

CONDITIONS FOR THE PROTECTION OF MARINE ENVIRONMENT

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A b s t r a c t

The multi-use of the sea calls for a greater need for the protection of marine environment. Living resources are most sensitive to man-made changes in the environment and hence it is necessary to make an assessment of marine pollution in conjunction with living resources, monitor priority pollutants and develop conventions for the control of marine pollution. Without such steps towards the protection of marine environment, important programmes like coastal aquaculture are not likely to achieve the desired success.

In India considerable efforts are being made for generating extra food resources by aquaculture. In recent years, several research institutions have been involved in developing suitable techniques for sea farming on a commercial scale and a number of fishes such as Channa, mullus, sea bass, barbon, pearl spot and Tilapia are being cultured in backwaters and estuaries. Similarly, the culture of penaeid prawns is being practised in both public and private sectors, although investments in these projects have been rather limited because of possible fear of uncertain monetary returns. Cultures of lobsters and crabs also seem to have a good future once the techniques for their upkeep are properly standardised. So far, the greatest success has been achieved in the culture of molluscs,

- 2 -

especially mussels on ropes and the edible oyster and the pearl oyster in cages. From the pearl oysters, techniques of producing cultured pearls have also been developed. The culture of agrophytes and edible seaweeds on oar ropes is giving excellent results.

Since only a few coastal areas of the world have remained free from pollution, there is an urgent need for developing a compromise between conflicting interests which pollute the waters and those which are concerned with keeping it clean for generating more and more food resources by sea farming.

INTRODUCTION

Today marine environment in almost all countries of the world is being put to a variety of uses. Besides the two conventional uses of the sea, i.e., fishing and shipping, some of the other uses include exploration and exploitation of mineral resources including oil and natural gas, utilizing recreational facilities which the sea provides and development of coastal aquaculture. The recent energy crisis in the world has accelerated the pace of exploration of fossil fuel and in the next decade, many countries including India will be using fossil fuel from the sea on a commercial scale.

The multi-use of the sea, therefore, calls for a greater need for the protection of marine environment so that the sea could continue to provide, for the benefit of man, a source of exploitation of different types of resources without depleting the most important and perhaps the most sensitive of all -- the living resources.

- 3 -

In most countries of the world, a high priority is being given to coastal aquaculture for generating extra food resources. The success of aquaculture largely depends upon the prevailing conditions in the sea for supporting a large scale plant and animal life and in keeping it free from undesirable bacterial contamination. The programme of work in India, therefore, has been designed on the following lines:

a) Assessment of marine pollution and living resources

A general survey is being undertaken to determine the state of pollution along the Indian coastline so that it is possible to divide the areas according to classification developed by GEMS (Global Environmental Monitoring System) as a part of INS (International Referral System) components of "Earthwatch". The living resources assessment programme will be directed primarily towards determining changes in stocks of commercial fish and changes in the food chain. The objective is to detect when marine bio-ecobalance gets seriously disturbed. Work also includes on the direct effect of toxicity on different stages in the life cycle of marine organisms, eutrophication, bio-accumulation of residue leading to unacceptably high toxicity and loss of quality of marine organisms.

b) Monitoring of marine pollutants

Monitoring is to be done of "priority pollutants" as identified by the meeting of the Intergovernmental Working Group on 'Monitoring' held at the UNEP (United Nations Environment Programme) headquarters in Nairobi. For monitoring, the accepted sampling techniques and methodologies will be followed.

c) Development of national conventions for the control of marine pollution

The work in this field includes the distribution of informations to different regions of the country so as to promote plans and take initiative for the control of marine pollution. The programmes will be dealt with in conjunction with the management of living resources. International agencies such as UNEP, UNESCO and FAO would play an important role in developing regional programmes and for providing the necessary advice on the control of marine pollution.

The above steps are necessary for the development of coastal aquaculture in India, which is going to be a sizeable programme and with which we are vitally concerned. The salient features of this programme are as follows:

COASTAL AQUACULTURE

It is estimated that over two million hectares of backwaters, estuaries, shallow-water lagoons, creeks, bays and marshy swamps are found adjoining the coastline of India. These are of considerable magnitude for stepping up the fish production by coastal aquaculture. In the light of the knowledge gained during the last one decade on the nature of responses of the cultivable species in the estuarine ecosystem, aquaculture has become an integral part of the fishery development in India, which is largely under governmental management. Investments, however, from the private sector on sea farming are not easily forthcoming, because of the lack of expertise in this new venture and for fear of uncertain monetary returns. Government sponsored marine and brackish water fish farms are being established in almost all the maritime States.

Under the Indian Council of Agricultural Research, the Central Marine Fisheries Research Institute has achieved in recent years remarkable success on the culture of mussels, oysters, pearl oysters, prawns, lobsters and seaweeds. In the following account, some of the main features of the culture of important species have been summarized. Many of the species used for culture, though indigenous, are widely distributed in the Indo-Pacific region.

a) Fishes

The milkfish, Chanos chanos has been tried with much success for nearly 50 years in India mainly because of the efforts of the State Departments of Fisheries. However, a systematic programme has recently been launched on the collection of its fry from the coastal waters, rearing them to fingerling stage in nursery ponds, acclimatizing them to fresh water conditions, transporting them in suitable containers and finally stocking them in ponds. Unlike Indonesia and the Philippines, where Chanos is largely cultured in fresh water habitats, but saline coastal waters are not altogether excluded.

Chanos is a marine fish which grows up to 150 cm in length and frequently enters the inshore waters, estuaries and backwaters. It is highly tolerant to changes in salinity and can live in both freshwater and salt water. It largely feeds on algal mats and detritus. In farms, besides algae and detritus, it has also been found to feed on protozoans, copepods, and ostracods. It has a fast growth rate attaining about 40 cm in one year (Hora and Pillay, 1962). In experimental salt water ponds, fingerlings measuring 8 cm in length have been reported to grow up to 30 cm in one year (Tampi, 1960). The fish does not attain sexual

maturity in farms. The fecundity of the adult fish, caught from the sea, has been found to range from 1.9 to 5.7 million eggs (Tampi, 1957). Spawning takes place in waters very near the shore and the transparent fry of about 13 mm in length enter the shallow coastal lagoons in millions from February to April. The fish probably spawns a second time during the monsoon months. Chanos is a highly esteemed fish and remains in demand throughout the year. Although very rich grounds for the collection of fry are found along the south-eastern coasts of India, fry and fingerlings occur along both the coasts.

The grey mullets of the family Mugilidae are represented by cultivable species such as Mugil macrolepis, Mugil parsia, Mugil tada, Mugil cephalus and Mugil cuneatus. All these species are found in coastal and estuarine waters of both east and west coasts of India. They are capable of withstanding sudden fluctuations in salinity and thrive well under farm conditions. They grow to about 30 cm in length. Food habits, growth rates, fecundity and breeding periodicities of mullets have been intensively studied. Like Chanos, the mullets are non-carnivorous and are therefore very suitable for farming. Fries of all the species are abundantly available in salt water lakes, backwaters and estuarine lagoons from where they are collected for stocking. Under rearing conditions, the survival of fry to reach the fingerling stage is low. Rhinomugil corsula is a freshwater mullet which enters the estuaries and backwaters where it is known to thrive well. Induced breeding with hormonal injections has been successful in Mugil cephalus.

Latea calcarifer, popularly called the sea bass or the cook-up

- 7 -

of the family Centropomidae, is a highly esteemed table fish and grows to about 150 cm in length. It is found in salt water, brackish water and freshwater environments. The growth rate of this species is very fast and its food consists of fish, crustaceans, molluscs and worms. It is highly predaceous and very often cannibalistic. Growth in weight during the first year is estimated to be 300 to 500 g. Juveniles weighing 500 g grow to 3000 g in one year and to about 5000 g after the second year under culture conditions (Gopalakrishnan, 1973). Sexual maturity is attained when the fish is two years old. The main spawning season seems to be from June to July, followed by a supplementary spawning period from January to March. Breeding seems to take place close to the river-mouths and the eggs which are demersal in nature, sink readily to the bottom. Large quantities of fry are usually collected from the river-mouths for stocking in impounded waters. Being a carnivorous and fast-growing fish, it requires an abundance of forage fish in the environment. It cannot be stocked in ponds where non-carnivorous fish such as Channa and mullets are cultured.

Elops saurus, commonly known as ten-pounder, is a marine fish with a carnivorous habit. It feeds on other fishes and crustaceans and grows to about 50 cm or more in length. It enters the estuaries and backwaters where it is known to thrive well. Its larvae occur in inshore waters of the south-east coast of India from October to November and from December to January along the south-west coast (Alikunhi and Rao 1951; Gopinath, 1946). It is a highly relished food fish and its culture is quite profitable. Being a carnivorous fish, its culture with non-predatory fishes is not considered desirable. However, in Hawaii a related species, E. hawaiiensis is satisfactorily

cultured along with Chanos and mullets in brackish water ponds.

The tarpon, Megalops hybridoides, is another carnivorous fish, belonging to the family Megalopidae. It is a salt water fish, but enters the backwaters and estuaries and also ascends the rivers and reaches the freshwater lakes. It grows up to 100 cm in length. The adult fish feeds on prawns, other crustaceans, insect larvae etc., whereas the fry subsist mostly on smaller crustaceans and diatoms. The adults are known to penetrate some of the rivers upto 100 km from the sea. Its culture along with Eloa in impounded brackish waters appears to be a satisfactory proposition.

The pearl spot, Etroplus suratensis is found in almost all types of brackish water and estuaries of India. It grows upto 45 cm in length and can easily be acclimatized to freshwater conditions. It largely feeds on algae and phytoplankton but also consumes zooplanktonic organisms, worms, shrimps, insect larvae, gastropods etc. Its fecundity is estimated to be 1300 to 6000 eggs (Menon et al., 1959; Hora and Pillay, 1962). Its average growth rate (length) is as follows: first year = 21 cm, second year = 30 cm, third year = 36 cm, fourth year = 41 cm and fifth year = 46 cm. The female selects a suitable site where it deposits its eggs. The eggs lie attached to stones and other objects. The female guards the eggs until they are hatched. The Chilka Lake in Orissa (east coast of India) is an excellent area for collecting the fry and fingerlings of this species from April to July and from September to November. They are stocked all over the country.

Tilapia mossambica is an exotic fish. It was brought to India from Bangkok and introduced by the Central Marine Fisheries

- 9 -

Research Institute for experimental farming in the early fifties. Soon afterwards, the Department of Fisheries, Madras, brought another consignment of this species from Ceylon and stocked them in ponds all over the State. It is a freshwater fish but capable of thriving well in brackish water and salt water with salinities upto 30‰. At salinities varying from 30‰ to 40‰ the growth of Tilapia appears to be satisfactory but no breeding takes place. The adults feed mostly on algae and detritus, but also make use of a variety of benthic animals. Tilapia is a fast-growing and quick-maturing fish. It begins to breed when about 2 months old and thereafter it continues to breed throughout the year. Its fecundity varies from 80 to 100 eggs. The male scoops the mud or sand at the bottom and the female deposits its eggs which are fertilized and then picked up by the female for oral incubation. The high hopes of many Asian countries for culturing this fish to meet the protein shortage have met with disappointment. Wherever this species was cultured, it presented an acute problem of population explosion resulting in 'runting', i.e. it became smaller and smaller, but breeding continued uninterrupted. It thus created a problem of overcrowding and competition for food and space. When cultured along with carps and Chanos, the other species first became stunted and were then eliminated. Culture of Tilapia with predatory fishes kept the Tilapia population within control resulting in better growth and survival of Tilapia.

Estuaries and backwaters offer good collecting grounds for fry and fingerlings of several other fishes. Eelers of the freshwater eel, Anguilla bengalensis enter the estuaries in certain seasons in very large numbers. So far the culture of eels is not

- 10 -

being practised in this country. However, efforts are being made by the Central Marine Fisheries Research Institute to culture the eels on a commercial scale. Eleutheronema tetradactylum is another highly esteemed fish. The fingerlings of this species enter the estuaries in fairly large numbers. Although it is a predatory fish, it can be cultured in brackish waters along with forage fishes as its food.

b) Crustaceans

The important crustacean species of India are the penaeid prawns such as Penaeus monodon, Penaeus indicus, Metapenaeus dohsoni and Metapenaeus affinis. These species breed in the sea. The post-larvae migrate into the backwaters where they grow to a fair size. They then migrate into the sea for maturity and spawning. In almost all parts of India, farming of the shrimps consists of trapping the larvae and juveniles in enclosed waters. The young shrimps reach these areas with the incoming tides. They are allowed to grow on natural food for 3 to 6 months and are then harvested periodically.

In Kerala, after the paddy crop is harvested, the fields adjoining the backwaters are extensively utilized for prawn culture. It is estimated that over 44,000 hectares of paddy fields are used for this purpose. Prawn larvae coming from the sea through the backwaters are allowed to enter the fields at the flood tides, but their return to the sea is prevented because of the introduction of meshed screens into the sluice gates constructed for the entry of water. They feed intensively on the natural food available in paddy fields and grow rapidly. The estimated production in this environment ranges from 500 kg

- 11 -

to 2000 kg per hectare. It has been found that using artificial feeds, the yield could be increased considerably. One major drawback in this type of operation is that the juvenile fishes which also enter the fields with the incoming tides take a heavy toll of the young prawns.

Highly elaborate techniques have been developed in Japan to allow Penaeus japonicus to breed under controlled conditions. The larvae are reared upto juvenile stage and then they are transferred into larger tanks and fed on artificial feeds until they reach the commercial size. In India the species suitable for such culture operations are Penaeus indicus and Penaeus aztecus, but the results obtained so far, although encouraging, have not been commercialized.

Of the non-penaeid prawns, the giant freshwater prawn, Macrobrachium rosenbergii is being successfully reared and cultured in India.

The spiny lobsters are represented by Panulirus polyphagus, P. ornatus and P. homarus. The phyllosoma larvae of some of these species get successfully metamorphosed under laboratory conditions but the rearing of the juveniles present considerable difficulties, because of their cannibalistic habit at the time of moulting.

The portunid crustaceans are extensive along both the coasts of India. The larvae of both Portunus pelagicus and Scylla serrata have been successfully reared up to the juvenile stage and attempts are being made at present to culture the juveniles till they reach the commercial size.

*) MOLLUSCS

Ark shells, mussels, edible oysters, clams, pearl oysters

and numerous gastropods and cephalopods are abundantly found in estuarine and marine habitats. However, their utilization as food within the country has been of a limited extent. During the past two decades, much biological information has been gathered by the Central Marine Fisheries Research Institute and experimental farming has been successfully undertaken not only on rearing the clams, edible oysters and mussels but also on producing spherical cultured pearls from the indigenous species of pearl oyster. The industry for spherical cultured pearls was first developed in Japan, but subsequently Australia, Korea, Philippines, Hong Kong, Malaysia, Thailand and Burma started producing cultured pearls in substantial quantities largely with the assistance provided by the Japanese scientists and technicians. Recently, a pearl culture laboratory has been established in India using the locally available scientific talent.

Very high yield of mussels has been obtained by culturing them on ropes suspended from floating rafts. The information obtained in experimental farming of the backwater clam, *Meretrix casta* and the bay ark shell *Apadara granosa* has indicated that these species could also be cultured on a large scale. The possibilities of transplantation of wedge clams (*Saxidomus*), razor shells (*Solenidae*), false clams (*Macridae*) and the black clam (*Corbuculidae*) are being worked out to establish new beds where environmental conditions are favourable. Modern scientific methods of collecting the oyster spats have been applied, but the utilization of such techniques on a commercial scale for the culture of edible oyster is yet to be developed.

By far, the most spectacular results have been obtained on pearl culture operations in India by the Central Marine Fisheries Research Institute at a recently established experimental farm near Tuticorin (south-east coast of India). Pearl oysters collected from their natural habitat by skin divers are raised in very large numbers. They are acclimatized to farm conditions in 'pearl nets' of 60 x 40 cm and suspended from wooden floating rafts (6 m x 4.5 m). Healthy oysters are then anaesthetised with menthol. Incisions are made at the base of the foot and in the viscera. Mantle graft and shell bead are then introduced into the incisions. The treated oysters on recovery are again suspended in pearl nets from the rafts. The cultured pearls obtained from the oysters are of high quality and have a remarkable lustre. In the beginning, the shell beads used as nuclei were imported from Japan but subsequently beads made out of the indigenous chank shells have been utilised with considerable success (Velu et al., 1973). Although initial success has been achieved on pearl culture in India, considerable refinements in the methodology are necessary to put these techniques to commercial use (Alagarewami and Qasim, 1973 & 1974).

d) Seaweeds

India has vast resources of seaweeds along its long coastline. Rich algal beds also occur in the Laccadives and the Andaman and Nicobar Islands. About 164 genera and 389 species of algae have been reported from the Indian coast. Some of the seaweeds form a source of phytoecyloids such as agar-agar and algin. A few like

- 14 -

Gaultheria, Ulva and Porphyra are used as food, although in small quantities. Most weeds washed ashore are used as manure for coconut and tea plantations.

About 30 species of agarophytes have been reported to occur in these waters. The ratio of the dry seaweed and agar production is approximately 4 : 1. Gelidiella and Gracilaria species are of considerable importance for the agar-agar industry. Several species of Sargassum, Turbiparia and Cystophyllum form a rich source of alginic acid.

The method of collection of the weeds is mostly by cropping them periodically from the rocky beds where they are found. With the rise in demand at the recently established seaweed processing factories, culture techniques have been initiated and the weeds are grown on coir ropes mounted on wooden frames. Experimental culture has been undertaken in respect of the following species: Ulva, Sargassum sinense, S. vulgare, S. swartzii, Gelidiella acerosa and Gracilaria sp. and their yields have been found to be very high.

CONCLUSION

A stage has reached now that perhaps no one can ignore the question of the protection of environment. Perhaps there will be very few coastal areas in the world which have remained free from pollution. There is an urgent need in almost all coastal areas to look at the overall picture of their use and develop elaborate plans for the judicious utilization of coastal resources. Every country must develop research capability to deal with the complex development problems associated with the multi-use of the sea.

- 15 -

Our goal should be to develop an administrative structure needed to execute proper management programmes and at the same time ensure that the sea remains as clean as possible. We must also take into account of the economic problems of sharing the coastal zones by competing interests so that the sea continues to fulfil our social, economic and recreational needs for a long time to come.

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