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Aquaculture of spiny lobsters in sea cages in Gujarat, India

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Abstract

A total of 2,256 juveniles of the mud spiny lobster, *Panulirus polyphagus* with a mean carapace length of 40.44 mm and mean body weight of 67.83 g after acclimatization for a period of twelve weeks in 8000 litres FRP tanks were stocked in open sea cage near Veraval on the coast of Gujarat, India at a density of 12.4 m^{-3}. The lobsters were fed twice daily with fresh fish and mollusc meat at 10% of lobster biomass per day. Monitoring of the water quality parameters in the vicinity of the cage found that they were well within the favourable ranges for shellfish culture indicating that the cage has not made any adverse impact on the local environment. The lobsters were harvested from the cage after 120 days at a mean wet weight of 212.65 g. Survival was 86.1 %. The results of this preliminary experiment indicate that there is commercial potential for the development of sea cage culture of *Panulirus polyphagus* in Gujarat.

Keywords: Spiny lobsters, sea cages, aquaculture, Saurashtra coast

Introduction

The state of Gujarat contains about 20% of India's coastline, 33% of the continental shelf area (1,64,000 sq. km) and over 2,00,000 sq. km of EEZ and ranks second among India's nine maritime states in marine fish production. However, intensive and uncontrolled fishing pressure in the coastal waters of the state has resulted in major shifts in the marine ecosystem of the State (Mohanraj *et al*., 2009). In recent times the bulk of the fish catch of Gujarat has been composed of low value species, which are sundried, or block frozen and exported to China and Southeast Asian countries (Mohanraj *et al*., 2009). The production of larger sciaenids and perches, as well as pomfrets, threadfins, penaeid prawns, lobsters, eels, clupeids and mullets is declining fast and has reached a critical level (Mohanraj *et al*., 2009). Some of the valuable fishes like large sharks and whitefish had completely vanquished from the fishery of the state. The fishery at present is dominated by low value fin fish and shell fish, such as smaller croakers, carangids, Bombay duck, ribbonfishes, threadfin breams, lizardfishes, flatfishes and nonpenaeid prawns. It was therefore felt to be a necessity to revitalize the dwindling fishery of the State. Capture based aquaculture (CBA) is perhaps the best alternative to augment the low catches and low economic returns in recent times. In this context, open sea cage culture offers much promise in allowing fishermen to maximize their economic returns.

Lobsters (both spiny and slipper varieties) form one of the most important natural resources of Gujarat. Spiny lobsters are particularly expensive, fetching a price depending on size, from Rs. 600 to Rs. 800 kg^{-1} (US $ 13.3 to 17.8 kg^{-1}). In terms of seed availability, pueruli and early post-pueruli spiny lobsters are abundantly available in nearshore waters along the Saurashtra coast in the post-monsoon months (from September onwards). The mud spiny lobster species *Panulirus polyphagus* was selected for stocking in sea cages.

Material and Methods

The most important factors determining the success of cage culture is the design of the cages

and the selection of an appropriate site for installation of the cage. As part of the project "Open Sea Cage Culture Demonstration Farms in India" funded by National Fisheries Development Board, a 6 m diameter cage was fabricated and launched (Fig. 1) in January 2009 off Sutrapada Village, 18 km south of Veraval in Gujarat. The project was facilitated by involving the local "Sagar Fishermen's Co-operative Society" and to this end a Memorandum of Understanding was signed with their officials relating to the site chosen for the project. This prevented disputes concerning navigational routes and property rights in relation to the experimental sea cage. The water quality parameters *viz.*, temperature, salinity and pH were monitored on weekly basis. Dissolved oxygen content, total ammoniacal nitrogen, nitrate nitrogen, phosphate phosphorus and total bacterial load were analysed fortnightly (APHA, 1998).

The cage was made of 140 mm HDPE material and was provided with a railing of 1 m. The nets for the sea cage were made up of nylon (20 mm) and were attached to 10 m diameter ballast at the bottom. The cage was 6 m in height and was held in position by attached floats, Gabion boxes and shock absorbers. It was also provided with 1.3 m catwalk to provide working space for the fishermen to complete their daily work. An additional velon screen was provided at the bottom and a bird's net (80 mm mesh size) on top of the cage. The total volume of net cage was 182 m^3.

A total of 2,256 juveniles and sub-adults of *P. polyphagus* of mean carapace length (CL) of 40.44 mm, total length (TL) of 124.72 mm and mean body weight (BW) of 67.83 g, were stocked in cage in at Sutrapada in January, 2009 after acclimatization for twelve weeks during October – December, 2008 in 8000 litre FRP tanks.

Lobsters were selected based on their external appearance with all appendages and exoskeleton intact exhibiting good pigmentation. Before stocking, morphometric data such as carapace length (CL), total length (TL) and body weight (BW) of random samples of lobsters (n=100) were recorded. The lobsters were fed daily with a mixture of fish and molluscan meat in 1:1 ratio at 10% of the biomass distributed evenly in morning and evening hours. Frequent observations were made on the growth rate of caged lobsters by randomly sampling the population with cast net fortnightly to ascertain their health status and adjusting their feeding ration in accordance to the changes in the biomass of the caged population. The nets were cleaned on alternate days to remove the unconsumed feed, clogging with silt and fouling with barnacles. The cage was harvested in May, 2009 after 120 days of culture.

After harvesting, CL, TL and BW of random samples of lobsters (n = 100) were recorded when the lobsters were harvested. Growth parameters were estimated using the formulae given below:

$$\text{Body weight gain (\%)} = \frac{\text{Mean final wet weight} - \text{Mean initial wet weight}}{\text{Mean initial wet weight}} \times 100$$

$$\text{Total length gain (\%)} = \frac{\text{Mean final total length} - \text{Mean initial total length}}{\text{Mean initial total length}} \times 100$$

$$\text{Carapace length gain (\%)} = \frac{\text{Mean final carapace length} - \text{Mean initial carapace length}}{\text{Mean initial carapace length}} \times 100$$

$$\text{Mean survival (\%)} = \frac{\text{Number of lobsters survived at the end of the experiment}}{\text{Number of lobsters stocked at the start of the experiment}} \times 100$$

$$\text{Specific growth rate (SGR)} = \frac{\ln W_t - \ln W_o}{\text{Days of culture}} \times 100$$

W_t = Final average wet weight (g), W_o = Initial average wet weight (g)

Results and Discussion

The cage structure used in the present study was found to be sturdy and durable and had not made any adverse impact on the local environment. Similar floating net cages (5 m x 7 m x 4 m) provided with additional velon screen at bottom and hideouts for preventing cannibalism were used for rearing spiny lobster, *P. homarus* at Vizhinjam Bay (Syda Rao *et al.*, 2010).

Puerulii and post-puerulii, early juveniles and sub-adults of the spiny lobster, *Panulirus homarus* and juveniles of *P. ornatus* were grown in different floating sea cages along the southeast coast of India (Vijayakumaran *et al*., 2009) made of galvanized iron pipe frame (2 m x 2 m x 1.2 m) with steel woven mesh and four inner detachable compartments (0.75 m x 0.75 m x 1.10 m). In Vietnam, various sizes of floating cages (3.5 m x 3.5 m x 1.5 – 4 m; 4 m x 4 m x 1.5 – 4 m and 3 m x 4 m x 1.5 – 4 m) were used to grow, *P. ornatus* (Tuan *et al*., 2000). However in New Zealand and Australia, smaller submerged cages were used for growing spiny lobster, *Jasus edwardsii* (Jeffs and James, 2001; Bryars and Geddes, 2005).

All the water quality, nutrient and bacteriological parameters recorded from the cage in the present study were well within the optimum ranges recommended for lobster culture (Table 1). The optimal environmental requirements for lobster farming are temperature (26-33^{o}C), salinity (25-35 ppt), pH (6.8-8.5), dissolved oxygen (>3.5 ppm), ammonia (<0.1 ppm) and nitrate (<0.1 ppm) (Philips *et al*., 1980; Van Olst *et al*., 1980; Kittaka, 1994; Vijayakumaran *et al*., 2009).

Table 1. Water quality, nutrient and bacteriological parameters recorded from cage during lobster culture

Water quality parameters	Range
Temperature (^{O}C)	26.5 - 27.7
pH	8.1 - 8.2
Salinity (ppt)	34.7 - 35.1
Dissolved Oxygen (ml l^{-1})	4.38 - 5.34
Ammonia (µg. at. NH_4 – N l^{-1})	0.139 - 0.307
Nitrate (µg. at. NO_3 – N l^{-1})	4.22 - 6. 1
Phosphate (µg. at. PO_4 – P l^{-1})	0.022 - 0.088
Total microbial count (log cfu ml^{-1})	4.37 - 4.89

Juveniles/ sub-adults of *P. polyphagus* having mean CL of 40.44 mm, mean TL of 124.72 mm and mean BW of 67.83 g after rearing for twelve weeks in FRP tanks during October – December, 2008 reached on an average 50.89 mm CL, 144.39 TL and 114.12 gm BW. The same were stocked in the cage at Sutrapada and after culturing for 120 days had grown to mean CL of 65.68 mm, mean TL of 178.23 mm and mean BW of 212.65 g. A sizeable proportion of the lobsters reached 300 g body weight at the time of harvest. The percentage increments in body weight, total length and carapace length in cages were 86.34, 23.44 and 29.06, respectively.

The survival rate was 86.1% in cage and Specific Growth Rate was 0.519. The biomass production and total production of *P. polyphagus* was 143 kg and 308.6 kg from the cage. The results of the present study are in full agreement to Syda Rao *et al*. (2010), who recorded a survival of 75%, weight increment of 0.82 g per day and SGR of 0.50 in cage reared spiny lobsters *P. homarus* at Vizhinjam Bay. Vijayakumaran *et al*. (2009) reported that sub-adults of *P. homarus* with an average weight of 123.61 g reached 341.25 g in 225 days at a stocking density of 21 m^{-2} with a survival of 73% in floating sea cages along the southeast coast of India. Their growth rate was 0.97 g per day with a SGR of 0.43 which are comparable to the present study. Sreekrishnadas *et al*. (1983) recorded 0.6 g growth per day with survival rate of 57.5% for *P. homarus* from open sea net cage at Tuticorin Harbour. The survival rates recorded was similar to 70 – 95 % recorded for *P. homarus* by lobster growers in Vietnam (Tuan *et al*., 2000). There was no incidence of disease in cages during the experimental period.

Another important role of cage in sea is that it can function effectively as a fish aggregating device. It was observed at Sutrapada, that the fish and lobster population around the cage increased and were feeding on the feed thatwas leaching from the cage. The structure of cage is efficient in attracting pelagic fishes which move in shoals. Hence, the fishermen can travel directly to the site of the cage and fish which will save fuel and labour charges at the same time will increase the quantum of catch.

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