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50 Problems and prospects for lobster farming in India

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ABSTRACT

The potential for increasing the lobster yield from the wild is limited, as most of the stocks have reached optimum levels of production. Hence attempts were made by the CMFR Institute to successfully grow the non-cannibalistic species under captivity in view of the above and demand for live lobster in export market. The paper reviews the previous culture attempts and the present status on the spiny lobster, distribution of culturable species for farming and fattening, brood stock maintenance, larval culture, availability and growth of puerull, collection and transportation of juvenile lobsters, fattening of subadults, growth acceleration by eye stalk ablation, farming in intertidal pits, environmental conditions for juvenile rearing, stock density, food,diease, economics of farming and fattening, and the future prospects in Indian condition.

Introduction

Lobsters are a low volume, high value resource which support one of the most valuable coastal fisheries in India. Annual landings increased from 350 t in 1965 to 4,100 t in 1985, but has generally declined since then. The current production is around 2,000 t, most being exported alive and in whole cooked form to the southeast Asian market. The potential for increasing the yield from the wild is limited, as most of the stocks are fully exploited and near their long term equilibrium yield. Farming spiny lobsters is probably one of the management strategies to be considered to cope with intensifying fishing effort and decreasing lobster stocks.

For many years, homarid lobsters alone have been thought to be suitable for aquaculture, as their seeds could be produced in less than 2 weeks when reared at 20°C. On the otherhand, spiny lobster has a complex and prolonged larval phase and earlier attempts to complete their life cycle was unsuccessful. However, studies conducted at the Central Marine Fisheries Research Institute have indicated that spiny lobsters are non-cannibalistic under normal conditions and can be successfully ongrown in groups under captivity. Later studies by Tuticorin Fisheries College also confirm that spiny lobsters grow fast and they are amenable to cultivation. Recent success in rearing the larval phyllosoma phase in captivity (Kittaka, 1988; Kittaka and Ikegami, 1988; Kittaka and Kimura, 1989) has further increased the commercial prospects of spiny lobster farming.

This review will cover previous culture attempts, the present status and major constraints in farming palinurids. Some thoughts on the ideal species to grow, the strategies for farming and fattening and the future of lobster culture are also presented.

Distribution

Among the nine species of lobsters distributed along the Indian coast, *Panulirus polyphagus*, *P. homarus*, *P. ornatus* and the deep sea lobster, *Puerulus sewelli*, are the most significant commercial species. The mud spiny lobster, *P. polyphagus* forms a major fishery along the northwest coast comprising Maharashtra and Gujarat coasts. The scalloped spiny lobster *P. homarus* is mainly distributed along the southwest and southeast coast of India (Tamilnadu coast). This species inhabits shallow waters, mostly between 1 and 10 m in rocky areas. The ornate spiny lobster, *P. ornatus* mainly forms a fishery on the southeast coast of India, in the Gulf of Mannar. This is one of the largest of the *Panulirus* species. Other species which form minor fishery are *P. versicolor*, *P. penicillatus* and *P. longipes*. The sand lobster *Thenus orientalis* is distributed on the east and west coasts of India and forms fairly good fishery on the northwest and east coast.

Broodstock and larval culture

Tropical spiny lobsters breed almost throughout the year. Egg bearing spiny lobsters occur in commercial catches regularly and form a sizeable percentage during the peak breeding season. Attempts to rear spiny lobsters from postlarva (puerulus) to adult have been successful. Chittleborough (1974) successfully reared puerulii of *P. cygnus* to sexual maturity and bred them in captivity. Later Radhakrishnan (1977) succeeded in rearing juvenile *P. homarus* to sexual maturity and breeding them in the laboratory. These studies show that broodstock development in spiny lobsters may not be difficult. However, information is inadequate on the quality and quantity of eggs produced by captive population, compared to the wild broodstock. The egg mass of both captive and wild berried lobsters are often infected with bacteria and protozoans and have to be treated with antibiotics, before they are released in the spawning tanks.

Berried spiny lobsters will release viable phyllosoma larvae in captivity. The phyllosoma larvae are all characteristically delicate, dorsoventrally flattened, transparent and have numerous appendages. The larval phase is so complex and prolonged (4-22 months)hence attempts to rear them to the postlarva (puerulus) were not successful for many years. Proper diet for different larval stages is considered to be a major constraint in the larval culture. Most researchers fed the earlier stages with freshly hatched *Artemia* nauplii. Mitchell (1971) and Dexter (1972) fed the larvae on Tubifex, *Mytilus* gonads, fish larvae, ctenophores and chaetognaths. Polycheate worms were accepted by larval *J. edwardsii* (Bantham, 1967). Mussels have been shown to be an excellent food for complete culture of phyllosoma larvae (Kittaka, 1994). Since availability and quality of natural food may vary, development of formulated feed is essential for the establishment of commercial scale culture of phyllosoma larvae. In tanks, increases in food availability and temperature can accellerate growth and development in early larvae (Vijayakumaran and Radhakrishnan, 1986; Mikami *et al.*, 1994). Light levels can also influence feeding rates and moulting frequency of the phyllosoma larvae (Radhakrishnan and Vijayakumaran, 1986).

Another major factor in rearing phyllosoma larvae is maintenance of exceptionally high water quality throughout. Left over feed and excreta affect water quality considerably. Increase in Chemical Oxygen Demand (COD) and accumulation of ammonia are also detrimental factors. Kittaka (1994) set safety level for COD at 1.2 ppm, provided the culture water is exchanged every two weeks. Biological control of water quality in larval rearing system with the microalga *Nannochloropsis* sp., and certain marine bacteria is found to be clearly effective (Kittaka, 1994).

Kittaka (1988) and Kittaka and Kimura (1989) succeeded in rearing the phyllosoma larvae of spiny lobsters from egg to settlement. Six temperate species, *Panulirus japonicus, Palinurus elephase, Jasus lalandii, Jasus hybrid, Jasus verreauxii* and *J. edwardsii* were successfully reared to puerulus in the laboratory. The larvae were fed with *Artemia* nauplii and *Mytilus* gonad throughout the culture period. Though the survival was poor, this success opens up the possibility of developing a hatchery technology for the spiny lobsters. New Zealanders achieved success in rearing the phyllosoma larvae of *J. edwardsii* (Booth, 1995). However, further research is needed to completely understand the food and water quality requirements of the phyllosoma larvae.

Puerulii availability and grow out

The final stage phyllosoma larva after metamorphosis to puerulus swims towards the shore and settle on suitable benthic habitats nearshore. Several investigators have successfully ongrown the puerulii to commercial size. Chittleborough (1974) reared the puerulii of western rock lobster, *P. cygnus* to the legal harvestable size (76 mm carapace length and 387 g weight) in 30 months at an optimal temperature of 25^0 C. P. *polyphagus* puerulii have been grown to 300 g in 27 months under laboratory conditions (Radhakrishnan and Devarajan, 1986). Lellis (1990) was able to grow *P. argus* to marketable size of 454 g in 18 months at a constant elevated temperature of 29^0 C. Compared to several other commercially farmed crustaceans, the time required to grow puerulii to marketable size is too long. Moreover, collection of large number of puerulii from nature is capital intensive and impractical. So, for the present, ongrowing juveniles to commercial size looks more feasible.

Juvenile availability

In India, since a minimum legal size for capture has not been strictly enforced, gill nets and trammel nets are used for lobster fishing in many areas and 30-40% of the catch consisted of undersized lobsters. Since small size lobsters do not fetch good price, they could be collected for a reasonable price and used for farming. On the northwest coast of India, in Gujarat, large scale trapping of juvenile *P. polyphagus* by stake nets fixed in intertidal areas is practised and sold to lobster farmers (Sarvaiya, 1991). Along the Tamilnadu coast, trammel nets are widely used for lobster fishing. Unrestricted exploitation of juveniles is, therefore, not recommended, as they may adversely affect the natural recruitment and the fishery in the long run. One of the major reasons for overall decline in lobster fishery in India might be destructive fishing of juvenile lobsters affecting their natural recruitment to the fishery.

Collection and transportation

Since large quantities of juveniles to stock a farm may not be available from a single landing centre on a single day, they have to be collected from different centres whenever they are available for careful transport to the farm site. While the juveniles can be used for farming, subadults can be kept in holding tanks for a shorter period, until they attain the prime size. Ongrowing the juveniles to the prime size may take a longer period.

Spiny lobsters have the ability to stay outside water for long periods, provided their gill surface is moist enough to exchange atmospheric air. In order to keep the gill surface moist, they should be covered with moist sand, or wet cloth and not exposed to the sun. This could avaid mortality of lobsters after their procurement and until sold to the farmers.

To maintain spiny lobsters in healthy condition during onboard transport, the holding tanks should be well aerated. To increase efficiency, a large space of about four times the water volume must be left in container to hold air (Sugita and Deguchi, 1994). Since temperature influences the metabolic activity and rate of oxygen consumption of the animals, high temperature has to be avoided. For the tropical lobsters, upper limit of temperature during transportation is estimated to be 28° C, which corresponds to that of the Japanese spiny lobster, *P. japonicus*. Healthy and weak lobsters have to be separated and maintained in different tanks for at least two days, before stocking.

Ongrowing juveniles in the laboratory

Juveniles of several species of spiny lobsters have been reared to marketable size under laboratory conditions. Ongrowing juveniles is relatively easy and growth rates exceeding those in the wild have been achieved. The Western rock lobster *P. cygnus* has been estimated to reach legal marketable size (76 mm CL, 387g) in 17 months from an average size of 45 g at about 25° C (Chittleborough, 1974). At 29° C, some males of *P. argus* reach 450 g in 12 months and 1.4 kg in 2 years on a mixed diet of ground fish, clam and squid (Lellis, 1991). *P.homarus* has been estimated to take 12 months to grow from 80g to 400g and *P. ornatus* a little less than this period (Radhakrishnan and Vijayakumaran, 1990). Kaleemur Rahman and Srikrishnadhas (1994) contend that it will be possible to culture *P. homarus* weighing 50-100g to a size of 250g in 5-6 months.

Fattening subadults

Another attractive proposition is growing larger sizes (300-350g) to the prime size of 400g in a shorter period. Live lobsters of *P. ornatus* weighing 400g and above are in great demand in the Chinese market and fetch premium price. Animals weighing just below this size can be procured much below the premium price and fattened to the required size in a shorter duration. The fast growing *P. ornatus* can be grown from 300 to 400g in 2-3 months. *P. homarus* and *P. polyphagus* weighing around 100-350g are mostly exported in whole cooked form. However, the preferred size is between 250-350g. So, for fattening, lobsters weighing around 200g will be suitable and this could be achieved in 2-4 months.

Growth acceleration by eyestalk ablation

Growth in tropical lobsters can be accelerated severalfold by bilateral eyestalk ablation (Radhadrishnan and Vijayakumaran, 1984). Different size groups of *P. homarus* have been ablated and the ablated animals moulted faster and gained 3-7 times more weight than the control group, with an average 70% survival. Radhakrishnan and Vijayakumaran (1990) estimated the yearly growth of ablated *P. ornatus* as 2173g, *P. homarus*, 749g and 779g for *P. polyphagus*, if the initial weight is considered as 80g. The practical application of eyestalk ablation technique for accelerating growth in a commercial farm has not been attempted yet and information is inadequate on the consumer acceptability of ablated lobsters.

Lobster farming in intertidal pits

A unique system of lobster farming is practised along the northwest cost of India, in Bhavanagar district of Gujarat. Large number of juveniles of *P. polyphagus* collected from intertidal areas by a traditional stake net called 'bandhan' are stocked in ponds excavated in the intertidal area, which are flushed by incoming tidal water twice daily. These ponds or 'pits' are covered by nylon netting to prevent escape of the lobsters. Juveniles weighing 30-50g are grown to 100 125g in 90 days and sold live for Rs.250 per Kg.

Conditions for juvenile growout

The major water quality requirements for the spiny lobsters occuring in Indian waters are known. Spiny lobsters are hardy and can tolerate changes in environmental conditions to a limited extent but prolonged exposure may affect growth and survival drastically.

Temperature :

Temperatures above ambient (but up to a maximum) usually result in faster growth, greater than that seen in nature (Booth and Kittaka, 1994). Tropical lobsters are subjected to only limited temperature fluctuations (23-29°C) and temperature dependent growth variations are negligible.

Salinity :

Most of the palinurids though are strictly marine can tolerate wide range of salinities. *P. homarus* can endure salinities from 15-55ppt and *P. polyphagus* 5-55ppt (Kasim, 1986). *P. ornatus*, on the otherhand, is sensitive to changes in salinity and pH. Continuous exposure to extreme salinities may adversely affect growth and the flavour of the meat (Konosu and Yamaguchi, 1994). Optimum salinity for good growth and survival of spiny lobsters is 30-35 ppt.

Dissolved oxygen :

Oxygen consumption in spiny lobsters depend on body size, moult stage and the feeding condition. Spiny lobsters have been referred to as oxygen regulators (Winget, 1969) but are oxygen independent below the critical oxygen tension. This facilitates them to adjust to low oxygen conditions. The lethal low oxygen level appears to be between 0.5 and 3.0 mg per litre, depending upon species.

Ammonia :

In intensive lobster culture systems, accumulation of ammonia may be a critical limiting factor affecting the growth and survival. Forteath (1990) recommends that total ammonia should be below 0.5 mg per litre and levels of ammonia nitrogen should not exceed 0.1 mg per litre. Nitrite levels should be at or below 1 mg nitrite-nitrogen per litre and nitrates below 100 mg nitrate nitrogen per litre.

Water quality maintenance :

Maintenance of good water quality in the culture system is most essential for any successful aquaculture venture. In flow through system.

continuous flow of fresh filtered seawater has to be maintained, especially during night, when the lobsters feed and undergo moulting. The dissolved oxygen and ammonia may reach critical levels during early morning due to decomposition of excess, feed and accumulation of excreta of the lobsters. Sudden fluctuations in salinity, pH and alkalinity of the seawater may happen during rainy season. Recirculation system with either mechanical or biological filters are better, especially where the seawater quality is unpredictable. Care should be taken not to overstock the tanks so that the lobster biomass exceed the carrying capacity of the filters. The filters should be properly maintained so that the benevolent bacteria continue to survive and control the water quality.

Photoperiod and light intensity :

Spiny lobsters are nocturnal and always occupy shaded areas in the culture tanks during daytime. Normal day length and light intensity less than 1000 lux is found to be conducive for normal growth in captivity.

Stocking density :

Optimal stocking density will not only improve the growth rate but will have a major effect on the overall cost of production. Phillips (1985) estimated the stocking density for *P. cygnus* as 25 Kg/m^2. According to Lee and Wickins (1992) for a single layer of older juveniles, 351m of tank area may be required to produce 1 t of market-sized animals with an overall annual yield of 11.4 t per ha. Kaleemur Rahman and Srikrishnadhas (1994) suggested 25 lobsters of 50-100g size per square meter as the most economical stocking rate for *P. homarus*.

Food and food utilisation :

Although lobsters accept a wide range of food, they prefer molluscan meat to finfish and that too fresh food. Daily feeding rate of 3-10% bodyweight has been determined for *P. homarus*, depending upon the size. Wet weight food conversion ratio for different feeds are 5.0 for mussel, 5.8 for clam, 6.6 for fish and 4.8 for a mixed diet comprising all the above ingredients in equal proportions (Radhakrishnan, 1994). Increased conversion efficiency has been reported for eyestalk ablated lobsters (Vijayakumaran and Radhakrishnan, 1984). Diet like mussel meat, which contains carotenoid pigments, maintains natural exoskeletal colour of the lobster (Radhakrishnan and Vijayakumaran, 1984).

Commercial lobster farming cannot entirely depend upon naturally available feeds, as their collection, transportation, storage, continuous supply and handling will be difficult. Artificial diets are more dependable in quality and is convenient for feeding. Moist diets are more suitable than dry ones, as they suit the feeding behaviour of the lobster, but needs refrigeration for storage. A useful artifical diet has been reported for *P. argus* by Lellis and Russel (1990), but specific requirements for one species may not suit others and the requirements will vary even for the closely related species (Conklin, 1980). Death at moult (MDS) has been widely reported among captive spiny lobsters, which may be due to stress and poor nutrition, including insufficient dietary B vitamin and manganese (Castell *et al.*, 1991).

Disease

Lobsters maintained on good feed and water quality are rarely infected by any disease. Poor water quality and hygiene in the rearing system may provide favourable conditions for the growth of epiphytic protozoans, fungi and bacteria. Protozoan infestation can be controlled by treating with 20-30 ppm formalin for one hour. Furazolidone (10 ppm/hr) treatment is effective against bacterial infections (Radhakrishnan, 1994). Infected lobsters have to be isolated for treatment.

Farming system

Growing spiny lobsters in growout ponds in India is practised only in Gujarat. Experiments conducted in CMFRI and Tuticorin Fisheries College show that indoor grow out system is most suited for lobster farming and fattening, as it is convenient for management. Experimental culture of lobsters in floating cages has been reported from Tuticorin, but the commercial feasibility of the farming operations is not available. An indoor growout system consisting of a series of circular or square cement tanks, 9 to 16 square meter area, has several advantages, as the different units can be managed easily. The farming system can be either flowthrough or semi-closed recirculation system incorporating biological filters (Radhakrishnan, 1994).

Economics of spiny lobster farming and fattening

Fattening of undersized lobsters to the highly priced premium size in a short period is most practical and profitable for the present. There is a good market for live lobsters ranging in 200 to 400 g size. Under optimal conditions with good water quality and feed management, 90% survival can be obtained. The average production of lobsters, weighing 400g each, from a fattening unit of 100 square meter has been estimated to be 900 Kg/year and sale price of live lobsters at the rate of Rs.800/Kg would be Rs.7,20,000. Considering the estimated capital cost for establishing a 100 square meter indoor farm as Rs.5.5 lakhs and the operational cost as Rs.4 lakhs per year, a gross profit of 3.2 lakhs could be obtained in a year. Higher profit is possible with increase in sale price of live obsters in the export market.

Future prospects

Commercial farming of spiny lobsters intensive culture systems is possible, but not recommended for the present. Any farming operation cannot sustain on seeds caught from the wild and a perfected hatchery technology is highly essential to supply seeds to the farms. The indicators are favourable and until then smallscale fattening of lobsters just below the prime size to the highly priced export size alone can be taken up and is highly profitable. Development of a hatchery technology for spiny lobsters shall be given top priority under the mariculture research and development programmes in the country.

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