Hatchery and farming of spiny lobster
An overview

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Introduction

Spiny lobsters are high value crustacean fishery resource having great demand in the international market, especially as whole live. Caught in trawl, bottom set gill nets and traps, some of the important Palinurid species of spiny lobsters are- Panulirus homarus, Panulirus ornatus, Panulirus versicolor, Panulirus polyphagus, Panulirus argus, Panulirus cygnus, Panulirus japonicus, Panulirus echinatus. In India they form bycatch in trawls along Maharashtra, Gujarat (P. polyphagus) in Northwest and Tamil Nadu (P. homarus, P. ornatus) and Kerala (P. homarus) in the southeast and southwest coast respectively.

Panulirus homarus *Panulirus ornatus*

The importance of spiny lobsters as an export commodity and foreign exchange earner generated interest in understanding their biology and fisheries aspects. Kittaka and Booth (2000), reported average world catches of spiny lobsters as 77,000 t in the 1990's. They observed that the resource is either over exploited or fully exploited and one of the few ways of expanding production was via aquaculture. Lobster Research in Japan is more than a century old. Here Research into hatchery rearing of Palinurid lobsters began in late 1890's and developed into the 1900's (Kittaka and Booth, 2000). In New Zealand successful larval rearing for Jasus edwardsii was completed in 1990's. In India, Radhakrishnan (1977) reared a group of juvenile P. homarus (Linnaeus, 1758) to sexual maturity and bred them in laboratory.

Spiny lobsters are good candidate for culture because of - high demand and high value, can be grown in high density, have low protein dietary requirements, good food conversion ratio, disease resistant in optimal water conditions, can be readily bred and are highly fecund. But the greatest hurdle in culturing them is the lengthy larval life which is amongst the longest for marine invertebrates: Jasus sp.-12 to 23 months (Booth, 2006), P. Cygnus- 9 to 11 months (Phillips and Melville Smith, 2006); P. ornatus- 4 to 7 months (Dennis et al., 2001). P. ornatus is considered the best candidate species for aquaculture as they have the shortest oceanic larval development phase (Dennis et al., 2001) and the fastest post larval growth rate, attaining a market size of approximately 1 Kg within 18 months after settlement (Hambrey et al., 2001). In India, P. ornatus of 100 g reached 1.5 Kg in 8 months (Radhakrishnan and Vijayakumaran, 2000). Tholasilingam and Rangarajan (1986) reported 12-15 months for P. homarus to reach the marketable size (250 g).

In the wild the berried (egg bearing) female migrate to the edge of the continental shelf. The eggs hatch into the larval phase known as phyllosoma. The larvae are transparent, dorso-ventrally flattened and planktonic. They drift in ocean currents during their prolonged development and may travel hundreds of kms (Johnson, 1960). They get recruited to the coastal environments by drifting parallel to coastlines with assistance from wind generated shoreward surface currents. During the day they may concentrate in the vicinity of chlorophyll maximum layer and migrate to surface water at night in particular during periods of new moon. They migrate between 30-60 m depth during daylight (Yeung and McGowan, 1991).

Larval rearing

Japan was first to complete the larval cycle of several species of lobsters. Rearing phyllosoma larvae of Panulirus cygnus and Jasus verraeusxi to settlement was achieved by Australia and New Zealand. Inoue (1978) reared the phyllosoma larvae of P. japonicus from egg to final stage in 253 days. The hatchery rearing of the tropical species P. ornatus has been accomplished in Australia. The species has rapid growth rate from post lar-

vae to market size and has larval phase of only 5 months. M.G. Kailis in Western Australia produced the world's first hatchery reared P. ornatus post larvae in 2006. More post larvae were produced in subsequent years by Lobster Harvest Pvt Ltd, set up for the purpose of commercializing lobster propagation. The larval cycle for some of the palinurid lobsters have been successfully completed: P. argus, P. elephas, P. japonicus, P. longipes, P. ornatus, P. pencillatus. P. homarus, P. interruptus, P. polyphagus and P. echinatus are some of the species for which the completion of phyllosoma stages to pueruli is yet to be achieved.

Adult lobsters from wild or juvenile lobsters reared to maturity in captivity are maintained as broodstock. Egg bearing females are also used from the wild for hatchery purpose. The eggs are initially orange in colour and before hatching attains black/ dark brown colour. Incubation period usually is from 15-25 days.

Phyllosoma larva of P. homarus

The phyllosoma larvae of Panulirus homarus were successfully reared up to the sixth stage at the Kovalam laboratory (Madras) of CMFRI on an exclusive diet of newly hatched Artemia salina. The larvae moulted through the entire range of stages within a minimum period of 52 days and a maximum of 64 days (Radhakrishnan and Vijayakumaran, 1995). The larvae were reared individually and in mass culture systems. The temperature of the rearing system ranged from 26-29oC and salinity from 34-35 ppt. The mean total length of newly hatched larva was 1.48 mm and that of stage 6 was 4.87 mm. Attempts made at rearing phyllosoma larvae of P. homarus at the Calicut hatchery of CMFRI reached up to the sixth stage in 48-55 days with the mean length of 4.63 mm (unpublished). Later phyllosoma were reared to stage 8 in 42 days on a mixed diet of Artemia and plankton (Radhakrishnan, 2012). Larvae of P. ornatus, P. polyphagus and P. versicolor were also reared through early stages.

Feeding is a critical factor in the rearing of phyllosoma larvae. Delayed feeding or decreased feeding may prolong intermoult period or cause death (Abrunhosa and Kittaka, 1997). The phyllosoma larvae are fed on Artemia, Sagitta, Ctenophore medusa etc. Initially the larvae feed on freshly hatched Artemia nauplii and in the later stages on mussel gonad, Artemia juveniles, Sagitta etc. Artemia is the most widely used feed item worldwide in the larviculture of fish and crustaceans (Van Stappen, 1996). They can be produced on a mass scale, are relatively small in size (450 μm), nutrient rich and the dormant cysts can be hatched on demand. Mussel gonad is a superior source of protein and lipid in comparison with Artemia nauplii. But it involves chopping, disinfectant steps which ultimately results in small product yield (Takeuchi and Murakami, 2007). The nutritional composition of mussel gonads also varies seasonally, hindering ability to provide guaranteed levels of nutrition to phyllosoma on a year round basis.

Farming

As mass scale production of pueruli/juveniles of spiny lobsters is yet to be accomplished, farming depends on the wild for seed. Studies conducted off Kovalam near Chennai show that pueruli of three species P. homarus, P. polyphagus and P. ornatus settle in rocky areas. There is no information on settlement density of pueruli anywhere along the Indian coast (Radhakrishnan, 2012). Tropical palinurid lobsters tolerate temperature fluctuations of 23-29oC. They show optimum growth in sea water of 30-38 ppt salinity and can adjust to low oxygen conditions. In India, on growing of juveniles in indoor tanks was developed by CMFRI and Tuticorin Fisheries College. Radhakrisnan and Vijayakumaran (1990) got a growth rate of 0.75 g by stocking juveniles of P. homarus in indoor tanks at a stocking density of 7 individuals/m2. Sand filtered sea water with a salinity of 30-38 ppt, pH 7.8-8.4 can be used. Shelters should be provided. Studies in certain species of spiny lobsters have shown that shelters improve survival of juveniles. Chittleborough (1974) also found that P. cygnus consumed more

food and grew faster when shelters were provided.

The Central Marine Fisheries Research Institute conducted sea cage farming of spiny lobster P. homarus. In Vizhinjam, Southwest coast of India, growth of juveniles and sub adults of P. homarus were evaluated in land based FRP tanks and a large floating cage anchored at Vizhinjam Bay. The FRP tanks were stocked with 100 numbers of juveniles and reared for 120 days. The tanks had a water holding capacity of 10 l. In circular cages with HDPE frame and Poly Urethane foam (PUF) with a total volume of 110 m3 the lobsters were reared for 135 days. 1100 juveniles/sub adults were stocked and the cage was moored at a depth of 10 m, 75 m away from the shore in the Vizhinjam Bay (Rao et al., 2010). Specific growth rates of 0.45% and 0.50% of the body weight were obtained per day in FRP tanks and sea cages respectively. Better survival was obtained in the cage (75%) than in tanks (71%). P. polyphagus were reared in open sea floating net (18 mm mesh) cages of 6 m diameter at 8 m depth, 300 m away from Prabhas Patan, Veraval, Northwest India. In cage I lobsters 80-120 g were stocked and in cage II lobsters weighing <80 g. Cage II had a specific growth rate of 1.51% per day which was significantly higher than the specific growth rate of 0.80% per day in cage I (Mojjada et al., 2012), suggesting good potential for capture based aquaculture of the species in sea cages.

National Institute of Ocean Technology (NIOT), Chennai conducted sea cage farming of P. homarus using mild steel cages and reinforced plastic cages. The latter appeared to be better owing to higher durability and higher stability in unfavourable sea conditions (Vijayakumaran et al., 2009). Juvenile of < 90 g and sub adults 90-150 g from the regular fishery were stocked and fed once a day in the evenings. They were fed mainly on Donax spp. The gastropod Xancus pyrum, marine crab (Charybdis sp.), mantis shrimp (Squilla sp.) and squid (Loligo sp.), fish (Clupeids and Leognathus sp.) and green mussel Perna viridis were also fed. Growth rate of 200 g in 365 days and 350 g in 490 to 520 days were obtained for P. homarus.

In Vietnam, sea cage culture of spiny lobsters (main species P. ornatus) was developed in 1992, which significantly expanded in south-central Vietnam in 2000 (Hung and Tuan, 2009). Lobster sea cages grew rapidly here from 1999 and reached its peak (approximately 49,000 cages) in 2006. But the milky disease outbreak in late 2006 resulted in the decline of sea-cages to 47,000 and 41,000 in 2007 and 2008 respectively. Different types of cages are used in Vietnam depending on the characteristics of the culture area: floating cage supported by a frame and buoys (used at a depth of 10-20 m); wooden fixed cages made of salt resistant wood (used in sheltered bays); submerged cages of iron mesh framework (used for nursing juvenile lobsters and grow out farming). Most commonly used feed for the lobsters is Saurida spp; Priacanthus spp., Leiognathus spp; pomfret; snails, oysters, cockles, small swimming crabs and shrimps. Lobsters are fed 3-4 times / day. Wild caught juveniles are used for culture.

Research conducted at NIWA, New Zealand, has showed enormous potential for sea cage on – growing of Jasus edwardsii (James, 2007). A study on the effects of salinity on lobster growth and mortality found that both fluctuating (25ppt-35ppt) and low (25ppt) salinity treatments had significantly lower growth and higher mortality than 30 ppt and 35 ppt treatments. Following the commercial success, NIWA has continued research into both sea-cage design and the development of artificial lobster diets to improve the economic viablility of lobster on-growing in sea-cages.

The main market for farmed lobsters is China, Hong Kong and Taiwan. China is the main export market especially for P. ornatus. Their larger size, beautiful colour and firm pearly flesh are perfect for serving raw as 'Sashimi'. The large producers and exporters of lobsters in the Indian and Pacific oceans are Australia, New Zealand and Indonesia. Potential for sea cage farming of spiny lobsters is being assessed in different countries. An industry equivalent to that in Vietnam is developing in Indonesia (Jones and Shank, 2009). In India, demonstration on cage farming of lobsters was successfully conducted in Tamil Nadu and Gujarat by CMFRI. This has opened up new vistas for alternate livelihood for the coastal fisher folk. The undersized lobsters that form an incidental catch in the fishery are used for farming. There is need for detailed survey to assess the pueruli/early post pueruli settlement areas.

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