CMFRI

Summer School on

Recent Advances in Seed Production and Growout Techniques for Marine Finfish and Shellfish

Course Manual

Compiled and Edited by
Dr. G.Gopakumar, Principal Scientist & Director, Summer School and
Dr. Boby Ignatius, Scientist (SS)
Central Marine Fisheries Research Institute

भाकृ अनुप
ICAR

Regional Centre of
Central Marine Fisheries Research Institute
Marine Fisheries P.O. Tamil Nadu – 623 520

20 SEED PRODUCTION OF THE SAND LOBSTER THENUS *ORIENTALIS* (LUND)

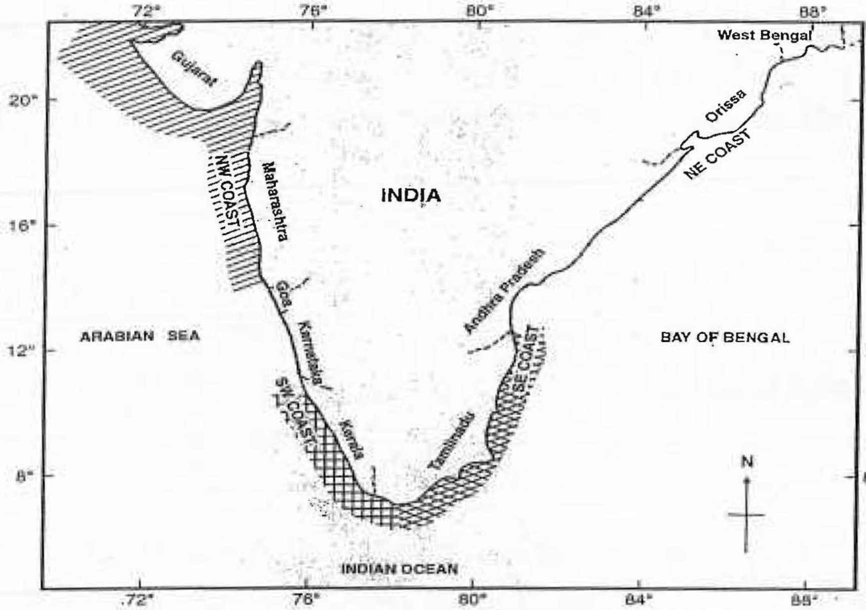
Joe K. Kizhakudan
Research Centre of CMFRI, Chennai

With the decline in many commercial fisheries worldwide and an ever-increasing demand for seafood protein, there is a growing need for augmenting the production of high-protein, high-value resources like lobsters. Aquaculture remains the ideal measure to augment production and ensure conservation, and even enhancement, of natural stocks. Aquaculture provides a two-pronged solution towards increasing the fish production through

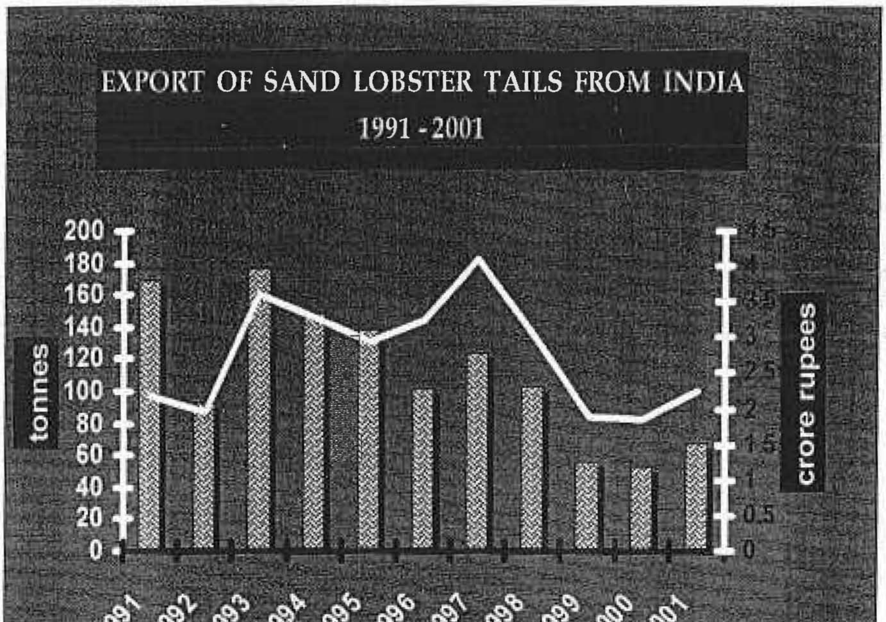
- farming of hatchery-produced seed of commercially important finfishes and shellfishes
- enhancing natural stocks by sea ranching hatchery-produced seed of commercially important finfishes and shellfishes

Lobsters are among the most priced seafood delicacies enjoying a special demand in international markets. As against a world average annual production of 2.1 lakh tonnes, India's average annual lobster production is about 2000 tonnes. With the distinction of being perhaps, the only seafood resource in India's trade economy, which remains relatively low down the ladder in terms of quantity of production but brings in maximum foreign exchange, lobsters have been the subject of study for more than two decades now. The lobster fishery in India is supported by two groups of lobsters - the spiny lobsters (*Palinurus homarus*, *P. polyphagus*, *P. ornatus* and *P. versicolor*) and the scyllarid lobster (*Thenus orientalis*).

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). The sand lobsters are represented by a single species in India's lobster fishery - *Thenus orientalis* (Lund, 1793).



Distribution of sand lobster resources along Indian coast



While India's lobster production averaging about 2000 metric tons (MT) annually, has been on the decline, India is one of the leading producers of *T. orientalis,* which has been a relatively late introduction in Indian seafood exports. However, the annual landing of this resource has also 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.

The resource is most abundant off the northwest coast and also occurs along the coast of Tamil Nadu. Along the Madras coast the peak breeding season is between November and March. In recent years, the fishery along the Maharashtra coast has seen an almost complete elimination of this resource.

SAND LOBSTER RESOURCE OF INDIA

Distribution	:	Gujarat, Maharashtra, Kerala and Tamil Nadu
Fishery	:	30 - 40% of India's lobster production
Fishing gear	:	Trawl nets and Bottom-set gill nets
Peak fishing	:	North-west coast, October - December
Landings	:	Average annual landing : about 400 t
Status	:	Stocks declining
Size	:	Maximum length : 25 cm Weight : >0.5 kg
Life span	:	3 - 4 years
Spawning season	:	November - April
Fecundity	:	15000 - 55000
Minimum legal export size	:	150 g (65 - 66 mm CL; 160 - 164 mm TL)
Exports	:	Average annual export : 130 t
Value	:	US $ 10 - 12 per kg
Marketed	:	Frozen tails
Major markets	:	Japan, USA, Italy, Greece and France
Meat yield	:	28 - 33%
Proximate composition	:	Protein 21.6%, fat 0.35%, ash 1.46%, moisture 73.6%

The average annual catch of *T. orientalis* in Bombay has been reported *(Source : CMFRI Annual Reports)* to have fallen drastically from 185 t (1978 - '85) to 7t in 1992 - '93 and to negligible quantities during 1999 - 2000. Unlike the spiny lobsters , which exhibit habitat diversity during their life span, the sand lobsters tend to aggregate in the same grounds, irrespective of their developmental phase. They are found in relatively deeper offshore waters and are highly susceptible to being captured by trawl nets (the major gear used for exploiting this resource) in every phase of their life cycle. Thus continued exploitation of this resource from the same trawling ground over the years will prove to be disastrous.

As the most obvious remedy to the growing imbalance between the fished and the fishable quantity of lobsters in Indian waters, interest in lobster research has widened from resource monitoring and fishery management to fattening and grow-out of juveniles lobsters, duplicating the transition of other species from wild-catch to aquaculture. The amenability of different species of lobsters to rearing in captivity provides the basis for attuning the sand lobster to culture conditions. Complete larval rearing has been successfully achieved in different parts of the world in panulirid lobsters - *Jasus lallandi* (Kittaka, 1988), *Palinurus elephas* (Kittaka & Ikegami, 1988), *Panulirus japonicus* (Kittaka & Kimura, 1989) and *P. interruptus* (Johnson, 1956) and in scyllarid lobsters - *I. alticrenatus* (Atkinson and Boustead, 1982), *I. ciliatus* and *I. novemdentatus* (Takahashi and Saisho, 1972), *Scyllarus demani* (Ito and Lucas, 1990), *S. americanus* (Robertson, 1968) and *S. rugosus* (Kizhakudan et al., 2004, 2005)

C.M.F.R.I. has been leading the mariculture development in India, achieving success in induced breeding and larval rearing of several prime species of crustaceans, molluscs and fishes. Viable technologies have been developed for captive production of pearl oysters, edible oysters, mussels, clams, penaeid shrimps and oceanic crabs, similar breakthrough is yet to be achieved in the case of lobsters. Breeding of the spiny lobsters, *Panulirus homarus* and *P. polyphagus* have been achieved in captivity and rearing of early larval stages has been done in different Research Centers of the Institute. Complete larval development of *T. orientalis* and *Thenus sp.* was first achieved in Australia by Mikami and Greenwood (1997). Complete larval development of T. orientalis and *Petrarchus rugosus* was achieved for the first time in India at the Kovalam Field Laboratory of CMFRI in March 2004 (Kizhakudan et al., 2004).

The goals, and indeed the strengths of aquaculture are higher survival and growth rates as compared to the wild, together with the ability to smooth out annual and seasonal fluctuations of product supply. The key to the success of an aquaculture enterprise emanates from a constant and steady supply of seed. Hence the primary requisite is to achieve a control over the reproduction and larval metamorphosis of the animal in captivity. The issue of ensuring a supply of newly hatched larvae over a long period can be achieved by -

- rearing a wide size range of females to ensure different mating times
- raising the berried females at different temperatures so that egg development is accelerated or slowed.

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. The advantage in captive rearing of the sand lobster will be the relatively shorter span for larval metamorphosis as compared to the spiny lobsters. (Robertson, 1968).

Understanding the effect of environmental factors on growth and development of sand lobster in different stages of its life cycle is essential to define culture conditions and to set experimental baselines for the development of broodstock and seed. The primary management of stress induced in any animal when transported from its natural habitat to an artificial one is achieved by ensuring a healthy feeding regime providing the required nutrient supply which optimize growth and development in the animal. It is necessary to develop an artificial feed combining requisite levels of protein sources, vitamins, minerals, pigment, attractant, binder and so forth to serve as an alternative to some of the natural feed preferred by the animal, which cannot be provided in captivity. Nutrient supply acts as a limiting parameter in growth, and nutrition of the broodstock is probably the most important influential factor, especially in the months approaching mating. While seed production determines the success of an aquaculture industry, the success of the process itself is largely dependant on the nutrition of the larvae. Diet is an important factor affecting survival of phyllosoma, and one of the key issues in successful lobster aquaculture.

Maturation and breeding in captivity

Broodstock maintenance and development in *T. orientalis* can be done in a Closed Recirculatory System with fluidized bed filter and minimum light exposure (LD 1:23). 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. This was found to be true in the case of T. orientalis also as the animals show good reception to fresh clam meat.

Juvenile (<30 mm CL) and sub-adult (30 - 40 mm CL) lobsters collected from the wild and reared in recirculatory systems developed into mature adult lobsters (65 - 70 mm CL) in a period of about 6 - 8 months. Regulation of light exposure and feeding @ 5% of body weight in two divided doses daily give good results.

Males are 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 captivity. However, the phyllosoma that hatched from the eggs of laboratory-developed broodstock are more viable than the ones that hatch from berried females collected from the wild.

The fecundity in these animals ranges from 15000 to 30000. The incubation period lasts for about 35 to 37 days and hatching occurs over an extended duration of 30 to 36 hrs. The rate of egg pruning by the brooder and the length of the incubation period is dependent on the quality of the water in which the animals are held.

Larval development

Phyllosoma larvae stocked @ 5/litre of seawater in Clear Water Systems with minimum light exposure and 100% water exchange daily can be reared on a combination of live zooplankton and clam meat (*Meretrix casta*) Water quality is major factor affecting the success of all rearing works done in captivity. The optimal water conditions that are suitable for larval rearing and grow-out are summarized in Table 1.

Table 1 : 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	<10μg
Ammonia	<50μg
Hydrogen sulphide	nil

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 are -

Phyllosoma I	(1st instar)	: 24 hours (24-36 hours)
Phyllosoma I	(2nd instar)	: 6 days (6 - 8 days)
Phyllosoma II		: 5 days (6 - 5 days)
Phyllosoma III		: 7 days (7 - 8 days)
Phyllosoma IV		: 7 days (7 - 8 days)
Nisto		: 4 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 survival rates were 5-20% upto nisto stage.

Grow-out

The early seed stages moult successively with initial increments of almost 100% of the body weight. As the size progresses the inter-molt period increases from six to forty days. The subadult size weighing approximately 35 g in weight is reached in about three to four months time (Fig. 1). In 180 days, the animals, attains an average weight of about 150 g (160 - 164 mm TL), which is the minimum legal size for export of ***T. orientalis***. The animals showed good reception to bivalve meat. Juveniles fed on fresh clam meat show better survival and moult rates. (Table 2)

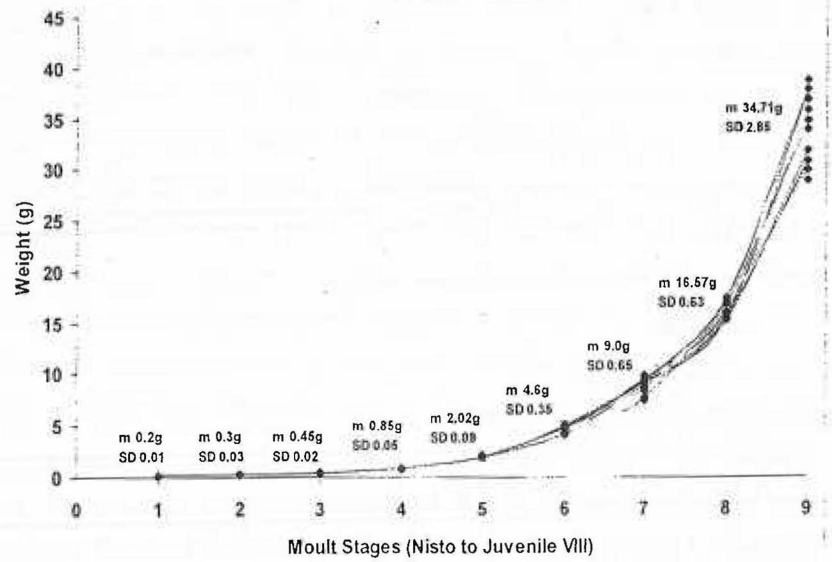


Fig. 1 Growth of laboratory-reared juveniles of T. orientalis in 120 days from nisto stage

Table 2 : 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

Lobster rearing in other parts of the world

Japan has been leading the world's nations in initiating research on lobster aquaculture. Complete larval rearing has been successfully achieved in different parts of the world in panulirid lobsters - ***Jasus lallandi*** (Kittaka, 1988), ***Palinurus elephas*** (Kittaka & Ikegami, 1988), ***Panulirus japonicus*** (Kittaka & Kimura, 1989) and ***P. interruptus*** (Johnson, 1956) and in scyllarid lobsters - ***S. americanus*** (Robertson, 1968), ***Ibacus ciliatus*** and ***I. novemdentatus*** (Takahashi and Saisho, 1978), ***I. alticrenatus*** (Atkinson and Boustead, 1982), ***Scyllarus demani*** (Ito and Lucas, 1990) and ***I. peronii*** (Marinovic *et al.*, 1994) Kittaka (1997) has obtained the highest survival of phyllosoma for ***J. verreauxi*** and has reared several hundred pueruli. Robertson (1968) has described the larval life span of scyllarid lobsters to last from 30 days to nine months, depending on the species and influential factors. Highly promising results achieved by the Japanese with the larval culture of ***J. verrauxi*** (the eastern rock lobster) has shifted the focus of larval culture research at the ***National Institute of Water and Atmosphere Research Ltd (NIWA)*** (Wellington and Auckland) from ***J. edwardsii*** to ***J. verrauxi***. Larval rearing is carried out mostly along the lines described by Illingworth *et al.* (1997), employing a recirculating upwelling system with no biofilter.

Research on lobster aquaculture is assuming large dimensions in Australia, where the emphasis is on rock lobsters and, to an extent, spiny lobsters. Interest in spiny lobster culture is fast developing in the United States. Studies in this regards however are based on the large-scale harvesting of pueruli from the wild and maintaining them in grow-out systems till they attain commercial size. The American lobster, ***Homarus americanus*** is a species that enjoys top priority in the lobster production of the United States, from both, capture and culture fishery.

A lot of research is being directed worldwide on the propagation of lobsters, with detailed focus on different ancillary activities that are essential to the successful establishment of an aquaculture industry. The developments in India are yet to come on par with the strides made in other parts of the globe. However, with recent advancements made in this field, there is plenty of scope for developing lobster aquaculture in India.

Candidature of *T. orientalis* for aquaculture

- ✓ *Hatchery phase –labour intensive but of relatively short duration*
- ✓ *Nursery phase and grow-out 9-12 months*
- ✓ *No dependancy on mass phytoplankton culture or Artemia*
- ✓ *Juveniles : sturdy and easily maintained in captivity (FRP tanks)*
- ✓ *Growth in laboratory-raised juveniles : on par with growth in juveniles collected from wild*
- ✓ *Seed of 20 g size attained 150 g size in about 180 days*
- ✓ *No cannibalism*
- ✓ *Grows well in high densities*
- ✓ *Feed reception : similar in both, wild and laboratory-raised seed*
- ✓ *Preference for fresh clam/mussel meat*
- ✓ *Trash fish and commercial (shrimp) pellet feed – low acceptance*
- ✓ *Food conversion : 1: 4 wet weight*

- ✗ *Success achieved : only at experimental levels*
- ✗ *Cost-effectiveness to be worked out*
- ✗ *Trials required : in outdoor cement tanks and ponds (Open Water Systems)*
- ✗ *Moult Death Syndrome and tail rot : major problems*
- ✗ *Supplementary feeds for larval and grow-out phases to be developed*
- ✗ *Salinity and temperature tolerance - low*
- ✗ *Meat yield – relatively poor*

Suggested reading

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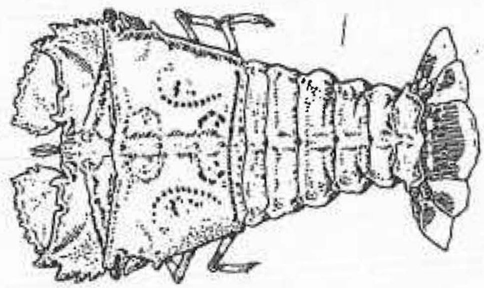
THE FLATHEAD LOBSTER, *THENUS ORIENTALIS* (LUND, 1793)



Phylum	ARTHROPODA
Class	CRUSTACEA
Order	DECAPODA
Suborder	MACRURA REPTANTIA
Infraorder	PALINURIDEA
Superfamily	PALINUROIDEA
Family	SCYLLARIDAE
Subfamily	THENINAE
Genus	***THENUS***
Species	***ORIENTALIS***

Common names : Squat lobster, Sand lobster, Shovel-nosed lobster, Slipper lobster

Vernacular names : Kaka (Gujarat), Madakka erra (Tamil Nadu), Poozhikonchu (Kerala)

Morphology

- Dorsoventrally flattened body
- Carapace trapezoid and depressed
- Anterior part of lateral margin with only two teeth
- Rostrum absent
- Eyes in distinct orbits
- Frontal horns absent
- Antennae plate-like
- Fifth abdominal segment armed with a strong postero-median spine
- Pleura directed downwards

Colour

- Body brown dorsally with reddish brown granules
- Ventral surface yellowish white
- Antennules yellowish white with red-brown bands
- Tail fan and pleopods orange-red.

Habitat

- bottoms of soft substrate, sand or mud, with shells or gravel
- Depth : 8 to more than 200 m, usually between 10 – 60 m
- Buries into substrate with only eyes and antennules visible during daytime
- Nocturnal

Feed

- Feeds mainly on benthic bivalves and gastropods