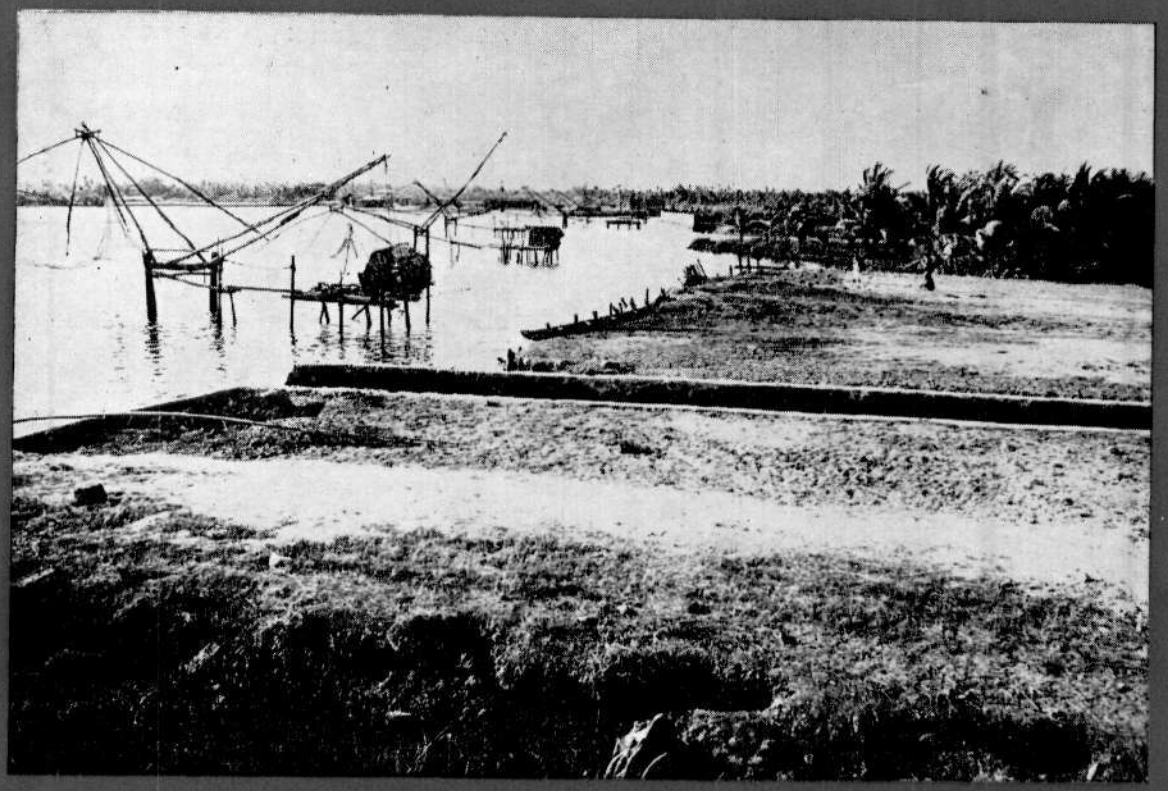
MARINE FISHERIES INFORMATION SERVICE



No. 73
JULY 1987

Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

IMPACT OF ENVIRONMENTAL CHANGES AND HUMAN INTERFERENCE ON THE PRAWN FISHERY RESOURCES

C. Suseelan

Central Marine Fisheries Research Institute, Cochin

Introduction

Although the marine prawn production of India has shown phenomenal increase over the past two decades, year to year fluctuations in the landings are a common feature noticed during the last few years. Many possible reasons have been attributed to this and the general conclusion is that the unsteady nature of production, in several areas, is due to fishery independent factors. Depletion of stock due to overfishing has also been suspected in some of the heavily exploited areas of the west coast. In this context it is worthwhile to examine the impact of various changes occurring in the environment and human interference (other than fishing) on the natural stock of prawns so that necessary protective measures could be taken to ensure sustainable yield.

It is a well established fact that the commercial prawn fishery of our waters is dependent on two distinct environments having different ecological features, *viz.* the sea and the estuaries. The adults of these prawns breed in the sea and the postlarvae migrate into estuaries and backwaters where they grow fast and return to the sea on reaching adulthood. The important species occurring in the marine as well as estuarine environments are *Metapenaeus dobsoni, M. affinis, M. monoceros, M. brevicornis, Penaeus indicus, P. monodon, P. semisulcatus* and *P. merguiensis*. The giant freshwater prawn *Macrobrachium rosenbergii* and a few other species of the same genus utilise the brackishwater areas for breeding purpose.

The major brackishwater systems of India include the estuaries of river Ganga, Mahanadi, Godavari, Krishna, Cauvery, Narmada and Tapti and the lakes such as Chilka Lake, Pulicat Lake, Ashtamudi Lake and Vembanad Lake with their connected backwaters. All of them are permanently connected to the sea and are subjected to strong tidal influence and mixing of freshwater influxes. Besides these, there are innumerable small estuaries also distributed all along the west and east coasts, having perennial or seasonal connection with the sea. All these areas are good nursery grounds for many species of prawns that support commercial fisheries in the adjoining seas.

As in the case of any other aquatic organisms, the biology of prawns is closely governed by the physico-chemical conditions of the environment in which they live. Due to the rapid advancement in civilisation, many kinds of changes are brought about in their habitats by natural as well as unnatural processes. The impacts of such changes on the prawn resources are enumerated below.

IMPACT OF ENVIRONMENTAL CHANGES ON THE PRAWN RESOURCES

Generally speaking, the ecological conditions of prawn's habitats in the sea are not easily affected by external influences to cause deleterious effect on these animals except in extreme cases. In the small, shallow water areas like the estuaries, on the other hand, frequent changes in the environmental parameters are quite common and they have profound influence on the life processes of the estuary-dependent species. The major factors regulating the recruitment, survival and growth of the juvenile prawns in these environments are: opening and closing of the barmouth, tidal effect, water circulation and currents, temperature, salinity and other chemical properties, turbidity, fertility, vegetation and the nature of the substratum.

Environmental changes are brought about by two different ways, *viz.* by natural causes and by human interference. The former may include physical changes in the bar openings, unpredictable weather conditions leading to heavy floods and droughts and prolific growth of undesirable aquatic weeds. The important changes

brought about by the activities of man are those caused by (1) large scale reclamation, bulkheading and filling and dredging, (2) engineering works such as construction of barrages, salt-water barriers, spill-ways *etc.* and (3) water pollution caused by various factors.

Formation of sand-bars across the opening of estuaries and lakes

Formation of sand-bars across the opening of small estuaries and other coastal ecosystems is a common feature noticed along Indian coasts during the summer period. The barmouth establishes proper connection with the sea in the beginning of monsoon season as a result of the flushing of rain water into the sea and remains open till the end of that season. During the land-locked condition after the monsoon period it is natural that the movement of penaeid prawns between the two environments is totally arrested, and this could ultimately result in low production of prawns in the fishing grounds. The closure of bar mouth also brings about adverse conditions to the impounded prawns, due to stagnation of water, low oxygen, high temperature and excessive increase in the salt contents beyond the tolerance limit, on account of extreme evaporation.

Floods and droughts

Occurrence of heavy floods in the estuaries and riverfed backwaters during the monsoon period gradually reduces the distributional range of juvenile prawns in those areas. Field studies conducted by the author on the seasonal distribution of penaeid prawns in Vembanad Lake in Kerala have shown that juveniles of *Penaeus indicus* disappear from the upper reaches along with the discharge of monsoon flood and recolonise these areas again after the rainy season is over. The prawns recruited into this environment during the monsoon period fail to penetrate the interior areas due to the strong flow of freshwater and also possibly due to the very low salinity conditions brought about by this physical change.

Extreme cases of drought pose serious problems to the prawns that live in salt-water pools and shallow impoundments. Here, due to the high rate of evaporation the temperature and salinity of the water increase considerably and the prawns become exposed to conditions beyond their tolerance limit.

Prolific growth of aquatic weeds

Presence of moderate amount of vegetation is an essential factor in any aquatic environment as it increases the productivity and provides food as well as shelter for many organisms including prawns. However, excessive growth and accumulation of undesirable weeds in the water can have harmful effects as well, since they reduce the tidal effect, light penetration and photosynthetic oxygen production in the ecosystem. A typical example of this phenomenon is the infestation of the African weed *Salvenia auriculata* in the fresh and brackishwater areas of Kerala. This exotic weed multiplies enormously in the freshwater systems and are transported to the backwaters and lagoons during the monsoon season. In the postmonsoon period when the river flow is low, tidal water carries large quantities of the weed upstream, building up stagnant blankets over the backwaters where they undergo decay due to salinity and get deposited at the bottom. Besides being a hindrance to various aquatic activities, this plant is a biological menace as it depletes the oxygen and nitrates in the water column and changes the nature of the bottom by depositing decayed parts. The depletion of oxygen occurs by different ways such as (1) formation of the thick mat-like covering on the water surface preventing mixing of atmospheric oxygen with water and light penetration thereby affecting photosynthesis of algae and diatoms and (2) decaying of the dead plants at the bottom. This can make the affected areas unsuitable for the growth of young prawns.

Land reclamation, bulkheading and filling and dredging activities

One of the major changes now taking place in many parts of the brackishwater systems of our country is the large-scale reclamation of water areas for agriculture, aquaculture and other purposes. While some of these activities are in connection with the various developmental schemes of the Government, like the few that could be seen progressing in Cochin backwaters at present, many are undertaken by private parties, either legally or illegally, without any control. These activities not only reduce the total acreage of the shrimp nursery grounds but also considerably alter the physical features like tidal flow, water circulation and current, which in normal cases together act and make the environment congenial for the prawns. Similarly, bulkheading and filling of shorelines and shallow salt-water areas undertaken as part of the water front development programmes in urban coastal areas also have their bad effects if carried out in an unplanned manner. This is particularly a problem which has relevance to the postlarval and early juvenile prawns that inhabit mostly the surf-beaten submerged sea-shores and shallow marginal areas of the backwaters.

Various dredging activities associated with clearing of navigational channels, mining of mineral resources like fossil shell deposits, and filling process are quite common in the marine and estuarine areas inhabited by prawns. Dredging in shorelines is most destructive of marine habitats. Prawns being bottom dwellers, feeding on the rich organic substances available at the bottom, are affected by the depletion of biological productivity due to increased silt load and turbidity in the areas disturbed by dredging.

Construction of barrages, salt-water barriers and spillways

The most important among the various activities of man which cause changes in the natural habitat of prawns are the construction of engineering structures on river basins and estuaries, such as barrages, saltwater barriers, stream diversion spillways and tide control structures. These projects may alter the entire physico-chemical conditions of the ecosystems, particularly of estuaries and backwaters, and reduce the nursery areas of prawns by restricting the influx of sea water. This results in impeded exchanges of fresh and saltwater, loss of tidal exchange benefits, change in water circulation pattern affecting the distribution of salinity, temperature, *etc.* and lessening of average depth. Salinity being the most affected parameter in these cases, the pattern and extent of its variation modify the distribution of juvenile penaeid prawns as well as the estuary-dependent breeding population of palaemonids.

The Thanneermukkom Bund Project of Vembanad Lake in Kerala is an ideal example for such barriers put in the natural brackishwater environments, which have considerably influenced the prawn resources. This bund was constructed in 1976 to prevent saline water from the sea entering the extensive paddy fields of Kuttanad area in Central Kerala. While this has considerably helped to augment the paddy production of the State, it has also brought in a number of problems concerning the natural resources of the lake and the socio-economic condition of the people inhabiting that area. Since the tidal flow was completely arrested by the bund and the salinity reduced to almost zero level, the penaeid prawns became very scarce in the lake beyond Thanneermukkom. Experimental try-net fishing conducted by the author on either side of the bund during the peak summer period (February–April) of 1977–'79 yielded only less than 5 prawns/haul in the freshwater side as against an average of 110/haul recorded from the saltwater side. Because of the drastic reduction in the abundance of penaeid prawns beyond the bund, all the stake nets and dip nets used for catching the prawns in that area had to be removed after closure of the shutters in 1976. In the saltwater side also the prawn production in the areas nearer to the bund has considerably declined due to the reduced tidal effect and therefore most of the fishermen engaged in prawn fishing there have now taken up other avocations.

Water pollution

Aquatic pollution is a serious and growing threat to the living resources of our waters and also to human health. Although the extent of biological effects of pollution on the animals living in large water-bodies like the ocean are not fully understood, there is increasing evidence to believe that it can cause havoc to those occurring in estuaries and other nursery areas which are more prone to pollution than the sea. Some of the possible effects of aquatic pollution on animals including prawns are: (1) large-scale mortality, (2) reduced rate of growth and survival, (3) retarded maturation and inhibition of spawning, (4) reduced rate of egg production, (5) uptake and accumulation of toxic substances and other pollutants making the animal unfit for human consumption and (6) reduced quality and export value of the product.

The marine and brackishwater environments constantly receive several kinds of pollutants, directly or indirectly. While some of the pollutants are leached out from the land and carried by rivers to the estuaries and coastal waters, others are deliberately introduced by man. Some are also transported by the atmosphere and ultimately washed down by rain. The important pollutants that reach these environments are: pesticides, various types of industrial effluents containing heavy metals and toxic chemicals, municipal and domestic sewages, oils and oil dispersants, heated water and radio-active wastes. To some extent pollution of water also occurs as a result of large-scale retting of coconut husks and other materials in stagnant backwater areas.

Large quantities of pesticides like DDT and its derivatives used for agricultural and public health purposes find their way into the estuaries and coastal waters. While the concentration of these pesticides in the open waters are lowered by dilution, in areas with reduced circulation, mortality of animals occur at all levels. Crustaceans are particularly sensitive to these chemicals which in concentration as low as 0.003 ppm have often been found to be lethal to shrimps. Fishes and shellfishes containing high concentration of DDT (above 5 ppm) are considered to be unfit for human consumption.

Industrial effluents containing a number of inorganic wastes such as acids, alkalies, ammonia, mercury, chromium, copper, lead, arsenic *etc.* and several synthetic organic compounds, detergents and organic wastes are periodically discharged into the water, which are potentially harmful to aquatic life. Although fish and crustaceans can detect concentration of acids and alkalies much below the toxic level and thus avoid areas of contamination, higher doses can corrode their gills affecting respiration and eventually leading to death. Consumption of fish and shellfish having high concentration of mercury (methyl mercury) has been reported to have caused dangerous diseases among people in Japan and other countries. In Sweden, fishes with more than 1 ppm mercury are considered to be unfit for human use. Many synthetic organic compounds like polychlorinated biphenyls (PCB), chlorinated hydrocarbons and organophosphorus are highly toxic to fishes, prawns and various planktonic organisms and therefore leaching of these compounds into estuaries and inshore waters is detrimental to the ecosystem. Contamination with organic wastes discharged from the paper factories, seafood processing units *etc.* can interfere at various trophic levels in the food chain by increasing the Biological Oxygen Demand and consequent depletion of oxygen in the water, which ultimately lead to reduction in the fishery resources.

Dissolved and suspended organic constituents of the municipal and domestic sewage could increase the productivity of the environment, but when accumulated excessively they cause oxygen depletion and other unfavourable conditions to aquatic life. They are also known to harbour many pathogenic bacteria and viruses, and human life may be endangered by eating the prawns contaminated with them. There have been several reports of outbreak of hepatitis, polio, cholera and other enteric diseases by eating shellfish contaminated with these pathogens.

Oil pollution of marine and estuarine environments can occur from various sources such as accidental spills from tankers and offshore wells, nearshore ship operations, urban and industrial sewage effluents and also through the atmosphere. When oil is released into the water, the lighter fractions evaporate and with the residues a water-in-oil emulsion is formed over the surface. In the sea, this spreads to extensive areas by wind, waves and tides and gradually reaches the beach. A film of oil on the water surface acts as a barrier to exchange between water and atmosphere. This reduces the dissolved oxygen content in the water which affects the planktonic larvae. Direct contact of oil with the respiratory organs weakens or kills the animals. The oil, polluting the shores may damage the small juvenile prawns by smothering them and cutting off respiratory exchange and by interfering with their movement and ability to withstand wave action. Oil is also known to affect the hormone system responsible for the reproduction and behaviour of larger crustaceans like lobsters and crayfishes. The oil spill in the Lakshadweep Sea from the American oil tanker 'TRANSHURON' is reported to have caused serious damages to living organisms in the polluted zone. Due to the formation of thick layers of oil in the lagoon and the wide spread deposit of tar-like paste along the beaches and intertidal areas of Kiltan Atoll, mass mortality occurred among planktonic organisms and benthic animals including lobsters and crabs. Considerable depletion in the population of planktonic decapods has also been reported from the Madras coast as a result of oil spills occurring during transport of oils and from ocean liners, tugs and mechanised fishing vessels.

Thermal effluents discharged from power plants and other shore-based industries may cause serious environmental stress in shallow estuaries and backwaters. The added temperature brings about local increase in salinity which in turn reduces the oxygen content in the ecosystem. Rise in temperature can also intensify the toxicity of other pollutants and increase the susceptibility of prawns to diseases.

Radioactive wastes dumped into the ocean are potentially very dangerous to the marine organisms. Prawns being bottom dwellers feeding on suspended detritus, are likely to ingest radioactive substances also along with the food, and they may get concentrated in the body tissue. These substances are highly mutagenic and carcinogenic and can also affect human beings indirectly.

The various types of pollution discussed above will have far reaching effect on the prawn fishery resources of our waters. Due to the rapid technological advancement and urbanisation most of the nursery areas of commercially important prawns get badly polluted. The Hooghly Estuary down stream from Calcutta receives the wastes from about a hundred industries. Other polluted coastal areas are near Bombay, Trivandrum and the outlets of the rivers Krishna, Godavari, Cooum and Chaliyar. The effluents from the industrial complex at Alwaye and nearby areas poured into the Periyar River flow through the backwaters enroute to the Arabian Sea and pose serious threat to the fish and prawn population of the estuary and inshore waters of the Kerala

coast. Large scale mortality of fishes and other organisms due to the contamination of industrial effluents has been reported from Cochin backwaters, Chaliyar river and other estuarine systems.

IMPACT OF LARGE-SCALE CAPTURE OF PRAWN FRY FOR FARMING

In recent years prawn culture has been receiving increasing importance all over the country for augmenting production for export purpose. One of the major requirements for undertaking large-scale farming is the availability of the seed of desired species. Presently this problem is solved by capturing the post-larvae and small juveniles from the surf, estuarine and backwater regions. These small fry (measuring upto about 40 mm) are collected by using velon screen drag nets and a number of other devices from the shallow nearshore areas where they mostly concentrate. In these areas the young ones of several species of prawns contributing to our commercial fisheries occur in different compositions. Since the prawn farming is mainly aimed at culturing large growing species like *P. indicus* and *P. monodon*, millions of young ones of smaller species belonging to the genus *Metapenaeus* obtained in the seed collections are often discarded. Apart from the fact that uncontrolled exploitation of the young ones from their natural nursery areas itself is a destructive process, as it can adversely affect the fishery of adult prawns, the heavy damage caused to the smaller species incidental to the procurement of larger ones is a problem that deserves more concern in the context of conservation of the resource. Since large scale exploitation of prawn fry from the wild for farming purpose is only of recent origin, the extent of its impact on the capture fisheries is yet to be evaluated.

Conclusion

It is evident from the foregoing account that apart from the usual changes associated with the commercial fishing activities, the prawn resources of our coastal waters are faced with several problems which deserve due consideration in the context of conservation of the resource. As the prawn fishery of the marine region is largely dependent on the emigrating sub-adults of the adjacent brackishwater areas, the reduction in the juvenile stock brought about by the various environmental and external influences will have serious impact on the coastal fishery. When compared with the sea, the estuaries play a more prominent role in the life and survival of the prawns, but at the same time such areas are vulnerable to human alterations which ultimately lead to the deterioration of the resource.

The problem of aquatic pollution is becoming more and more acute everyday in most of the major nursery grounds and large-scale mortality of fishes and other organisms due to environmental contamination are increasingly reported. Although specific instances of mass mortality of prawns due to these changes are not reported from any of the natural environs, probably because the dead prawns remain at the bottom and do not float up like fish, the increasing tendency of many productive areas like the Cochin backwaters getting polluted by industrial effluents and other harmful substances is alarming. Oil pollution in Indian seas has reached to such an extent that the northern region of the west coast has now become one of the world's most highly contaminated parts, with petroleum hydrocarbons. The Maharashtra coast which comes under the spell of this serious situation is one of the richer prawn producing areas of the country and how far this rate of oil contamination will affect the productivity of this coast deserves attention.