PHYSIOLOGICAL ZOOLOGY AND FISHERIES

BY

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Speaking in general terms, the main objective of fishery biology is to increase the available fishery resources by the exploration of new fields and facts concerning the organisms that comprise the fisheries. Their periodical abundance or scarcity, habits, movements and life histories, if fully known, would help us to take full advantage of what already exists in Nature, and to work out measures to prevent their depletion or even total extermination by indiscriminate fishing. In this aspect of work, we have only made a beginning in India and have yet to learn a great deal, considering the vast number of species that live in our waters and the wide variety of habitats they confront.

An equally important aspect of fishery development is to attempt to increase the already existing resources. If we know well enough about the constitution and habits of our fishes, can we increase their populations by natural or artificial means or by planned cultivation ? It is in this direction that physiological zoology can contribute to fisheries development by providing the basic data on conditions of life and adaptation of culturable fishes on which the success of pisciculture depends. I shall now indicate a few aspects of functional activities of organisms that may help us solve some of our problems.

1. *Temperature :* We are indebted to the work done by European workers in countries bordering the North Atlantic for much of our fundamental knowledge of the science of marine fisheries. Problems of fresh water fisheries have also until very recently, received close and critical study only in Europe and America. While applying this most useful information to fishery problems in the tropics we have to contend with the considerable difference in the temperature conditions that prevail between European waters and our own. In many tropical regions there is the complete absence of sharply demarcated periods of winter and summer with the result that annual fluctuations in temperature of tropical waters

are small as compared with those of the colder regions. The natural inland waters such as lakes are perpetually active in the biological sense, that is, without any period of dormancy which, if present at all, is the period of total drying up of the smaller areas of water in summer resulting in the destruction of most of the organisms contained therein.

It is well known that biological and chemical processes are activated by rise in temperature. Consequently the rate of growth in tropical waters is much faster than in colder regions; often we may have within the same year several generations of a species whose opposite number in temperate waters may require one full year or more to pass from one period of spawning to the other. While the rapid growth and early attainment of sexual maturity are an advantage in the culture of tropical fish, the small size of some of the quick growing species is a disadvantage as they seldom grow to the same size as the slow-growing ones. In the selection of an ideal species for culture one has to strike an advantageous mean between the mass of food produced and the time involved in producing it. In successful large scale operations it is usual to select a species which is tolerant to variations in temperature and adjusts its behaviour to suit widely varying temperatures.

2. *Salinity and Regulation*: Marine fishes of the coast tolerate slight variations in salinity corresponding to the seasonal changes taking place in the seas but there are not many marine species of commercial value which can survive great changes in salinity. Migratory forms like the *Hilsa* are known to live in fresh and salt water. Marine teleosts or bony fishes have highly developed powers of adjusting their salt and water content—osmoregulations as it is technically spoken of—involving steady elimination of salts through the gills to maintain a concentration much below that of the sea water, but the power of penetration of such fishes into fresh water is confined only to a few groups. It is essential for us to know which species have high powers of regulating their salt and water content, as these would be the most suitable for culture work as shown below. The milk fish, *Chanos chanos,* and many mullets are capable of living in waters of varying salt content, especially in their young and juvenile stages, and have been cultivated for centuries in S. East Asian and other countries. They seem to offer new fields for further development in our own country, if we could determine the most suitable for farming and the most suitable habitats for successful culture. Methods introduced to cultivate *Chanos* in India have already yielded valuable results.

The long coast line of India is indented by large and small rivers flowing into the sea, forming deltas, and a number of smaller creeks and backwaters. The very considerable amounts of fresh water brought down by rivers in spate during the monsoons contribute to the formation of a significant habitat on the coast line which may be called "the blackish water zone". The marine lagoons, so characteristic of the Coromandel Coast of India form a distinct zone of great potentiality for piscicultural operations which could be developed like the "tambaks" of Indonesia. These areas, as indicated by surveys carried out in the Gangetic delta, the Chilka Lake, the Madras backwaters etc., have a high biological productivity as shown by their rich fauna both in numbers and species. Many young fishes and prawns from the sea are known to ascend into the habitats described above to feed and grow, only to return to the sea when full-grown where alone they breed.

Although in cultural operations, the considerable variations in salinity occurring in the coastal zones are a hindrance to their full utilisation, a fuller knowledge of the physiology of the species would help to obviate certain difficulties. The predominant elements of the fauna and flora of these zones are known, and judged by the ecological data available there are species of Cichlids, Mullets and Perches among fishes and many species of Penaeid and Palaemonid prawns among shell-fish that could probably be employed for culture work. I venture to think that more intensive studies on the adaptational behaviour of these estuarine animals, with a view to selecting such of those as may be suitable for artificial culture would yield valuable results than direct observations on these animals in the field which may take many years. With some experimental data gathered it should be easy to apply them to practical field tests.

3. *Importance of trace elements in growth :* A line of work which has come to the fore recently is that which concerns the importance of minute traces of certain elements for the growth of plant life as well as for the continued vigour and growth of certain animals. It is well-known that minute plant life, particularly the flagellates and the diatoms, form the first and the strongest link in the chain of marine and fresh water life. More than 25 years ago Allen found that it was possible to culture artificially certain marine diatoms only either in sea water or in artificial sea water to which a small amount of natural sea water has been added. The presence of the natural sea water seemed to act somewhat like vitamins in food substances ! A very effective method of artificial

culture of diatoms and zooplanktonic organisms has been developed by Gross which has been successfully employed on a large scale in what are called plankton shafts. In this method, an extract of the earth or the soil (hence called in German "Erdschreiber" method) is added to the culture, in addition to inorganic salts, presumably to provide the trace substances essential for growth, of which, it has been found by Harvey that manganese was one. The importance of phosphates, nitrates and silicates in plankton production and control is too well known to need emphasis.

The problem of finding the essential nutrient salts for culturing organisms, although far from being fully solved, has helped us to appreciate the importance of fertilizers in increasing the productivity of natural waters. The subject is of particular interest to our country with a large number of small areas of inland waters both saline and fresh water suitable for artificial treatment. There is great need and urgency for fundamental research on the lines indicated above. Recently, British biologists led by Gross achieved striking results in their experiments on a Scottish Loch (an arm of the sea) where they grew flat-fish under what may be called artificially manured conditions by adding considerable amounts of nutrient salts. The detailed results now published may well provide the starting point for a new phase in pisciculture. The use of chemical fertilizers for increased yields in fisheries may not necessarily be economical or practicable even in industrially advanced countries like the U. K. Under the present economic conditions in India any extensive use of chemical fertilizers for culturable water masses appears remote. The fundamental idea that waters, like agricultural land, can be fertilized to increase the yields should, however, receive wide publicity in this country, so that we could explore possibilities of utilizing organic and other waste products for enriching our fallow waters.

A better appreciation of the properties of the natural waters would again be of great value. The presence of small amounts of chloride is essential for the physiological regulation of most freshwater animals. Owing to the widespread occurrence of the phenomenon of active ion-absorption, most aquatic animals are able to utilize these irons, even when they are present in the surroundings in exceedingly minute quantities. Secondly, calcium is essential for growth and for the maintenance of healthy epithelia through its influence on membranes, thereby playing a vital part in adaptation to the surroundings. Chloride and calcium ions present in water are thus important factors to be considered in fish cultural opera-

tions as also the acidity or alkalinity of the waters. It is often found that acid waters invariably contain only lean fish not growing to any appreciable size which are obviously uneconomical. Fortunately, acid waters are few in India. Fish culturists always find it essential to correlate the properties of the environment with the physiology of the edible fishes cultivated.

4. *Reproduction :* The physiology of reproduction of species which are of value in fish culture is a problem which requires special attention. Most of such species do not spawn in captivity and hence the elaborate technique of collecting the fish spawn or fry from the natural spawning habits and transporting them to fish farms has had to be developed. If methods are found to induce adult fish to produce young ones in captivity the fish cultural procedures would be substantially simplified.

A few aspects of physiological work relating to fisheries have been indicated here but only the fringe of a vast field has been touched upon. Active investigations on problems of growth, adaptation, and reproduction are essential and should commend themselves to our rising zoologists who will find in them not only topics of absorbing scientific interest but of successful practical application to fisheries.