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Cochin, India

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Culture potential of the sand lobster *Thenus orientalis* (Lund)

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Abstract

Complete larval development of the scyllarid lobster Thenus orientalis *was achieved for the first time in India at the Kovalam Field Laboratory of CMFRI. There has been only one other earlier report of a similar achievement in* T. orientalis *from Australia. Sub-adult male and female* T. orientalis *collected from the wild matured and mated in captivity. Larvae (phyllosoma) were reared in treated seawater of salinity 37–39 ppt and pH 8-8.2 and fed on a combination of fresh clam meat and live zooplankton. The larval cycle is completed in 26 days and the larvae progress through four phyllosoma stages before settlement as the nisto, which is a non-feeding stage. The nisto later moulted into the juvenile stage and resumed feeding. When the juveniles maintained on a diet of fresh clam meat attained a growth of 35 g in 120 days. The study indicates the amenability of* T. orientalis *to being bred and reared in captivity. The relatively shorter duration of the larval phase will be of advantage in captive rearing of the sand lobster as compared to the spiny lobsters. In the light of decreased lobster catches from Indian waters and a high demand for this commodity in international seafood markets, lobster aquaculture will hold the key to augment lobster production and export.*

Keywords: *Sand lobster, Thenus orientalis, Breeding, Larval rearing, Growth, Culture*

1. Introduction

Lobsters are among the most priced seafood delicacies enjoying a special demand in international markets. Scyllarid lobsters contribute to about 8 % of the world's lobster production. The genus *Thenus* acquires significance in the Indo - west Pacific (from the east coast of Africa through the Red Sea and India, up to Japan and the northern coast of Australia). While India's lobster production averaging about 2000 metric t (MT) annually, has been on the decline, India is one of the leading producers of the flat-head lobster, *Thenus orientalis*, which has been a relatively late introduction in Indian seafood exports. However, the annual landing of this resource has fallen drastically from about 600 MT to about 130 MT over a span of a decade (1991 – 2001). In 2001, the export of sand lobster tails from India was about 70 MT, which is less than half the quantity exported in 1991. There is an urgent need to evolve strategies for decreasing the gap between supply

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and demand and to strike a balance between the fished and the fishable quantity of lobsters in Indian waters.

Lobsters have a complex and prolonged life cycle, which often involves several planktonic ("free floating") larval stages. Larval rearing of lobsters in captive conditions has always posed a problem owing to the complexity of their life cycle with delicate larval stages. The key bottleneck for lobster aquaculture is the hatchery-nursery phase. Like the spiny lobster, the sand lobster, too has a complex and prolonged life cycle, though not as prolonged as in the case of the former.

While there is documented information available on the larval stages and development of other scyllarid lobsters (Robertson, 1968, Takahashi and Saisho, 1978, Ito and Lucas, 1990, Marinovic *et al.*, 1994), information on the larval rearing of *Thenus spp.* is very scanty. Ito (1988) reared phyllsomas of *T. orientalis* up to the fourth (gilled) instar and phyllosomas of *Thenus* sp. upto the second instar. Complete larval development of the scyllarid lobster *T. orientalis* was achieved for the first time in India at the Kovalam Field Laboratory of CMFRI. There has been only one other earlier report of a similar achievement in *T. orientalis* from Australia - complete larval development of *T. orientalis* and *Thenus sp.* was first described by Mikami and Greenwood (1997). There has hitherto been no report of the complete larval development and seed production *T. orientalis* in any other Indian laboratory. (Senthil Murugan *et al.*, 2004) described development up to Stage III phyllosoma.

Although reports of research conducted in different parts of the world indicate the amenability of lobsters to being cultured in closed systems (Kittaka and Booth, 1980), lobster aquaculture is still a virgin arena in India. The primary aim of this study was to rear *T. orientalis* larvae from egg stage to juvenile and to study the growth performance of laboratory-raised juveniles to establish a basis for exploring the possibilities of aquaculture of this species in India.

2. Material and methods

The study was carried out at the Kovalam Field Laboratory of C.M.F.R.I. during 2003 -04. Animals for the study were collected from Besant Nagar-Kovalam-Pudupattinam stretch on the Chennai-Chinglepettu coastal dist of Tamil Nadu. Juveniles (20 - 30 mm Carapace Length) and sub-adult (31 - 50 mm CL) lobsters were collected for maturation and breeding experiments. Berried lobsters (65 - 80 mm CL) were collected for hatching and larval rearing experiments.

Aged seawater filtered through 10 m filter bags and treated with dry lime (@ 100 g t^{-1} of seawater) was used for all the experiments.

Water temperature was maintained between 25 and 27 °C and the salinity was maintained between 36 and 39 ppt. Water quality was maintained by monitoring the levels of Dissolved Oxygen, Ammonia, Nitrites, Nitrates and Phosphates daily and by keeping the rearing medium free of organic wastes.

Broodstock maintenance and development were tried out in three types of rearing systems - Closed Recirculatory Systems with external biofilters, *insitu* filter-based rearing tanks and tanks with fluidised bed filter. The tanks used were black FRP tanks of 2 t capacity. Each system was set up with varying light intensities. Light held animals were exposed to cool white fluorescent tube lights of average room intensity 150 – 200 lux and maintained on a diurnal cycle of 12 h: 12 h light: dark. Dark held animals were exposed to light of less than 1lux light intensity (1 h: 23 h light: dark) except when fed or cleaned and observed. Feeding experiments were carried out with fresh bivalve (clam and mussel) meat and trash fish.

Phyllosoma that hatched from laboratory-bred females were used for larval rearing experiments. The larvae were reared in 1-2 l plastic and glass cylindrical containers in Clear Water Systems with minimum light exposure. Stocking was done @ 5 l^{-1} of seawater. 100 % water exchange was given daily. Water temperature ranged from 25 – 27 °C and water pH was maintained at 8 – 8.2. Live marine zooplankton and clam meat (Meretrix casta) were used as larval feed. The zooplankton was collected from the coastal waters off Kovalam using zooplankton net. The larvae were fed twice dai Mortality and moulting were recorded daily. Larval development studied at each moult, following the description given by M and Greenwood (1997).

After completion of the larval cycle, the juvenile were reared in a Closed Recirculatory System. Blac FRP tanks of 1 t capacity and filter tanks of 0.2 coupled together. The animals were reared in while the 1 t tanks were used as reservoir water quality. Filtered water collected at the tanks was lifted to the reservoir tanks by continuous water flow into the filter t gravity. The substratum provided in t mixture of seashells, gravel, river sa Throughput of the filter system was maintained trials were done with fresh clam meat, fresh trash fish. Increase in morphometric dimensions w to 0.1 mm accuracy using a vernier scale and weights were estimated using an electronic balance accuracy.

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3. Results

3.1 Maturation and breeding in captivity

Juvenile and sub-adult lobsters collected from the wild and reared in all three types of rearing systems developed and matured. The best results were obtained in a Closed Recirculatory System with fluidized bed filter and minimum light exposure (LD 1:23).

Sub-adults (30 – 40 mm CL) raised in clear water with no substrate and about 50 % water exchange daily and those raised in recirculatory systems developed into mature adult lobsters (65 - 70 mm CL) in a period of about 6 months. Juveniles of 20 – 30 mm CL matured in about 8 months. Regulation of light exposure and feeding @ 5 % of body weight in two divided doses daily gave better results. No hormonal or other drug-related tests were experimented. Increased rates of mating and egg laying were observed in the external filter-based recirculatory systems with 1m water depth and reduced light intensity. The animals showed good reception to fresh clam meat.

Males were generally smaller, that is they mature at a smaller size (55 - 65 mm CL) and their life span gets reduced after about 4 - 5 successive matings. Berried female lobsters collected from the wild showed amenability to being kept in all three experimental systems. However, the phyllosoma that hatched from the eggs of laboratory-developed broodstock were more viable than the ones that hatched from berried females collected from the wild.

Females, which matured and mated in captivity spawned, fertilized viable eggs. The fecundity in these animals ranged from 15,000 to 30,000. The incubation period lasted for about 35 to 37 days and hatching occurred over an extended duration of 30 to 36 h. The rate of egg pruning by the brooder and the length of the incubation period was found to depend on the quality of the water in which the animals were held.

3.2 Larval rearing

Complete larval rearing was achieved using wild zooplankton and fresh clam meat as larval feed. The hatchery was divided into three rearing sections. The rearing system in each section was modified to suit the habitat requirement at different stages of larval metamorphosis. There are four larval (phyllosoma) stages which metamorphose and settle finally as the post-larval nisto stage in about 26 – 30 days. The average lengths of the intermoult period for each stage of larval rearing were –

Phyllosoma I	7-9 days
Phyllosoma II	5-6 days
Phyllosoma III	7 days
Phyllosoma IV	7 days

The nisto is a non-feeding stage. It resembles the adult lobster but has a transparent exoskeleton. It does not swim actively unless disturbed and prepares for the next moult in another 2 - 3 days, following which feeding on clam meat starts. The total number of phyllsosma stocked was 100 and the survival rate was 22 % upto nisto stage. 80 % of the nisto moulted into juveniles.

3.3 Grow-out

The early seed stages moulted successively with initial increments of almost 100 % of the body weight. As the size progressed the inter-molt period increased from six to forty days. The subadult size weighing approximately 35 g in weight was reached in about three to four months time (Fig. 1). In 180 days, the animals, attained an average weight about 150 g (160 – 164 mm TL), which is the minimum legal size for export of *T. orientalis*. Experiments were carried out with juveniles of 15 – 20 mm CL collected from the wild using different fresh feeds like clam meat, mussel meat and trash fish. The animals showed good reception to all these forms of feeds, with a preference for bivalve meat. Juveniles fed on fresh clam meat showed betted survival and moult rates. (Table1)

Water quality is major factor affecting the success of all rearing works done in captivity. The optimal water conditions that were found suitable for larval rearing and grow-out are summarized in Table 2.

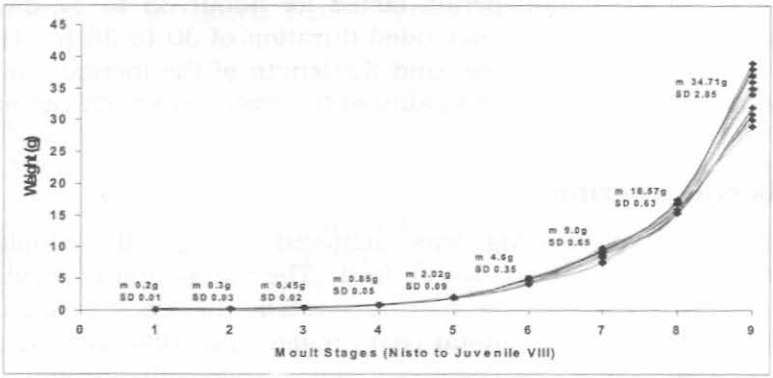

Fig. 1 Growth of laboratory-reared juveniles of *T. orientalis*_ in 120 days from nisto stage

Table 1. Survival and moult performance of juvenile sand lobsters (15 – 20 mm CL) fed on different diets

Feed	15 days	30 days	Total number of moults (%) recovered after 30 days
Clam meat	100	93	63
Mussel meat	90	77	45
Trash meat	47	30	20

**Feed (wet weight) given @ 5% of body weight in three divided doses daily

Table 2. Optimal water conditions required for larval rearing and juvenile grow-out of T. orientalis

Temperature	25 – 27 °C
Salinity	37 – 39 ppt
pH	8 – 8.2
Light exposure	6 h light + 18 h darkness
Water exchange	200 % - larval phase
	Closed recirculation – nursery & grow-out
Nitrate/Nitrite	< 10 mg
Ammonia	< 50 mg
Hydrogen sulphide	Nil

4. Discussion

There is not much information on growth, broodstock development and captive breeding of scyllarid lobsters. The growth rate of lobsters is dependent on several physical and chemical factors (Van Olst *et al.*, 1980) and several studies conducted in nephropid and palinurid lobsters suggest the influence of environment and nutrition on growth and reproduction. One of the most influential factors is light. Booth and Kittaka (1980) suggested that the light cycle may be varied to modify behaviour and promote feeding and growth (in spiny lobsters). The effects of temperature on growth and development in lobsters have also been studied extensively and Saisho (1966) has commented that water temperature is easier to control in culture tanks with a recirculating system. Research on the manipulation of photoperiod and temperature to control the reproductive cycle has been carried out in many species of spiny and rock lobsters. Kittaka (1997) reversed the cycle of several southern hemisphere species and successfully obtained larvae over many years. Food is a major factor determining the performance of the animals in captivity. Booth and Kittaka (1980) mention the preference of shellfish, particularly mussels, over finfish by juvenile spiny lobsters. The same is true in the case of *T. orientalis* too, as seen in the present study.

Kittaka and Booth (1980) make mention of the culture prospects of scyllarid lobsters owing to the short phase of phyllosomal development. The development of *Thenus sp.* through four phyllosomal stages before moulting to the nisto stage was suggested by (Barnett *et al.*, 1984 ; Ito 1988). Mikami and Greenwood (1997) established this fact for the first time through laboratory rearing of the larvae of *T. orientalis* and an allied species, *Thenus* sp. The present study which records the first instance of complete larval development of *T. orientalis* in the laboratory in India, also reiterates this fact. Larval development from hatching to nisto stage was achieved in 26 days. However, the duration of development upto Stage III averaged between 22 – 36 days while in the present study, the entire larval phase was completed in 26 days. Hence there is every indication of the strong dependence of *T. orientalis* larval development on some critical environmental conditions, which needs to be ascertained through further experimental trials. The effects of environmental conditions and nutrition on lobster larval development have been studied in several species of rock lobsters and spiny lobsters. Tong and Moss (1997) have described the effect of temperature on embryo and early larval development of Jasus edwardsii. (Shioda *et al.*, 1995) have described the role of water quality in the rearing of early phyllosoma stages of *Panulirus japonicus*.

Growth studies in *T. orientalis* have been centered around growth estimates made from fished stock. Captive rearing of *T. orientalis* seed has hitherto not been documented in detail. (Vijayanand *et al.*, 2004) reported an average growth increment of 97 g in six months during experimental fattening of *T. orientalis* seed of 5 g size. The animals were reared in 200 litre tanks and fed with mussel meat. The growth increments obtained in the present study, in both, laboratory-raised seed and in seed collected from the wild, are slightly higher.

Conclusion

The study indicates the amenability of *T. orientalis* to being bred and reared in captivity. The relatively shorter duration of the larval phase and faster growth rates will be of advantage in captive rearing of the sand lobster as compared to the spiny lobsters. The complete lack of dependency on mass phytoplankton culture and *Artemia* during larval rearing is an added advantage, as feed cost is reduced greatly. However, the cost-effectiveness of the rearing systems needs to be worked out for large-scale operations. Further trials on grow-out in outdoor cement tanks and ponds (Open Water Systems) need to be carried out to corroborate the fast growth-rates observed in the present study.

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