ZOOLOGICAL RESEARCH IN RELATION TO DEVELOPMENT OF FISHERIES*

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IN inviting me to participate in a symposium on "Zoology and the Food Problem", our last year's President, Dr. B. N. Chopra, wanted me to elucidate "how zoological studies and research can help us in conserving, augmenting and utilising in the best possible way the fishery resources of India". My task has been made much easier by Dr. Chopra himself because in his Presidential Address, he brought out very ably the necessity and importance of scientific research in the development of fisheries. The members will also recall that at the Jubilee Session of the Congress held at Calcutta in 1938, the overseas and the Indian delegates of the Zoology Section reviewed the fisheries of the country in relation to food supplies and felt it necessary to urge upon the Government of India the desirability and "importance of constituting an All-India Department of Fisheries for the development of the fishery resources of Indian waters on scientific lines". The delegates were further of the opinion that, "unless development of the fishery resources of Indian waters is carried out with due regard to the scientific principles which form the basis of successful fishery developments, there will be grave danger of irreparable damage to the fisheries concerned". In commenting on the limited scope of the work done by the Fish Committee of the Imperial Council of Agricultural Research, Dr. Chopra advocated that—

> "Fishery research is a wholetime job and the problems connected with it are too numerous and too involved to be satisfactorily handled as a subsidiary activity of a section of the Imperial Council. Like agriculture, fisheries should have an Imperial Council of Fisheries Research under the scientific control of an expert Fisheries Officer, with a band of scientists working on its staff, with technologists trying to solve the difficulties experienced under varying conditions all over the country, with marketing experts always keen to devise means for better distribution and better utilisation, and with the whole body alive to the ideal of providing 'better food, more food, more and better fertilizer, better organization', and last but not the least, to the improvement in the moral and material conditions of the poor fishermen, for on his well-being will ultimately depend the prosperity of the industry."

Thus, it will be generally conceded that for the development of the fishery resources of India, there is an urgent necessity of undertaking scientific investigations on fishery problems by means of a carefully planned programme of co-ordinated scientific research, which, to be effective and efficient, should be controlled by one central authority for all India. I hope this Session of the Congress will also urge on the Government the necessity and importance of starting a central organisation for research in fisheries.

Nature of Fishery Investigations

Confining myself now to zoological research in relation to the development of fisheries, I wish to invite your attention to the remarks made by the late Dr. N. Annandale regarding the nature of fishery investigations. According to him, these may be considered conveniently under two heads, (*a*) biological and (*b*) human.

> "Under the head 'biological', attention must be paid to the physical environment of the fish; to the fish themselves, their species, their life-history, breeding-habits and food, their enemies and, in the case of rapacious fish, their prey.
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> "Under the head 'human', one must take into account methods of capture, fishery statistics, fishery laws and customs, customs and regulations as to the sale of fish, prices, demand, even the character and social status of the fishermen."
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> "In all fishery questions it is of the first importance that due consideration should be given to all of these points and neither the human side of the enquiry sacrificed to the biological, nor, as is more common, the biological to the human. Biological training does not give a man local experience; it may not even make him a good judge of character, but still less does local knowledge or administrative capacity enable a man to speak sensibly on technical subjects such as biology without profound study."—(*A Note on the Fisheries of the Inlé Lake, Southern Shan States,* Rangoon, 1917, p. 1.)

Zoological Studies and Fisheries

In the light of these observations, let us now analyse how zoological studies and research can help us in the development of fisheries.

Environment of the Fish.—We all know that environment plays an important role in the life of an organism and that its rate of growth, health, longevity, etc., can be greatly influenced by making suitable alterations and adjustments in its environment, both physical and biological. For increasing the yield of our fisheries, it is necessary, therefore, that all factors that constitute the environment of any particular species should be studied and their influence on its well-being elucidated. For instance, in European countries through the accumulation of a vast body of accurate knowledge regarding the hydrography of the seas, the chemistry and physics of sea-water, its circulation, currents, seasonal changes and fluctuations in the water, and the planckton, both animals and plants, and its annual changes,

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rapid progress has been made in fishery science and most of the problems which the European fisheries present are now well understood. The problems of the marine fisheries of India are similar and, therefore, for their elucidation a study of all the ecological factors influencing changes in the fish populations is most essential. In the case of freshwater fisheries, it is well known that all pieces of water are not equally productive and that through manuring the tanks and artificial feeding of fish poor tanks can be readily converted into good fisheries. The sources of river pollution and the means to prevent it, and the construction of suitable fish passes in irrigation and hydro-electric weirs to ensure the free movements of migratory fishes are all problems of environment which need a careful study of the habits of fishes at the hands of zoologists before engineers can devise suitable measures for the conservation of fisheries. In all such studies, the role of the zoologists is to correlate the bionomics of any particular species of fish with the physical and biological factors in its environment. There is no doubt that in some cases collaboration and help of chemists and physicists is needed to understand properly the physical environment of a fish, but of late the bases of zoological teaching have been so broadened that several zoologists have qualified themselves for undertaking research in these lines also.

Systematics of Fishes.—The value of the systematics of fishes in the development of fisheries is generally underestimated, but a slight reflection will show that unless we can differentiate species, any real progress in ecology and bionomics of the food fishes is not possible. It is worthwhile to recall that in considering practical measures, which should be adopted for the development of fish industry in India, the *Ad hoc* Fish Committee of the Imperial Council of Agricultural Research in its meeting held in November 1937, expressed the opinion that—

> "In order to effect development upon satisfactory lines, it was necessary to carry out local surveys of the amount and class of fish available and in this connection proper identifications of the fish caught in each area was essential."

I can perhaps illustrate this point better by referring to the Hilsa fishery of India (*Journ. Roy. As. Soc. Bengal*, Science, VI, No. 2, pp. 93-112, 1941). We have found this species breeding under different conditions of salinity right from the deltaic region of the Ganges to as high up as Allahabad. We have also found that the Hilsa of East Bengal is somewhat different looking from the specimens taken from the river Hooghly at Calcutta. So the question naturally arises, are we dealing with one or more species under *Hilsa ilisha* (Hamilton)? On the analogy of Herring-fisheries in European waters and on the basis of our studies, European and American fishery experts have already surmised that there may be different races of Hilsa in our waters which breed under different environmental conditions. Hilsa, as we all know, is essentially a marine fish of the Herring family and, as at present understood, is known from the Persian Gulf, where it ascends into the Tigris river; from the coast of Sind, where it forms an important fishery in the Indus river and the Bay of Bengal whence it ascends into all the principal rivers of India and Burma. It is quite possible that different varieties and races of this species are found in Indian waters, but this point has not been investigated so far. Unless we thoroughly understand the systematics of this species, work on its ecology and bionomics for the proper management of its fishery may prove to be misleading.

It will thus be conceded that taxonomic studies form the bed-rock for all aspects of fishery research and development, and for these studies a sound knowledge of zoological science is most essential.

Breeding Habits and Life-Histories.—It is generally realised that for the development of the fishery resources of freshwaters, the establishment of hatcheries for the restocking of tanks, reservoirs, rivers, etc., and the framing of legislation to prevent interference with the spawning of freshwater fishes and the destruction of fry are some of the necessary measures which should be adopted. In recent years, these very measures have been advocated for the development of some of the marine fishery resources also. Even a very casual consideration of the above-mentioned problems will show the great need of zoological research, for without the knowledge of the breeding habits and life-histories of fishes, administrators are bound to commit several blunders in framing or administering fishery laws. I shall just cite one instance which will make this point clear. In the Inlé Lake, Southern Shan States, Burma, there are several species, about two dozen, which do not attain more than a couple of inches in length. There is an extensive and lucrative fishery of these small fish which yields a handsome revenue to the Government. Some administrator thought that these 'young' fish should be protected but the timely researches of the late Dr. N. Annandale (*Rec. Ind. Mus.*, XIV, P. 33, 1918) showed that these were adult fish and the fishery could continue without causing any deleterious effect to the productivity of the lake. "Close seasons to prevent annihilation of a species should always be based on research into the reproductive habits of the fish in question and disputes between owners of different types of gear can only be settled after attention to research on the swimming habits of the fishes taken by them" (P. E. P. Deraniyagala, *The Fisheries of Ceylon*, p. 8, Colombo, 1932).

The necessity and importance of the studies on the breeding habits and life-histories of all important food fishes for the development of fisheries is so obvious that I need not dwell any further on this point. Suffice it to say that these studies constitute purely zoological research which can be carried out best by specially trained fishery zoologists.

Biology of Fishes.—Under this heading we may consider all problems connected with food, growth-rate, enemies, parasites, migrations, and so on. The question of natural and artificial foods for fishes, especially in fish farms, is of

vital importance. We as zoologists know that all animal actions are determined by three main impulses, search for food, protection from enemy and propagation of the race. Several important fisheries depend upon the relative abundance and scarcity of food and the annual and periodic fluctuations in their yields are mainly influenced by the amount of food available in any particular year.

The biological problems enumerated above are more particularly concerned with freshwater fisheries where large number of fish are very often kept in a limited space, and where growth-rate, food, enemies and parasites can be controlled through the application of approved methods of fish farming. In the case of India the freshwater fisheries are of special significance from the standpoint of ameliorating the condition of the rural population.

"Human" Aspect of Fisheries

It has been shown above that in dealing with the 'biological' investigations connected with the development of fisheries, zoological studies and research have an important role to play. Even for the elucidation of the items listed by Annandale under "human", it will be noticed that a statistician with a zoological training will be able to collect more reliable fishery statistics than a person without any training to differentiate species or without any knowledge of the problems discussed above. For devising more suitable methods of capture, a knowledge of the swimming habits of fishes and the direction of migration will be of inestimable value. Similarly for devising fishery laws or regulations as to the sale of fish, a fair knowledge of the ecology and bionomics of fisheries is essential for suggesting effective measures.

It will thus be seen that for practically every aspect of fish production and conservation, zoological studies and research from the basis of an up-to-date fishery management. However, when we come to the utilisation of the product, zoologists need the help of technologists and marketing experts. Even here much better results can be expected from persons with a certain amount of zoological training and biological outlook.

Importance of Fisheries as a Source of Food

Having discussed the close relation that exists between the development of fisheries and zoological research and in view of the fact that the subject of the symposium is Zoology and the Food Problem, I wish to say a few words about the importance of fisheries as a source of food. As man must get his food either from land or aquatic sources, there are correspondingly two basic food industries, one comprising agriculture and animal husbandry, and the other, fisheries in a broad sense. The aquatic foods have one great advantage that they contain all the essential food elements, such as vitamins, minerals and proteins. It is necessary, therefore, that our fishery resources should be properly husbanded so that in times of emergency, like the present, they can be utilized very fully to supplement the deficiencies and failures of crops and food from the land. In their present undeveloped state, it is estimated that the value or primary production from fishing and hunting is only 120 millions of rupees and that the total catch of fish is 7,000,000 tons which, according to Dr. Radhakamal Mukerjee, yield ·7 billion calories as against the total requirement of the Indian population amounting to approximately 292 billion calories per annum, allowing 2,800 calories per man per day. These data indicate very clearly the great necessity of augmenting the present yield from our fisheries which are potentially very rich.

Importance of Fish in Indian Diet

As fish forms a specially valuable addition to a diet the staple of which is rice, it will be seen that its demand is greatest among the rice-eating population of India. For the same reason, in the countries of eastern and south-eastern Asia, and the adjacent great islands, the fisheries have always been of peculiar importance; since the mass of the people prefer fish to any other form of animal protein. In the north-western parts of India, where wheat forms the staple article of diet, dairy products and meat provide animal proteins in the dietary, while as we proceed eastwards along the Ganges or southwards to the peninsula, where rice forms the staple diet, dairy products become of less importance in the dietary, but fish, oil and root and leafy vegetables are in greater demand. In these parts of India even small fishes, which are good sources of protein, and sometimes of vitamin A, calcium and other inorganic elements, are consumed by non-vegetarian castes in fair quantities. From the dietetic surveys so far carried out in India, it seems that the conservation of fisheries and the greater use of fish as a principal article of diet are indispensable for the health of the nation.

Summary

Attention is directed to the necessity and importance of scientific research in the development of fisheries and it is indicated that nothing effective can really be done in India until there is a central organisation for fishery research. Reference is made to the nature of fishery investigations and it is shown how problems connected with the studies on the environment of fishes, systematics of fishes, breeding habits and life-histories, food, growth-rate, enemies, parasites, migrations and so on are dependent on zoological research for their proper elucidation. Even such items of fishery management as fishery statistics, fishery legislation, marketing, etc., can best be done by persons with zoological training and biological outlook. Thus in practically every aspect of fish production and conservation, zoological studies and research have an important role to play.

Reference is made to the importance of fisheries as a source of food and to the present-day estimated yield from Indian fisheries. The importance of fish in certain Indian diets is also indicated.