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Coastal Aquaculture in India—Review and Future Prospects

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1. Introduction

Aquaculture is being practised by humanity since very early times. It has acquired importance during the last three centuries with progressive increase in the demand for fish and shellfish. Aquaculture both in inland and coastal waters has become a very important food production activity during the last three decades due to the limitations of capture fisheries, especially the latter reaching maximum sustainable limits in the case of a number of resources and the large rise in cost of fishing effort. The annual world fish production is round about 100 million tonnes for the last several years, and of this as much as 25.5% is from aquaculture practice (Pillay, 1977).

The present annual fish production of India which ranks seventh in the world in successive years, is 4.88 million tonnes including 2.78 million tonnes from the marine sector and 2.1 million tonnes from inland waters. The bulk of India's aquaculture production comes from inland fish farming and 80,000 tonnes of salt water prawns and 200 tonnes of finfish are produced in farms in coastal areas (Dehadrai 1997, Devaraj 1997).

The production from coastal aquaculture in India is very low as compared to several other countries. This is due to the fact that coastal aquaculture consists of almost only prawn farming as prawns fetch high prices through exports. There are several other groups like finfishes, crabs, lobsters, the edible bivalve molluscs, oysters and mussels and clams, the pearl oysters which yield exquisite marine pearls and seaweeds which could be cultured along our coasts. Recognizing the prospects for raising production from mariculture practices, Central Marine Fisheries Research Institute has carried out intensive researches and developed techniques for the various cultivable marine organisms and also hatchery techniques for the production of seed. However, prawns remain almost the exclusive group farmed as they grow to marketable size in about four months and get high profits.

In India prawn culture has come to be practised by entrepreneurs and corporate companies in large farms in vast areas which has resulted in environmental degradation and outbreak of diseases leading to mass mortality and losses. Environmental deterioration has led to violent opposition and as a result the Supreme Court has prohibited aquaculture in the coastal zone upto a distance of 500 meters other than traditional practices until final decision by the Court. This has seriously affected prawn farming carried out along the maritime states. In this article the present status of coastal prawn farming in relation to environmental conditions and the future prospects for sustainable aquaculture of prawns and other cultivable organisms without adverse effect on the coastal zone environment are dealt with.

2. Prawn Culture

In India several species of penaeid prawns, *Penaeus monodon, P. indicus, P. semisulcatus, P. merquiensis, Metapenaeus dobsoni, M. monoceros, M. affinis* and *Parapenaopsis stylifera* occur in coastal waters. The seeds of these prawns are available in nature in inshore waters and seed could be produced adopting hatchery techniques. But the aquaculturists prefer to culture the tiger prawn, *Penaeus monodon*, as it is highly esteemed and sold at upto $23/kg. Seed of this species is obtained through collection from surf zone in several identified localities as in West-Bengal, Northern and Southern Andhra, etc. as well as numerous private hatcheries established and producing millions of seed. The white prawn, *Penaeus indicus* is next in importance with much less production of its seed and culture.

When postlarvae of *Penaeus monodon* and *P. indicus* are collected from coastal waters, enormous numbers of seed of other prawns as well as fish are brought ashore and discarded. The large scale destruction of millions of seed of other species should be prohibited by law as it is harmful to the natural populations and conservation. In prawn hatcheries breeder prawns, *P. monoden* and *P. indicus* are obtained from trawl catches, the prawns spawn naturally and the different stages of larvae reared with appropriate diet and prawn seed produced. The technique of induced maturation by feeding prawns with mussel meat and unilateral ablation of eyestalk has considerably helped in obtaining sexually ripe breedstock in hatcheries. This method has been successfully demonstrated by CMFRI in India (Muthu *et al.*, 1982).

Among the four types of prawn culture, traditional, extensive, semi-intensive and intensive cultures, the traditional culture is the simplest kind of farming with minimum expenditure. In this method the prawn seed coming into the lagoons, creeks backwaters or estuaries are diverted into ponds or impoundments provided with screens or sluice gates and reared until they grow to marketable size. No feed is given and the young ones of prawns live on whatever dietary organisms are found in the habitat. The yield from this culture method is only 40–500 kg/ha/year as the feed available to the prawns is low. Due to the low harvest obtained this method is in vogue only on a very small scale being practised by poor rural folk living in the neighbourhood of creeks backwaters and other sheltered areas. In the extensive method a maximum of 1,00,000 seeds of selected prawn species are stocked in ponds 1–5 ha in area, there is supplementary feeding and enough of water is maintained by change and pumping. The average production from this kind of farming is 1 to 1.5 tonnes/ha/crop.

In this semi-intensive culture method, ponds at the depths of 0.5–0.75 m are constructed in selected sites, fast growing hatchery produced seed of a particular species are stocked at high densities of 1,00,000 to 3,00,000 seeds/ha and fed with artificial nourishing feed. The salinity, temperature, pH and oxygen level are maintained at optimum levels for the particular cultured species. This method is practised in Japan, Taiwan, Koria, India, Indonesia, Thailand, Philippines, Australia and other countries. Production of 4 to 5 tonnes have been obtained in semi-intensive culture in India. The water quality is maintained by exchange of 10% daily and the ponds are well aerated with air blowers or paddle wheels. The production from semi-intensive culture varies from 4 to 5 tonnes/ha/crop.

In intensive prawn farming concentrate ponds 0.3–0–1 ha are constructed, quality hatchery is produced and production seeds are stocked at very high densities of 5,00,000 to 10,00,000 seeds/ha. Water exchange is 30% per day, there is very good aeration with mechanical aerators and the prawns are fed with carefully formulated high energy feed. The production from this type of farming is highest as 10 to 20 t/ha/crop. Although the yield from intensive prawn farming is very high the culture of huge number of prawns in unit area results in outbreak of diseases due to virus or bacteria and mass mortality due to accumulation of metabolites and residual food which contaminate water. Notwithstanding this serious problem, many entrepreneurs go for intensive and super intensive culture ending in large scale mortalities due to disease before harvest.

Prawn diseases are caused by different factors like inadequate water exchange, oxygen depletion, excessive or poor quality feed affecting water quality and over crowding, antibiotics and pesticides. White spot disease (WSD) is most common disease caused by baculovirus which attacks ectodermal and mesodermal tissues of prawns. When there is outbreak of the disease, closure of the form for some time, complete drying and ploughing of the site are advised to eliminate the virus. The prawns have a natural immune system against viral diseases. The duration of disease resistance is short extending from eight to ten days. It has been found to be possible to stimulate the response frequently by using microbial products as glucans, peptiglycens and lipopolysaccarides (Karunasagar & Karunasagar 1997). The scope for preventing white spot disease by adopting this approach has to be determined.

It is desirable to practise semi-intensive method of culture of prawns rather than the intensive method as there is regular incidence of diseases in intensive and super intensive prawn farmings where the number of prawns cultured is much higher and correspondingly the culture medium is loaded with large quantities of pollutants which affect water quality very much and in turn leads to high incidence of pathogenic virus, bacteria and fungi.

3. Finfish Culture

There is a good scope for practising finfish culture in innumerable low lying coastal areas. Seed of cultivable fishes like the milkfish, *Chanos chanos* and the mullets, *Mugil cephalus*, *Liza macrolepes*, *Liza vaigiensis* and *Valmugil seheli*, the sea bass *Lates cascarifer* and the sand whiting *Sillago sihama* occur in large numbers in several areas in the inshore waters. The young ones of other cultivable fishes like groupers and rabbitfishes abound in our neritic waters. However, fish farming is restricted to traditional culture in small stretches of backwaters, localities adjacent to estuarine systems and marshy mangroves in Kerala, Goa, West Bengal and Andhra Pradesh keeping whatever young fishes are found in the water bodies without selecting particular species. Often fish and prawn are cultured together as young ones of both occur. No special feed is given and the cultured fish and prawn subsist on phyto-and zooplanktons and other feed organisms that are present in the impounded areas. The culture period as well as production rates vary much. The yield from the culture practices is low. Researches on finfish culture carried out by Central Marine Fisheries Research Institute during the last four decades indicate good prospects for monoculture as well as polyculture of saltwater finfishes. Tampi (1967) had shown that the production of milkfish in pend culture was 450 kg/ha/year at Mandapam where the sediment quality and nutrient level were low and hypersaline conditions existed during most of the annual period. Polyculture of *Liza macrolepis*, *Chanos chanos* and *Penaeus indicus* were successfully cultured by CMFRI in salt pan area at Tuticorin and a total production of 591 kg/ha was obtained including yields of 325 kg (55%), 190 kg (32.1%) and 76 kg (12.9%) of three species cultured. Rice bran and groundnut oil cake were used as artificial feed. Fingerlings of mullets and *Chanos* cultured by CMFRI in pens lined by bamboo fencing in Gulf of Mannar at Tuticorin attained growth to marketable sizes of 190 mm and 301 mm in six months time (James, 1985). The fingerlings of the much realised Indian whiting, *Sillago sihama* (20–199 mm in size) which are common in Coondapur Estuary stocked in ponds adjoining Mulki Estuary, Karnataka in January grew to sizes ranging from 70 to 229 mm in five months and 244–262 mm in eight months.

Attempts for induced breeding in *Sillago sihama* by injection of pituitary extract from freshwater fish and catfish resulted in oozing of eggs from one female fish in one instance.

Cage culture of the rabbitfishes, *Siganus* spp. the groupers, *Epinephelus taurina* and *E. hexagenatus*, and the sand whiting have been carried out by CMFRI using trashfish as feed but the techniques have to be perfected and viability has to be demonstrated to adopt the culture method as it is carried out in fareast and southeast Asian countries.

The developing of appropriate design and size of fish farm is of utmost importance as they vary for different candidature species. Data on the magnitude of availability and seasonality of seed of cultivable fishes are available only in some parts of the country like Tamil Nadu, Andhra Pradesh and West Bengal. There is a need for work on this important subject in other maritime states also. Attempts have to be made to increase the yield from fish culture by developing formulated feed for different groups of fishes which will give maximum conversion efficiency. Information on favourable sediment characteristics, salinity, temperature, pH, productivity, elimination of pests and predators is also essential. Some of the groups like the milkfish and mullets tolerate and grew in a wide range of salinities. The seed occurring in nature will not be sufficient when farming is carried out on a large scale. Therefore induced breeding and hatchery production of seed of salt water fishes are of utmost importance. Researches have been carried out in this field on a few candidate species and a major breakthrough has been made with Central Institute of Brackishwater Aquaculture succeeding in induced breeding of the sea bass, *Lates calcarifera* at Chennai.

4. Crab Culture

The mud crab, *Scylla serrata* which is a seafood delicacy and the cost of which is as much as Rs.4–5/kg in export trade is cultured in India in coastal farms since some years. The juvenile crabs can be stocked at a density of 5000/ha. The production rate is 2500 kg/ha/crop of 5–6 months (Marichamy, 1996). The egg bearing berried crabs have been collected by CMFRI, eggs hatched, larvae reared and juveniles produced in hatchery at the Tuticorin Research Centre (Marichamy 1984). The early development of *Scylla serrata* includes five zoea, megalopa and two instanrs. Early zoeae are fed with rotifers and later zoeae and megalopa with *Artemia*. It has been observed that for the growth and survival of the crab the optimum water temperature is 28–31°C and salinity 35%. The early developmental stages of the blue swimming crab, *Portunus pelagicus* have been reared at the CMFRI hatchery at Mandapam Camp. Culture of *Scylla serrata* is carried out by several entrepreneurs in Andhra Pradesh and Tamil Nadu collecting young ones from estuaries, backwaters and creeks. The cultured crabs are air lifted live and exported to Singapore throughout the year. For expanding crab culture practices in India large scale production of young ones making use of the techniques developed is essential.

5. Lobster Culture

The lobsters are another shellfish delicacy for which there is high demand. The annual lobster production of India is about 700 t which is almost entirely exported. Due to the export potential researches have been conducted by CMFRI at Madras on the possibilities of culturing lobsters. *Peurulii* larvae of the lobster *Portunus homarus* have been collected from mussel culture rafts and these and juvenile lobsters were reared to 200 gm in eighteen months using clam and green mussel meat as feed. Success has been achieved in increasing the growth of *Portunus homarus* through eye stalk ablation. The eye stalk ablated lobsters with average weight of 85 gm grew rapidly to a weight of 432 gm in five and half months compared to an increase in weight of only 57 gm in control lobsters (Silas, 1982). cannibalism is a problem in lobster culture. An I.C.A.R. Cess Fund project has been taken up by CMFRI at Madras to upgrade lobster culture to commercial scale.

6. Culture of Edible Molluscs

The edible bivalve molluscs, oysters, mussels and clams are widely distributed and exploited along the Indian coasts. The growth of the bivalves is fast as they feed on phytoplanktons and are the most efficient converters of primary production.

It is quite essential that bivalves are cultured to meet increasing requirements of the shellfish. Considering this, at the beginning of this century James Hernell, the pioneer Fishery Scientist made efforts to collect the spat of the edible oyster in Pulicat Lake, north of Madras. CMFRI, has developed simple methods for the culture of all the three groups of bivalves which could be used for farming the shellfish. The researches conducted at the Institute has shown that *Crassostrea madrasensis* is the ideal cultivable oyster species in India as its spat could be collected on oyster or mussel shells strung on strings kept in the area where oysters in natural beds spawn during breeding period and growth is fast. The oyster larvae set as spat on hard substrata after a free swimming life of about two weeks. The spat feed on phytoplanktons and grew on the rens suspended from racks in shallow coastal waters to harvestable size of 90 mm at the end of one year. *C. madrasensis* is euryhaline and tolerates wide range of salinities. The oysters grew well in estuaries and backwaters where there is mixing of freshwater. As the setting of oyster spat is very meagre in nature CMFRI has developed hatchery techniques for the production of oyster of spat by induced maturation through feeding with good quantities of phytoplanktons, induced spawning by thermal elevation and rearing larvae in hatchery in controlled conditions. CMFRI has operated at Tuticorin Pilot project on oyster culture using rack and ren methods sponsored by NABARD. Oysters are the most relished and highly nutritious sea food and production could be increased by adopting culture practices. For the first time in our country, some persons have come forward and taken up bivalve culture by conducting oyster culture in Ashtamudi lake, Kerala using rack and ren method.

The sessile green mussel, *Perna virdis* and the brown mussel, *Perna indica* occurring along Indian coasts can be cultured by raft culture method developed at CMFRI. In this method seed mussels of 20–30 mm in length are kept around a thick synthetic rope covered with cotton netting and stitched along the length at top and lower ends and a large number of such ropes ranging from 5 to 8 m are suspended from a raft 5 m × 5 m or 6 m × 6 m fabricated with teak or bamboo poles. The raft is held in position with barrels and anchors in coastal waters. The cotton netting gets disintegrated in a few days and the mussels get attached to the central rope and adjacent mussels by means of their byssus threads and growth. They attain a size of 70–80 mm by five months which can be harvested. The total weight of green mussels at harvest is 4.4–12 kg/metre length and that of brown mussels 10–15 kg at the end of seven months. The mussels could be cultured in our country using pole method and rack and bag culture methods also. Hatchery techniques have also been developed at CMFRI for mussel seed production. Mussels are primarily marine and thrive well at salinities of 29–35‰. They could be cultured in lower salinities upto 25‰in lagoons, backwaters and estuaries. Mussel culture can be profitably done in shallow coastal areas for use of the meat as human food and as feed in prawn culture.

Clams are free living bivalve molluscs which live at the bottom of coastal, estuarine and other brackishwater environments burrowing in sandy or muddy sediments. The clams are easiest to culture as the seed can be broadcast in sheltered unpolluted areas free from predatory crabs and fishes. *Meretrix casta*, *M. meretrix*, *Katelysia opima*, *Paphia malabarica*, *Anadara granosa* and *Villorita cyprinoides* are the cultivable clams of Indian coasts. Like the Indian oysters, the clam species also tolerate a wide range of salinities. The clam growing areas are demarcated by fixing poles around it. Some put a low netting on bamboo fencing around the culture site when investment is higher. Off bottom culture of clams in lantern type of cages hung from rafts is practised in Japan. Experimental culture of the clam, *Meretrix casta* by CMFRI adjacent to Mulki Estuary, Karnataka in a bamboo pen with a stocking rate of 300 seeds/m^2 indicated a production rate of 7 t/ha at the end of four months. The culture of the blood clam, *Anadara granosa* at the stocking rate of 140–175/m^2 showed a production rate of 39–41 t/ha/6 months when pen enclosure was used and 21 t/ha/6 months when enclosure was not provided. Hatchery techniques developed by CMFRI for clams are useful for meeting seed requirement of clam culture. Clams could be cultured in India with very low expenditure and the meat used for human consumption as well as feed like mussel meat for prawn farming.

7. Pearl Culture

India is endowed with very valuable pearl oyster resources which yield the famous oriental pearls. The Indian pearl oyster, *Pinctada fucata* is distributed in the Gulf of Mannar off Tuticorin coast and in the Gulf of Kutch. The natural populations of the pearl oyster have dwindled very much due to fisheries conducted over time upto 1961 environmental changes in the bottom and predation by octopods, crabs and fishes. India imports pearls worth more than Rs.12 million annually from Japan a pioneer in pearl culture to meet the requirements for jewellery. Researches were begun in the first half of this century in India in the Fisheries Department of the erstwhile Government of Madras to develop the technique of producing cultured pearls. In 1973, Central Marine Fisheries Research Institute has made a major breakthrough by successfully producing perfectly spherical cultured pearls in the Indian pearl oyster by implantation of a shell bead nucleus along with a mantle graft and rearing the operated oysters on a raft in coastal waters near Tuticorin. CMFRI has carried out detailed studies on the biology and ecology of the pearl oyster and also developed the techniques for large scale production of pearl oyster seed in a hatchery at Tuticorin and trained several batches of personnel in technology of pearl culture and pearl oyster seed production. In addition, the Institute has trained a large number of scientists and technicians in underwater SCUBA diving to study the habitat and of pearl oysters in Gulf of Mannar and conditions prevailing there, which enable us to understand the habits and ecological conditions favourable to the pearl oyster growth. Pearl culture is carried out by a few entrepreneurs commercially. As there is huge demand for pearls there is very good scope for pearl culture in India. For carrying out pearl culture, regular supply of pearl oyster for implementation, ideal location of culture site in calm unpolluted sea area, nuclei, skillful implantation and careful farm management are needed.

Another major breakthrough has been made by CMFRI with the success achieved in producing spherical cultured pearls in *P. fucata* grown onshore in laboratory (Rao & Devaraj, 1996). This work has shown that it is possible to provide on shore environmental conditions suitable for the growth of the pearl oysters as well as of cultured pearl into pearl oysters both of which are very sensitive to environmental parameters like temperature, salinity, pH, dissolved substances and feed.

A second species of pearl oyster, *P. margaritifera* which yields black pearls is distributed around Andaman Islands and sporadically in Mandapam–Tuticorin area. Black pearls produced in culture of this oyster in French Polynesia coast as much as a few thousands of each. CMFRI is making efforts to raise this species to enable cultured pearl production. *P. margaritifera* needs warm flowing waters for its growth.

8. Seaweed Culture

The seaweeds of commerce are macroscopic algae which yield the most important chemicals, agar-agar, carragoonan, algin such as etc. Apart from industrial uses, they are harvested for food purposes in some countries such as China, Japan, Korea, Philippines, etc. In India, the economically important seaweeds are *Gelidiella acerosa*, species of *Gracilaria*, *Sargassum*, *Turbinaria*, etc. But the resources of these seaweeds from natural beds are inadequate to meet the ever increasing demand from the seaweed based industries. Hence the concerned research institutes such as Central Marine Fisheries Research Institute, Central Salt and Marine Chemicals Research Institute, etc. are engaged in developing suitable culture technologies for augmentation of these economic seaweeds.

The field culture experiments carried out so far with *Gelidiella acerosa*, *Gracilaria edulis*, *Hypnea musciformis*, *Ulva*, *Enteromorpha*, *Acanthophora spicifera*, etc. have revealed that these seaweeds can be successfully cultivated on coral, stones, long line ropes, etc. (Chennubhotla *et al.*, 1987). The cultivation of *Gracilaria edulis* in mainland coastal waters has yielded a three fold increase over the initial seed material introduced while in Minicoy lagoon the yield was found to be very high i.e. thirty one fold (Chennubhotla *et al.*, 1992).

The field cultivation of *Gelidiella acerosa* at Ervadi near Mandapam using coral stones as the substratum has yielded an annual harvest of 33 fold increase over the seed material (Patel *et al.*, 1979).

Of late the tissue culture of sea weeds, genetic manipulation of seaweeds to produce high yielding varieties and introducing fast growing exotic economic seaweeds such as *Eucheuma* are being undertaken to boost seaweed production in the country.

9. Environmental Impact of Coastal Aquaculture

It is true that prawn farming along our coasts has affected the environment and caused disease problems and losses in many areas. What has happened is due to wrong approaches, unscientific farming and culture in unduly large areas. When it was found that in intensive farming yield was high in Taiwan, many entrepreneurs acquired large stretches of land along the coasts in one country including land where agriculture was carried out hither to and started prawn farming. It was not realized that case has to be taken to see that the health of the prawns, environmental parameters and ecological balance in the culture area should not be affected.

In intensive prawn farming and what is called super-intensive farming the ponds were stocked with enormous numbers of seed thinking that if the seed density is high and large quantities of feed are provided the harvest will be correspondingly high. It worked to some extent initially in some farms. From the high stocking densities and dumping of large amounts of food loaded the farming areas with metabolites and residual food which polluted the areas and led to incidence of viruses and bacteria and prawn diseases. Use of harmful steroids as growth promoters and indiscriminate use of antibiotics worsened the situation. All the factors together led to prevalence and spread of diseases like white spot disease extensively and consequently large scale mortalities and losses.

In some farms the outbreak of disease is due to use of poor quality seed. In few instances it was found that the cause of disease was use of imported infested prawn seed. Water quality is of paramount importance. When stocking density is high there is a depletion of dissolved oxygen. The nutritional quality of artificial feed used is some times poor and results in poor yield. The use of pathogenic micro-organism infested artificial feed is responsible for incidence of disease in some farms.

The farms of many prawn farmers extends over three or four hundreds of acre at a stretch. Culture of huge number of prawns on an unduly large scale in numerous ponds causes rapid growth and multiplication of virus and bacteria with the decaying and decomposing of excessive feed, and production of ammonia, hydrogen sulphide and other toxic substances in the habitat. Farming in hundreds of acres of land in a single place has to be prohibited. There is mushrooming of farms. The drainage channel of one farm is often the inlet area for the adjacent farm. The water used in a farm has to be treated before release.

10. Damage to Coastal Ecosystem

There has been conversion of mangrove swamps in many places especially along the northeast into prawn farms which has affected rich flora and fauna. The mangroves are of great importance as binding and protective fauna of the coastline from storms, cyclones and tidal waves and should not be cut down. For the same reason grasslands and areas with polyarha coconut and casuarina trees should not be converted into aquaculture sites. The mangrove marshes are rich in cultivable prawn and fish seeds. Some entrepreneurs purchase large areas of agricultural land and land near human habitations for construction of prawn farms which in a short time leads to salination of the ground water in adjacent areas rendering it unfit for agriculture and drinking purposes. Therefore it is imperative that such interior land is not acquired for coastal aquaculture. There are other large areas available along the coastline itself for the practice of aquaculture.

11. Future Prospects for Coastal Aquaculture in India

Due to the problems which have occurred as a result of unplanned farming with high stocking and unfavourable methods like use of feed of poor quality, excessive use of feed and absence of maintenance of water quality by entrepreneurs, it should not be presumed that prawn farming is destructive to environment. Prawn culture in ponds is a well organized mariculture activity in several countries like Japan, China, Taiwan, Korea, Thailand, Philippines, Singapore, Indonesia and Australia. In India we have scientific and technical expertise in prawn culture. If prawn culture is carried out in medium size farms on scientific lines using semi-intensive method with selected hatchery produced high quality seed careful environment management with maintenance of dissolved oxygen, salinity and other parameters optimum quantities of good quality formulated diet given in appropriate qualities during growth and constant monitoring of the quality of cultured prawns the outbreak of disease can be prevented and sustained prawn culture could be carried out profitably. The prawn hatcheries and farmers should have laison with the Government Research Institutes, Central Institute of Brackishwater Aquaculture and Central Marine Fisheries Research Institute to solve any problem which they may encounter.

Prawn production from aquaculture could be stepped up not only by increasing the area under farming but also evolving high yielding and disease resistant strains through experimental breeding and genetic engineering. In

Australia, a super shrimp with 20–25% higher body weight than normal has been produced in a Commonwealth Scientific and Industrial Research Organization research programme in shrimp genetics (Anon 1997). The super shrimp has been obtained after breeding for four generations and the commercial possibilities of producing seed of this super shrimp are proposed to be investigated.

Diversification of coastal aquaculture by cultivation of organisms of different groups which are mostly neglected like finfishes, crabs, lobsters, oysters, mussels and clams and seaweeds is long due and is of utmost importance to India at this juncture with rising population. Culture of these groups has many benefits, providing seafood nutrition to people of our country where food scarcity and malnutrition are rampant, and opening avenues for employment as well as possibilities for export. Seaweed culture is another urgent necessity for use of marine algae as food and to meet the high shortage of agar and alginic acid in various industries in our country which need the raw materials. Culture of marine pearls is a field in which India can achieve greatly as we have natural resources and scientific and technical know how in producing very high quality beautiful pearls by culture techniques and entrepreneurs have started commercial ventures. If aquafarmers and entrepreneurs bieston greater interest than at present and diversify the culture activities making use of the research and development efforts, extension, training and consultancy programmes offered by research Institutions and the maritime state Governments and backing institutions lend necessary support, production from coastal aquaculture could be doubled from present level 80,200 tonnes of by 2000 A.D. and manifold by 2020 A.D. without adverse impact on coastal marine environment.

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