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POSSIBILITIES OF FURTHER EXPANSION OF FISH AND PRAWN CULTURAL PRACTICES IN INDIA

ONE of the geographical peculiarities of India lies in the existence of vast low-lying areas along the entire coastline both on the East and West Coasts, although they tend to occur more extensively on the East Coast. As these areas are saline they are unfit for agricultural purposes. Soon after the monsoons these get inundated with a few feet of rain water and in addition, tidal water often comes in from the sea, either trickling over the sand bars or through temporary connections established with the sea during the monsoon months. The water in them is invariably saline, but the salinity is subject to a great deal of fluctuation from about 5 to 50 parts per mille, the higher values being observed during the summer months. Towards the end of summer the salinity further increases; patches of water get isolated and the shallower ones dry up: some of the remaining deeper pools contain waters so highly saline as not to support any appreciable amount of life with the exception of halophilic blue green algæ and bacteria. These extreme conditions of drought are not observed on the West Coast which is served by both the South-West and North-East Monsoons.

It is obvious that if these areas can be developed so as to be available for food production they would make a substantial contribution to the food resources of the country. A good proportion of them is capable of being developed into marine fish farms of the type found in some parts of Italy and Southern France for the cultivation of marine fish, principally mullets. The suggestion was first made by Hornell,[1] but no active steps have been hitherto taken; most species which he considered suitable cannot now be recommended for culture. Fortunately, we are not lacking in other suitable species since many of the mullets (*Mugil* spp.) and the milk-fish (*Chanos chanos*) found on the Indian Coast can withstand wide salinity changes.[2] Physiologically, what would be ideal are species which prefer low salinities in their younger stages and as growth proceeds, prefer progressively higher salinities. Species chosen

for fish cultural purposes should in addition be such as would benefit from the primary food cycle of waters or, in other words. should be algal, vegetable or detritus feeders so that they will not have to be dependent on other animals for food. Many of these advantages are combined in *Chanos chanos*, the fry of which appear in considerable numbers in certain parts of the Indian Coast, particularly in the Pamban area in the months April-June. As *Chanos* fry can be stocked in inland waters and grown to marketable size, there is urgent need to expand the fry resources by locating more centres from where the fry could be secured. At the present time the supply is much less than the demand. The available information on the occurrence of *Chanos* fish-seed in S. India has been recently summarized.[3] The main season for fry is during the drought period but this drawback will cease if an auxiliary season is generally prevalent as has been recently suspected.[4]

For the proper utilization of the coastal shallow tracts for *Chanos* or mullet culture, permanent reservoirs of water should be formed by excavation, bunding and by the provision of sluice gates connecting them through feeder canals with the sea so that water could be allowed in as required. The coastal tracts are extensively developed into salt-water ponds or 'tambaks' in Indonesia where *Bandœng* or *Chanos* culture has been developed into a highly specialised fish cultural practice.[3,4] Where tides are not strong, pumping devices are employed in that country. So far as India is concerned, development of marine fish farms is a distinct possibility which should be explored by carrying out preliminary trials in selected areas. Rao[7] has estimated the available area for this purpose at 2,000 square miles and has computed an annual production of about 500 lb. per acre at an estimated initial cost of Rs. 10,000 per square mile; it is clear that fish production even at half the above figures per acre would be a major contribution to the annual fish-yield of the country. The problem is, however, the combination of tidal amplitude and sea level with the lay-out of the farms and, unfortunately, the tidal range is rather small in most of the open coasts of South India. Inexpensive pumping devices have to be worked out for such areas. In places where natural connections with the sea exist for these saline lagoons or where small streams open into the sea, it is observed that such areas have a rich fauna and flora both in numbers and species, contributing to the brackish-water or estuarine biotope.[1] Similarly, in sheltered areas along the coast there is a rich marine fauna; very productive fisheries exist in the saline coastal lakes of Chilka and Pulicat. These factors would probably indicate that coastal fish ponds, if developed, would likewise develop a rich flora and fauna and also offer possibilities of enriching these waters by organic manures. The employment of chemical fertilizers will probably be beyond our means until their production in the country has made substantial progress.

The question naturally arises whether we could make better use of these areas than is now done without much expenditure for developing them into artificial marine fish farms. If the area is to be used for growing fish, we should require species which would grow to marketable size within 3 or 4 months, for that is all the really reliable period when water is available, and whose fry could be obtained on the coast in large numbers for stocking purposes. No such species at present seems to exist which would give reasonable harvest in so short a time, but there is need for much closer study on the subject. *Trichogaster pectoralis* (Regan) which grows to a length of 8 inches in 10 months' time[8] is probably suitable for areas where water is retained for longer periods, but it is known to be suitable only for waters of solinity less than 10 parts per mille. Similarly, it would appear that *Tilapia mossambica* Peters which was introduced into Malaya by the Japanese during the World War II might be another successful species. Both are not found in India and have to be introduced, but we are now not in a position to recommend the introduction of these species without ruling out the indigenous species, and without making sure that these species are not likely to affect the local ecological conditions and cause adverse effects. However, since both these species are non-predators, the danger to the autochthonous fauna is not great. The short duration available for growth, and the fact that both these species prefer waters of lower than higher salinities introduce serious handicaps in their selection for the utilization of marine coastal belts. The question of introduction of *Tilapia mossambica* deserves close study and it is necessary to formulate a national policy as to whether this species should be kept out of India, or its introduction actively encouraged. Being a hardy and euryhaline species with a comparatively high rate of reproduction, mouth breeding and with intermittent spawning seasons, it may be fairly

certain that, once introduced, the species would become permanently established as it has in many places in the Far East. Our indigenous species which might be affected are probably the fishes belonging to the same family Cichlidæ in India, *viz.*, Etroplus *maculatus* (Bloch) and the Pearl Spot *Etroplus suratensis* (Bloch). The latter is a highly esteemed fish thriving in the back-waters and adjoining brackish tracts of the S.-W. Coast of India and in smaller numbers in some of the coastal districts of the E. Coast and steps have been taken by the State Fishery Department of Travancore-Cochin and Madras to popularize its culture. The fish is a nest builder and the rate of reproduction is discouraging for its selection as a species for large-scale culture. There has been a most marked depletion of the fisheries in the back-waters, canals and low-lying areas in Travancore during the past ten years, owing probably to the intensive fishing which has been going on without replenishment having taken place. Many areas which formerly used to yield appreciable numbers of *Etroplus* have ceased to be so. Although the probability exists that the fertility of the waters might have gone down in recent years, it is difficult to overlook that large amounts of organic food is still available in these waters especially after the first few rains. Under such circumstances the introduction of omnivorous feeders which can tolerate wide variations in salinity and which can reproduce more rapidly than *Etroplus* and establish as permanent species is an obvious suggestion. For raising a profitable crop of fish in the large numbers of small perennial ponds in the low-lying areas of the West Coast of India, there is also need for fish that would breed in the small volumes of water. *Tilapia mossambica* can successfully establish in closed waters and satisfies most of the requirements of salt-water fish culture.[9,10] However difficult it be for most zoologists to view the introduction of exotic species with equanimity, the question deserves close study.

It is well known that unchecked activity of predator species has in many areas been the cause of depletion of fisheries and no organized attempt has yet been made in many parts of India to remove and exterminate predators. It is also not realized that carnivorous species are best removed from small-scale fish ponds. On the other hand if they are cultured, the need for animal intermediaries in the food cycle of these species is not fully appreciated and provision is not made for the growth of species which would serve as food for the carnivorous forms. The author has come across large numbers of perennial ponds in Travancore which support a rich plant life, but as regards fish fauna they contain nothing except occasional *Ophiocephalus* and many ponds of brackish water on the fringes of saline tracts, although rich in algæ, often contain little or no useful fish life. The need for hardy and quickly establishing crustacea valuable as food to other fishes is necessary in these waters. There is already one indigenous mysid which is found in the back-waters and estuaries of the East and West Coasts of India, *viz.*, *Mesopodopsis* = *Macropsis orientalis* Tattersal which can be successfully spread by transplantation and can be cultured; it is a most hardy salt-water species capable of life in waters nearly fresh[11] and is consumed as food by most estuarine species.

Oyster culture is another line of utilization, but the people of this country have not yet taken a liking to this highly nutritive form of food, so that large-scale development of oyster farms cannot be recommended at this stage.

There is, however, a source of marine life which appears to be capable of more extensive utilization and offers scope for extended cultural practices. The prawns belonging to the family Penæidæ are extensively distributed in our seas and contribute to most valuable fisheries.[12,13] They are accepted as food by a majority of our people; they support a large volume of profitable export trade and fresh or frozen prawns are beginning to provide the basis of a luxury trade. The principal genera involved are *Penæus*, *Metapenæus* (= *Penæopsis*) and *Parapenæopsis*. The last-mentioned is mainly a marine genus, but species of *Penæus* and *Metapenæus* occur on the coast as well as in the back-waters. It is now known from the work of several investigators that these prawns which hatch out as nauplii unlike many other marine Decapods come near the shore when they are very young and ascend back-waters and estuaries when they are of sizes varying from 10-20 mm. In the habit of their breeding only in the sea and coming on shore when young, they resemble *Chanos chanos*. As is natural, the earliest phase in the development of farming operations is the trapping of fry found on the coasts and rearing them in convenient natural enclosures. The prawn clutural practices developed on the coast of Travancore-Cochin are based on the simple procedure of trapping the post-larval and young penæids in the paddy fields adjoining

coastal canals where they have entered from the sea by allowing tidal waters freely to enter the fields during high tides and to have closely meshed nets placed at the entrances to the field when the water flows out.[13] Selection of species is not possible by this method, but advantage is taken of the habits of the post-larval penæids whose appearance in large numbers coincides with the bunding operations of the rice fields soon after the North-East Monsoon, the fields being thus used for prawn culture during the season when not required for rice cultivation. In Bengal, Hora and Nair[14] have indicated how the salt-water Bheries of the Sunderbans area could be further developed so as to yield better supplies of fish and prawns than they do at present.

Young Penæids are found in all the coastal waters of India during most parts of the year—more especially, during the season October to January. On the East Coast of India large numbers of them are seen in the months immediately following the North-East Monsoon in October-November. Young ones of *Penæus indicus* M. Ed. and *Metapenæus monoceros* (Fabr.) have been found in most parts of the East and West Coasts and it appears from their distribution in the Indo-Pacific area that the species can be expected in most coastal areas, especially where there are tidal creeks or mud flats. On the East Coast a less abundant form is *P. carinatus* Dana which grows to a larger size than the other two in the coastal areas. Many other species like *M. dobsoni* on the Malabar Coast and *M. brevicornis* in Bengal are abundant and already form valuable fisheries. Most coastal areas of the E. Coast are admirable centres for the collection of prawn fry. Judged from the available data as well as from the observations of Schuster[15] in Indonesia, it is obvious that the young prawns grow extremely rapidly and attain marketable sizes within short periods. Schuster mentions that in the tambaks around the island of Java and Madura the prawns attain marketable sizes, *P. indicus* and *M. monoceros* growing to a length of 10-15 cm. within a period of 4-6 weeks. This amount of growth is probably too good to be taken as the general rule. From the observations made by Menon (unpublished) at Madras and Malabar, by Sadasivan (unpublished) at Upputeru at the mouth of the Collair (Kolleru) Lake and at Pulicat and from the author's observations made on different occasions at Cochin, Veli Lake near Trivandrum, Madras, Ennore, Akividu on the Collair Lake and from collections seen from many other parts of India, the rate of growth of these species may be considered to be between 20-36 mm. within a month, the higher figures being applicable to prawns of very small size. High amounts of calcium are available in the saline lagoons which is beneficial to young prawns which frequently moult. As regards prawns of 40 mm. and above the rate of growth is probably less than above and with longer intermoult intervals as is usual in the Natantia. If the shallow coastal creeks and lagoons are stocked with prawns it is clear that they will be able to grow to utilizable sizes before these waters dry up, in the same manner as they do in areas where they enter during the spring tides. It appears, therefore, that further expansion of prawn cultural practices is definitely possible in India by collecting young post-larval penæid prawns from the coastal areas where they abound and by stocking them in coastal shallow lagoons and saline fish ponds into which the fry do not naturally enter. Elements of an unorganized fishery of this type already exist in some parts of the East Coast. Simple experimental observations which the author has made during the past few years indicate that prawn fry can be safely transported in earthenware containers and it should be quite possible also to utilize tin fish carriers.

There is, however, one great limitation in the extension of prawn cultural practices. Unlike *Chanos* the penæid prawns cannot be cultured in fresh water. They are, however, at home in waters of low salinities; *Metapenæus monoceros* is known to survive in waters of salinity as low as one to two parts per mille. *Penæus indicus* and other species on the other hand require considerably higher salinities, but low salinities are tolerated by the young ones of these species. What is noteworthy is that the penæids and, especially *Metapenæus monoceros*, show extraordinary powers of osmoregulation, achieved by the active regulation of chlorides in blood[16] indicating the same type of hypo-osmotic regulation as the palæmonid prawns[17] endowing them with an ability to thrive in salinity ranges not tolerated by most species and which, in fact, has considerably enhanced their value as culturable species.

Young penæids mostly remain buried in the mud with just their eyes and antennæ protruding and their food mainly consist of organic detritus found in the mud, algal material and other extremely small organisms contained in the mud. They are able to thrive in areas

devoid of much algal vegetation which is so necessary for *Chanos*. It may be added that the young prawns do not compete with *Chanos* for food and is hence widely employed subsidiary to *Chanos* culture in the Indonesian tambaks.[15] So far as the Indian Coast is concerned, what is required is an intensive collection and stocking of these penæids in the coastal waters which are otherwise unused by the successful combination of the principles of the prawn culture of the Malabar Coast and the *Chanos* culture of the Eastern countries.

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SYMPOSIUM ON CYBERNETICS

A CHARACTERISTIC of the evolution of science in the present century has been the progressive intermingling of the various branches formerly considered as independent. This is especially true of the post-war years which have witnessed the emergence of the fascinating branch of study called cybernetics from the unification of the methodologies of the mathematical, physical and biological sciences. A Symposium on this subject was held on 31st January and 1st February, 1952, at the Indian Institute of Science, Bangalore. It was inaugurated by Prof. M. S. Thacker, Director of the Institute, who also presided over the Session the first day; Dr. J. Chandy of the Christian Medical College, Vellore, took the chair on the second day. The purpose of the Symposium was mainly to stimulate interest in the field and to have a discussion in which workers in different sciences could take part. With this in view, reports on the various aspects of cybernetics were invited from workers in mathematics, physics, engineering, neurology and psychology both in Bangalore and outside. The Symposium, the first of its kind in India on this new branch of science, was organised by the Bangalore Branch of the Association of Scientific Workers of India and its success was mainly due to the efforts of Dr. B. S. Ramakrishna, President, and Mr. N. N. Narayana Rao, Secretary of the Association. It is recognised that the greatest progress is likely to occur in those regions of science which are the meeting points of established subdivisions and symposia of this type should therefore act as a stimulus in furthering research in these borderlands.

In his inaugural address, M. S. Thacker pointed out that cybernetics, which considers the problems of control and communication in man and machine from a unified point of view, is a common field of investigation for scientists working in various fields. Thus, specialists in one field could place their intimate knowledge of their science at the service of other specialists and will in turn enrich their knowledge with what they can borrow from the others. On the practical side, cybernetics holds great promise to mankind, for instance, in the development of various devices which would help to replace one lost sense by another.

Opening the discussions, B. S. Madhava Rao dwelt on the scope of cybernetics and pointed out the fundamental role played by such diverse concepts as entropy in statistical mechanics and thermodynamics, feedback in engineering and even some aspects of mathematical logic in the terminology of cybernetics. The most important applications of cybernetics are in the field of neurology and rest on the hypothesis that the chief mechanism of the central nervous system is one of negative feed-back, which explains purposive and adaptive behaviour.

The next two papers dealt with information theory from the points of view of a communication engineer and a mathematician. B. S. Ramakrishna, who considered the former aspect,