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EFFECT OF STOCKING DENSITY ON GROWTH AND SURVIVAL OF SPINY LOBSTER (*PANULIRUS POLYPHAGUS*) IN PIT CULTURE AT INTERTIDAL AREA OF MAHUVA COAST, GUJARAT, INDIA

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ABSTRACT : In the present study, Pit culture of mud spiny lobster *Panulirus polyphagus* was carried out for 182 days near Mahuva on the coast of Gujarat and find out the effect on growth and survival with different stocking density 20, 25, 30 and 35no/ m^2 respectively. Maximum growth was obtained from 25no of lobsters/m^2 with weight gain of 134.99g followed by 124.90g, 111.44g and 97.56g weight in a treatment with 20, 30 and 35no of lobsters/m^2 respectively. Survivability recorded from 20no lobsters/m^2 was observed to be 91.88% where as 89.00% in 25 lobsters/m^2, 82.08% in 30 lobsters/m^2 and 80.00% in 35lobsters/m^2, this was affected due to low temperature during winter season. Maximum FCR recorded during experiment was 2.73, 3.08, 3.63 and 3.98 with treatment 25, 20, 30 and 35 no of stocking density. Highest SGR 0.74 with 25lobsters/m^2 followed by 0.68, 0.61 and 0.53 in 20, 30 and 35lobsters/m^2 was recorded.

Key words : Pit culture, growth, survival, Mud Spiny Lobster, FCR and SGR.

INTRODUCTION

Fishing industry is facing a major crisis with fish stocks declining all over the world. The list of depleting fish stocks is getting longer and longer every year. According to the FAO, about 70% of the world's major species and even of the 15 major fishing areas are in the process of disappearing. This decline in the world fish supply is the result of overfishing, indiscriminate fishing methods and degradation of coastal and inland ecosystems due to various reasons (FAO, 2010). By obtaining control over the production process and closing the production cycle for an increasing of species through research and innovations to what has taken place in agriculture, the competitiveness of aquaculture is rapidly improving and the blue revolution is following the green revolution.

Lobsters form an important fishery all along the coastline of India. Lobster fauna of India comprises 25 species among those shallow water species comprise of *Panulirushomarus*, *P. ornatus*, *P. polyphagus*, *P. penicillatus*, *P. versicolor* and *P. longipes*. The "greens", *P. homarus*and *P. polyphagus*, the "tiger", *P. ornatus* and the sand lobster *T. Orientalis.* High demand for live spiny lobsters particularly in South East Asian countries and its high price (800rs to 1000rs/kg of size more than 200g) have resulted in targeted lobster fishery in India leading to over exploitation. The Lobster resource potential of Indian EEZ is 50,000 MT (Radhakrishnan and Vijayakumaran, 2000).

Spiny lobsters (Family: Palinuridae) are one of themost highly priced export commodities from India fetchinghigh prices in various international markets. They are alsoamong the most important natural resources of Gujaratcoast. Increased demand for these animals has led to theirindiscriminate exploitation. Recent studies have pointedout that unless new fishing grounds are identified, the scopefor improvement of fishery is limited with regard to spinylobsters (Radhakrishnan and Manisseri, 2001). In this situation, besides fishery management and habitat restoration, augmenting the production through population enhancement, aquaculture and fattening remain the only option for sustaining export of lobsters to overseas markets (Raghavan, 2003).

Above one-third of the lobsters caught in India are below 150g with a major percentage below 100 g and is exported as live or whole cooked lobsters. Live lobsters of even less than 100 g were exported to countries like

Taiwan and China, where it was fattened for value addition.

Spiny lobster (*P. polyphagus*) culture is getting increasing attention in recent times due to the intense demand for live lobsters and lobster tails in the national and international market (Solanki *et al*, 2012). *P. polyphagus*is called *Titan* in Gujarati, *Shevand* in Marathi, *Chittakonju/KadalKonchu* in Malayalam and *Katearatioroyya* in Telugu. Spiny lobsters, tropical species have more favorable characteristics and are amenable to farming conditions. Tolerance to high stocking in controlled conditions communal living without cannibalism, acceptance of pelleted feed and strong market demand are some of the characteristics, which makes lobster as a widely accepted aquaculture species (Radhakrishnan, 2012). Culture-based grow out of tropical spiny lobster is an emerging and unique industry that faces a numbers of challenges and opportunities. Increasing global demand, a high market value, and concern for the sustainability of wild stocks have created significant interest in the development of spiny lobster aquaculture (Radford and Marsden, 2005; Simon and James, 2007).

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 only to Kerala among the maritime states in marine fish production. The annual marine fishery potential of the state is estimated at 0.57 million tones, which is about 17% of the all India potential. The width of the Indian continental shelf is greatest off Gujarat offering scope for exploitation of several finfish and shellfish resources by both traditional and mechanized fishing. In terms of seed availability, spiny lobster (pueruli) as well as early post-pueruli are abundantly available in near-shore waters along the Saurashtra coast (Mahuva, Bhavnagar, Jafarabad, Rajapara, Navabundar, Vanakabara, Madhvad, Kotda, Sutrapada, Veraval, Porbandar, Navibunder, Miyani, Rupenbunder, Okha, Jamnagar and Jakhau) in the post-monsoon months (from September onwards). The fishery at present is dominated by low value finfishes and shellfishes like small sized croakers, carangids, Bombayduck, ribbon fishes, thread fin breams, lizard fishes, flat fishes and non-penaeid shrimps. It was therefore felt a necessity to revitalize the dwindling fishery of the state. Capture based aquaculture (CBA) is one of the alternative to augment the low catches and low economic returns in recent times. In this context, Pit culture offers much promise and allows the fishermen to maximize their economic returns (Mohamed *et al*, 2010).

Pits are dug in the limestone intertidal areas and are mostly used in lobster culture near Mahuva in Bhavnagar district. The size of Pit varies but, in general two sizes have been found to be popular. The "virdas" or smaller pits measure 2.4 m in length, 1.8 m inbredth and 0.9 m in depth. The larger pits measure 6 m in length, 9 m in breadth and 1.5 m in depth. The "virdas" must be located at lower levels where flushing with tidal waters occurs twice a day (Philipose, 1994).

Many studies have shown considerable success in cage farming of lobsters in Gujarat region, (Mohamed *et al*, 2010; Solanki *et al*, 2012 and Mojjada *et al*, 2012). Moreover cage culture is rather very costly then pit culture. However, though there were no attempts made to standardize exact stocking density of lobsters in Pit culture. Therefore, the present study was proposed to evaluate effect of stocking density on growth performance and feed utilization of lobster (*P. polyphagus*) in Pit culture.

MATERIALS AND METHODS

Experimental site

Experiments was carried out at Katpar fishing harbour (Lat. $21^0 2' 43''$ N and Long.$71^0 48' 12''$ E) near light house located 10 km away from Mahuva in Bhavnagar District, Gujarat, India (Fig. 1). Duration of experiment was for 182 days, which was initiated on 15thSeptember 2013 to 15th March 2014.

Experimental design and experimental site

A complete randomized design (CRD) was employed in the present investigation. Other details are as under: No. of replication: Four, No. of treatment: Four (Stocking density).

Treatment detail

Total 20 lobsters /m^2 were stocked in Pit.

Total 25 lobsters /m^2 were stocked in Pit.

Total 30 lobsters /m^2 were stocked in Pit.

Total 35 lobsters /m^2 were stocked in Pit.

Total no of Pits (C): 16 Pits

Each lobster was fed by mix diet (shellfish, mussels, soft clams, small crabs, acetes and whole/chopped trash fish) at 8% of their body weight.

Pit specification

Pits are dug parallel to the coast line with hand tools as the bottom rock is soft in nature. After digging and leveling in the sides of the Pits, small holes of 0.15 m were made so as to provide hiding spot for the moulting lobster. The pits were covered with nylon nets to prevent the lobsters from being washed away by tidal waters.

The nets are fastened in such a way that the force of water does not easily displace them. Nets are fixed on rock using reapers and nails (Fig. 2). Sea water enters the pit during high tide and hence water exchange takes place without any manual effort. Pits are reported to be varying in size from place to place, in general, two sizes have been found to be popular the "Virdas" or smaller Pits (Philipose, 1994). The "Virdas" must be located at lower levels where flushing with tidal waters occur twice a day. In some cases Pits are also partitioned using nylon nets, so as to stock separate size groups, avoiding competition for food and shelter. Pits ranging from 2x1x1m^{2}sizes are in operation at present.

Collection of lobsters

The juveniles of spiny lobsters are available in abundance during the post monsoon months of August, September and October. The juveniles were collected from different potential sites along the Mahuva coast, the most promising among them are Khera-Patva, Chanchbundar, Uchha-Kotda, Datardi, Doliya, Setarda, Gujarda, Kuda, Visaliya and also from nearby harbor such as Jafarabad and SiyalbetBundar. The catching of lobster juveniles is a highly skilled job and the fishermen from this area are specialized in it. Juveniles are best caught in low tide using encircling net locally known as "wada" and "bandharan" (Fig. 3) such nets are costly and last for 2-3 months, but the cost is usually recovered in a day itself as marketable size lobsters are also caught along with juveniles. Lobsters were also collected from Jafarabad which had been caught in dolnet by the fishermen.

Stocking density

Total 20, 25, 30 and 35 of *P. polyphagus* of 85 ± 10 g were stocked in respective Pit.

Growth monitoring and sampling

Eight lobsters were randomly selected from the Pits, for weighing and total length measurement (Fig. 4).

Biometric observation *P. polyphagus*

The biometric observations were recorded from eight randomly selected *P. polyphagus* from the four replicate pits of lobsters fattening.

Average wet weight gain (g)

Randomly eight *P. polyphagus* were collected by scooping from Pit and then weighed by a physical balance, as per Kemp and Britz (2008). The observations were recorded weekly. Wet weight gain (g) was recorded using the formula given below.

Wet weight gain % = {Final weight (g) – Initial weight (g)} * 100/Initial wet weight (g).

Feed Conversion Ratio (FCR)

Weight of the feed fed to the animal divided by the weight of animal growth.

i.e. Feed conversion ratio = weight of feed fed (g)/ fish weight gain.

Specific Growth Rate (SGR)

Growth rates were calculated as specific growth rate (SGR) % body weight per day was recorded by using formula as given below:

Specific Growth Rate (SGR) = 100 × (lnt. FBW- lnt. IBW)/D

Where, FBW is final body weight (g) (weight at the end of the time interval studied)

IBW is initial body weight (g) (weight at the beginning of the time interval studied)

D is number of days

Survival (%)

Final survival of *P. polyphagus* was recorded on the last day (182th day) of experiment with the formula given below:

Survival Rate % = No. of live *P. polyphagus* at harvest * 100/ No of lobster at initial stocking.

Net weight gain (g)

It was calculated as per the formula:

Net weight gain (g) = Final weight (g) – initial weight at stocking (g)

Statistical analysis

All data presented are expressed as means ± standard deviation and was subjected to two way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test with the help of SPSS-16.0 version software.

RESULTS AND DISCUSSION

Before the experiment starts, almost all the lobsters were well acclimatized for the Pit condition. In the post summer season, the result obtained were encouraging, but on initiation of winter season few of the lobster skipped feeding and profuse mortality took place. The growth in term of weight gain was more in 25 no. stocking density/ Pit and more feed was consumed, but in mid winter season some of the lobsters died due to low temperature.

Biometric observation

The initial weight of lobsters varied in all replicate with average 85.00 ± 10 g. The detailed result is presented in Table 1.

Specific growth rate (SGR)

Specific Growth Rate (g/day) in pit with stocking

Fig. 1 : Map view of experimental area.

density 25no/m^2 was more than in the pit having 20 no/m^2, 30 no/m^{2}and 35no/m^2. Weight increment (g) during the 182 days of culture was 124.90 ± 4.45 g in Pit with (20no/m^2), 134.99 ± 3.08 (g) in Pit with (25no/m^2), 111.44 ± 3.29 (g) in Pit with (30no/m^2) and 97.56 ± 3.04 (g) in Pit with (35no/m^2) fed with mix feed (clams meat, small crab meat and trash fish meat). Maximum increment in weight was in Pit with 25no/m^2 (134.99 ± 3.08 g) as compared to 20no/m^2, 30no/m^2 and 35no/m^2 (Table 1). Higher SGR was observed in 25no/m^2 (0.74± 0.016%) followed by 20no/m^2 (0.68± 0.024%), 30no/m^2 (0.61± 0.018%) and 35no/m^2 (0.53± 0.016%).

Survival

Maximum survival % of mud spiny lobsters were obtained from the stocking density of 20no/m^2 with 91.88%, in pit with 25nos/m^2 it was 89%, in Pit with 30no/m^2 it was 82.08% while in those Pits having 35no/m^2 it was 80% and that was because of stress conditions high stocking density and prevailed during winter season.

Feed Conversion Ratio (FCR)

Maximum feed intake were in the Pits with 25 no/m^2 with higher FCR obtained in (2.73 ± 0.47) followed by 20no/m^2 (3.08 ± 0.54), 30no/m^2(3.63 ± 0.59) and 35no/m^2 (3.98 ± 0.57).

Feeding

Recent experiments with *P. argus* in Florida revealed that feeding juveniles spiny lobsters rations of frozen clams, shrimp, squid and oysters at 100% of their body weight once daily at the onset of dusk resulted in

Fig. 2 : Pits covered with nets fixed on rock using reapers and nails.

Fig. 3 : Collection of Juvenile lobsters with encircling net locally known as “bandharan”.

Fig. 4 : Length weight measurement of Fattened Lobster.

Table 1 : Growth performance and Survival of lobster (*P. polyphagus*) in Pit culture withdifferent stocking density for 182 days (±SD).

Parameters	20 lobster/m^2	25lobster/m^2	30 lobster/m^2	35lobster/m^2
Initial weight	90.00±9.65^a	89.55±10.11^a	89.43±8.58^a	92.06±9.80^a
Final weight	214.90±8.56^a	224.55±7.31^a	200.87±6.36^b	189.62±10.90^b
SGR	0.68±0.03^b	0.74±0.02^a	0.61±0.02^c	0.53±0.02^d
FCR	3.08±0.54^{bc}	2.73±0.47^c	3.63±0.59^{ab}	3.98±0.59^a
Survival	91.88±6.57^a	89.00±5.77^a	82.08±8.86^a	80.00±7.65^a

significantly better growth than those fed 50% of their body weight twice daily (Cox and Davis, 2006); same trend was recorded in present study when twice feeding a day, most of the feed remain uneaten but feeding once gave good result in maintenance of water quality and feed was consumed to 55%. Feeding was done with mix meat (clam meat, small crab meat, acetes and trash fish meat).According to Radhakrishnan (2008) in Gujarat state, juvenile of *P. polyphagus* (30-50g) were stocked in intertidal pits ($21 \times 7 \times 1$ m^3) at 20 no/m^2 attained 100-125g in 90 days. The present study is in agreement with the above result. Water temperature is one of the most important environmental factors determining the growth rate of crustaceans (Tong *et al*, 1997) specific growth rate (SGR) was significantly different between temperatures, with the highest values recorded for the 24 and 28°C treatments (Kemp and Britz, 2008).

CONCLUSION

Based on the results obtained from the experiments, it seems quite indicative that higher stocking density results in less growth rate and less stocking density results in more survival. Some mortality was seen and this may be due to lower temperature during winter season. Hence, it is advisable to carryout fattening of lobster in summer season. Whereas, experiment of lobster culture can be taken up in Pit rather than cage which may show less expensive, good growth and survival in the same.

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