Ocean production at something like 14 million tonnes. But whether the total yield could be 20 or 14 is a secondary factor when we consider that the possible increased production is many times more than the present yield. Calculations for production have been mostly made from two basic data, firstly, based on primary production studies, that is the amount of carbon produced per unit area of ocean and, secondly, production based on the existing yield and assessment of stocks as they are. It is natural that figures based on primary production may be as high as

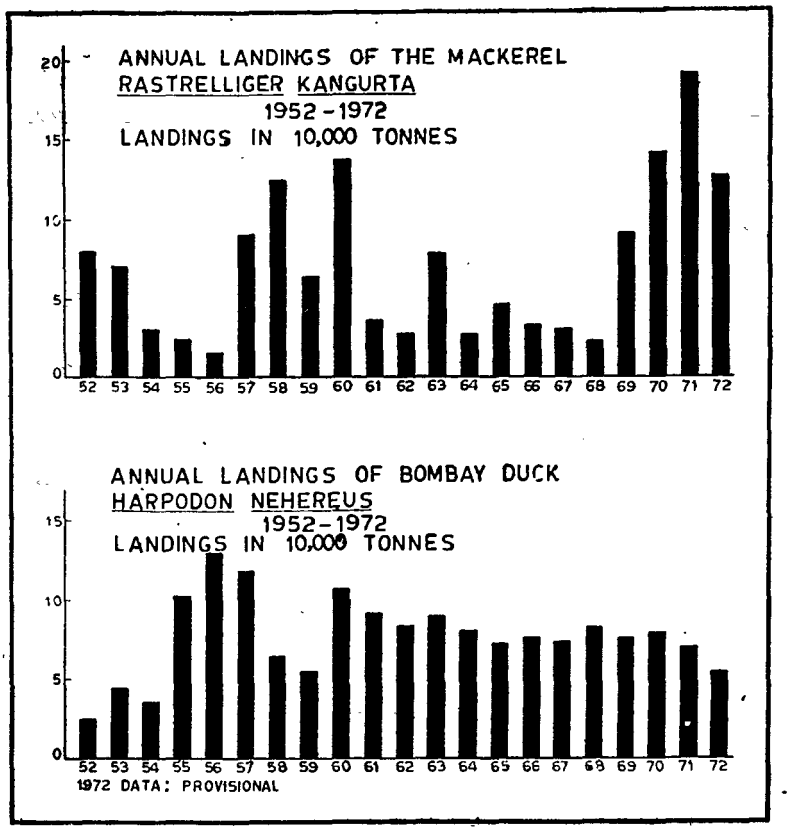


FIG. 7

200 million tonnes per year as has been computed in earlier studies. But it is equally admitted that the figures based on the stock assessment of existing and known stocks fall far short of the actual possibilities. The obvious reason for this is that yields may go up very substantially if any type of organism is harvested in the intermediate stages of the trophic web as against the apex of the food pyramid represented by the carnivorous fish. Towards the base of the pyramid are the shrimps, krills, molluscs etc. Recently Soviet scientists have estimated that the Antarctic krill alone could give an annual yield of a hundred million metric tonnes. The second reason why I consider the 14 million ton figure as small is the enormous openings provided by aquaculture in the coastal areas of sea where potentialities are immense. A third reason concerns the introduction of newer technology in the field of fish catching in the tropical areas where the populations of fish do not occur in high concentrations as in the temperate waters and as I ventured to suggest elsewhere, the use of light and even electrical energy would in the future be employed to concentrate populations.

Conservative estimates are that the total fish yield from the oceans will be twice the present figure, i.e. at about 140 million tonnes. Many colleagues, however, consider this too small and are inclined to place the world ocean yield at a ceiling,

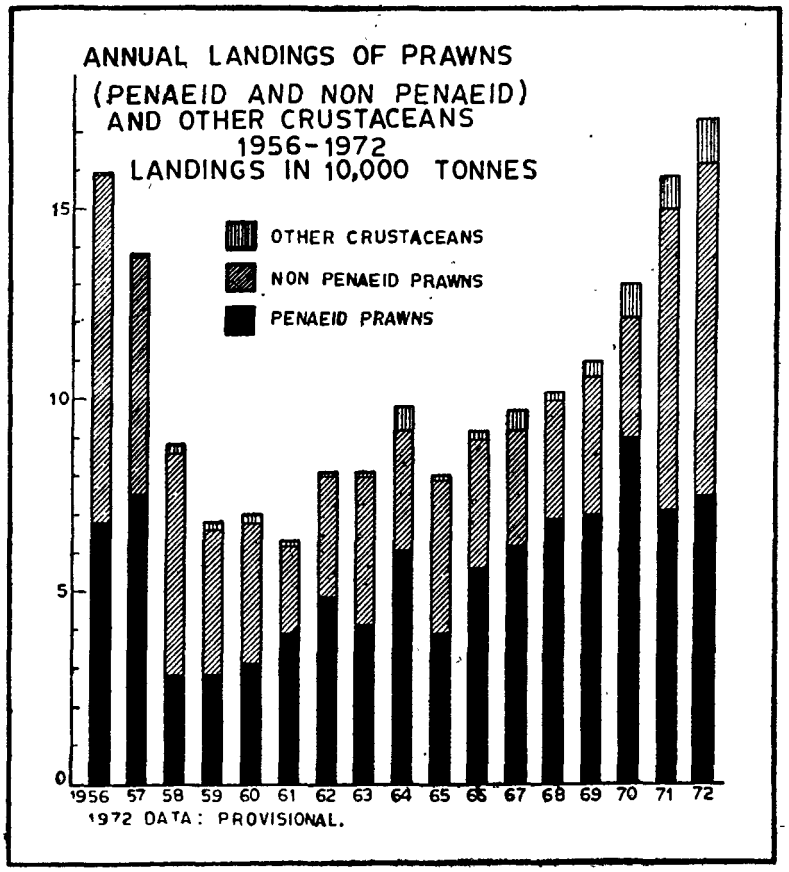


FIG. 8

figure of about 200 million tonnes per annum. But all these confirm beyond doubt that the Indian Ocean yield can be raised substantially. So far as the resources of the oceans around India are concerned in the context of the development of Indian Marine fisheries, it seems fairly certain that expansion has enormous scope but the constraints are in making the operations economically viable and seeing that the profits accruing are comparable with other industries.

If we have to obtain this increased catch and become a top maritime fishing nation, there are large scale changes which are imperative. The most important to my mind is the training and orientation of the personnel required for sustained marine fishing including distant water operations. It is here that the country must make full use of human capital already available in the several thousands of young men who live on the coast and who have been brought up on sea-going traditions. Such a tradition to brave the seas which has grown during the centuries cannot be built up by training alone. It is here that this finest human material could be harnessed by education and training towards the building up of a modernized coastal fleet and oriented towards an ever-expanding distant water fishing fleet. The efforts

already extended for fishermen training centres in the different states, the Central Institute of Fisheries Operatives and many such Institutional openings, although highly commendable, are indeed small in proportion to our needs in this sector.

The question of indigenous capability for trawler building has often been raised, but this need not be confined to fishing boats alone but to all types of equipment required for fishing operation. In this connection one of the happy developments in recent times has been that we are now able to meet the requirements of synthetic fibres for fishing nets which displaces the traditional cotton almost entirely from Indian manufacture. Modern fishing calls for sophisticated electronic equipment in echo-sounding and navigation and all these which we now import, should sooner or later be fabricated within our own country.

Integration of Marine Exploration, Research and Development

One of the earliest departments of the Government of India in fisheries has been the Deep Sea Fishing Station at Bombay. The primary responsibility of this station is exploratory fishing in offshore waters of the Indian coast. During these 25 years of exploratory fishing from Headquarters, at Bombay and the Centres at Cochin, Tuticorin, Visakhapatnam and Mangalore, considerable amount of work was done employing different types of vessels operated by them. There is no doubt that a large body of information has been obtained as a result of these studies. The types of fishes and their seasons for the different regions have been established in the regions north of Bombay. Commercial fishing has been opened up as a result of these pilot ventures. While these studies have been going on, the Central Marine Fisheries Research Institute has been making examination of the catches landed by the different types of vessels, and they have also been making studies of the fish landings on All-India basis. In fact, it is the work of the Central Marine Fisheries Research Institute through its Fisheries Survey Division which recognised the primary need to make a scientific assessment of landings throughout India and arrive at statistical estimates : species-wise, season-wise, place-wise and statewise. Today this is the only organization which provides All-India fisheries statistics of marine fish landings and for the first time now we have a clear picture of the resources on which the Indian marine fishery is based. It is unfortunate that a close link between exploratory fishing organisations in offshore waters and their catches for stock assessment on the major species has not been established; the two Institutions having all these years worked as independent components, namely, exploration on one hand and research on the other. Similarly, the Marine Fisheries Institute should have supplemented its observational data of fish landings with experimental fishing operation and field marine studies. This has unfortunately not been possible because of the lack of research vessel facilities for the Institute, although recognised by the Govt. of India as a need for the Institute right from the beginning. Even today the Institute has no vessel of its own but thanks to the support of the former Indo-Norwegian Project and commercial fishing organisations, the integration of research with the fisheries research problems is much better now than it used to be. It is equally hoped that a close tie-up of exploratory fishing operation with research would also be developed. One of the important developments in marine resources study in recent times has been the recognition of the part played by environment.

Oceanography has developed in a big way as a tool to successful commercial operations and in Japan, for example, oceanography and commercial fishing have been very well linked. The science of oceanography is itself new in India and it is only in recent times that a systematic study of the seas around the country has been taken up. A close integration of oceanographic research with experimental fishing and fisheries research is equally called for and we should aim at building up a good system of linking all aspects of processes in the sea beginning with the type of water masses, their mixing, their nutrient chemistry, primary production of these waters, secondary production and food chains, zooplankton distribution, fish spawning and nursery areas and commercial fishing areas and seasons. This aim is still to be realized but it is encouraging to note that there has been a steady movement towards achieving this and it is with this intention that different components in the entire gamut of marine research, have been fostered and strengthened.

Inland Fisheries

The inland fishery wealth of India is contributed by the fisheries of the rivers and lakes on the one hand and of the large number of ponds and larger bodies of enclosed waters on the other. To these may be added the new water resources created by the reservoirs developed out of multipurpose river valley projects where it has now been realised that fisheries could provide an excellent source of additional revenue and food. The rivers have been exploited for fisheries from time immemorial. Indian freshwater fisheries mainly depend on the major carps popularly known as Rohu (*Labeo rohita*), Mrigal (*Cirrhina mrigala*) and Catla (*Catla catla*) (Fig. 4). These carps breed in the rivers soon after the first rains of the monsoon. The spawn and fry are collected in large quantities from the major river systems in north India and used for stocking the large number of small bodies of fish ponds, notably in the States of Bengal, Bihar and Orissa. This kind of raising fish in the small ponds is popularly known as the pond culture industry. It is the fish cultural practice in the small bodies of waters which offers immense potential rather than fishing in the rivers themselves where the catch per unit of effort is steadily going down. The problem in regard to the river fisheries is likely to be one of conserving large fish reserves as the place where they could spawn providing fry and young for collection and stocking of the culturable waters.

The Indian fish culture industry so widely prevalent in the eastern part of the country, although diffuse and lacking in many scientific requirements, continues to make a most important contribution to fish supplies to the dietary of the people. Various State Governments during the past 30 years have tried to spread fish culture to their own areas either by raising the local species of carps or by importing carp fry and fingerlings from Bengal for stocking. Air transport of fry and spawn in oxygenated plastic bags has become increasingly popular.

The entire fish culture industry of the country depended upon the collection of fry and fingerlings from the natural spawning grounds of the major carps. They would never breed in confined waters. It was only towards the end of fifties that a break-through was achieved in inducing carps to spawn in captivity. This was achieved through the work of the Central Inland Fisheries Research Institute, particularly its Sub-station at Cuttack and some of our fisheries scientists, Choudhary

Rs. 56 crores per annum*(Table IV). Similarly, the amount of fish canned and utilised within the country and outside has also gone up. But we still have to effect a major breakthrough in regard to finding out an efficient alternative to canning fishes, in view of the prohibitive cost of cans in India caused by high cost of steel and tin. We have not done enough research in the direction of new packing material. Similarly the whole question of handling and marketing fresh fish which also involves transportation either by rail or by road have to be improved in a big way. It is not that ideas are lacking nor even the will, but the obvious difficulty is that improvements have to be effected without affecting cost structure and this is another area showing clearly the need for integration of research and development.

TABLE IV

Export of marine and allied products in India and foreign exchange earned during the last few years

Item	1963		1970		1971		1972	
	Q	V	Q	V	Q	V	Q	V
Frozen Prawn	3,967	2.12	22,135	24.25	23.181	31.34	30,550	50.88
Canned Prawn	1,231	0.78	2,578	3.95	1,864	2.98	1,058	2.10
Frozen frog leg	514	0.32	2,545	3.29	1,451	1.38	1,823	2.17
Frozen lobster tails	53	0.03	382	0.60	326	1.09	369	1.28
Dried fish	8,704	1.37	7,269	1.84	5,941	1.38	3,478	0.79
Others	3,439	1.24	2,266	1.60	1,269	1.00	993	0.91
Total	17,908	5.86	37,175	35.53	34,032	39.17	38,271	58.13

Fisheries Universities

Our universities and higher centres of learning are reluctant to accept new subjects within their fold, particularly those subjects which are reckoned as applied off-shoots of the major disciplines. Fortunately this attitude is rapidly changing and these few years have witnessed the emergence of several agricultural universities because it has been realised that a most important subject like agriculture in all its aspects could not receive adequate attention in the hands of the traditional universities. The most important industry in India is Agriculture. We have accepted this change as necessary. Fisheries is likewise dealt with in a perfunctory manner in the few universities which have taken interest in this subject. We have found in many places a complete ignorance of fisheries research because it is often confused with researches on fish, their structure, development, physiology, behaviour and many details which fall within the purview of zoological studies.

In the new concept of functions ascribed to agricultural universities, it is often envisaged that apart from agriculture, animal husbandry, and dairying should be legitimately handled by the agricultural universities, as one compact approach towards

*The latest values are of the order of Rs. 75 crores.

higher education, research, development and extension in the broadest sense in all aspects of land use. Some of the agricultural universities have thought it fit to include fisheries also within their ambit. If all the facilities required are provided together with qualified teachers and equipment, there is probably no harm in such an approach but often what happens is that the subject gets relegated to a minor position. Recently we have seen the opening of fisheries departments in the traditional universities and in some of the agricultural universities. The really well equipped institutions to impart instructions in fisheries and which have been discharging this function with great credit like the Central Institute of Fisheries Education in Bombay, the Central Institute of Fisheries Operatives in Cochin and the Training Centre in Inland Fisheries at Barrackpore, are not receiving recognition as university centres.

To my mind much confusion is now being created by the mushroom growth of fisheries departments proclaiming to give degrees without adequate provision for laboratories, equipment and good teachers. It is not realised that the question of organizing and developing a marine fishing industry as well as inland fish culture is a complex one in which the close intellectual association of biologists, chemists, technologists, engineers and economists are involved and the subject is broad-based enough calling for development of fisheries universities. This has been successfully carried out in Japan and a few other countries. If at least we have one National Fisheries University it should be possible for all the institutions imparting instruction in this subject to be affiliated to this, for teaching at degree, post-graduate and research level. This is probably the best solution to the complex situation prevailing in our country if we are to keep our standards of teaching really high and attract candidates of high intellectual calibre.

I visualise that in the same manner that agriculture has received a newer recognition through the emergence of agricultural universities, a big step forward would be achieved by the federation of the different centres of learning in fisheries and allied subjects into one connected system so that the status of teaching, research and higher learning in the subject will reach a high level of intellectual and industrial proficiency. It is hoped that in the years to come the subject of fisheries which has strong social objectives for food, employment, and increased national income will be fostered and consolidated at educational centres, bringing together physical, biological and social scientists, in the pursuit of knowledge relating to resources, development, conservation and utilization and the application of that knowledge for the good of the nation.

I have tried to give a brief review of the salient points concerning Indian fisheries with special emphasis on the need for close tie-up of research and development. We in India are always well-known for institutions and individuals working in isolation without adequate contact and communications with one another. This rugged individualism which is peculiar to Indian enterprise and which has been the main reason for lack of progress in many fileds is also evident in the field of fisheries. We find fragmentation of efforts between various institutions and even between Central and State Governments. This is a field requiring a higher sense of dedication to the common cause to achieve and solve the common problems in the quickest possible way forgetting the institutional, sectoral or governmental affiliations. Such

a unified approach, paying equal attention to research, development, education and extension, upholding the common cause of application of knowledge to the improvement of fisheries can go a long way to the rapid development of the Indian Fishing Industry.

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