LARVAL REARING AND SPAT PRODUCTION OF THE GREAT CLAM, *MERETRIX MERETRIX* (LINNAEUS)

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ABSTRACT

The venerid clam *Meretrix meretrix* (Linnaeus) was spawned in the laboratory and for the first time the eggs were reared successfully through various stages to spat. Setting was observed on day 7 and day 10 after fertilization and was mostly completed by day 9 and 12 respectively in the two experiments. The clam seed attained an average length of 2.895 mm and height of 2.475 mm on day 75. During the rearing experiments the haptophycean flagellate, *Isochrysis galbana* was given as food. In the light of the results obtained here the thrust areas for standardising the procedures in the hatchery production of the seed of *M. meretrix* are discussed.

INTRODUCTION

The venerid clam, *Meretrix meretrix* (Linnaeus) popularly known as the great clam is fished in considerable quantities along the Maharashtra and north Canara coasts and in the Kakinada Bay (Alagarswamy and Narasimham, 1973). Of late, a steady export trade for the frozen clam meat is developing and the venerid clams are much sought after in the foreign markets. *M. meretrix* is also amenable to culture (Rao and Rao, 1983). However, the seed availability in nature is uncertain and it is a major constraint to undertake culture of this species. The present study was taken up to develop appropriate technology for the hatchery production of the seed of *M. meretrix*. This report is the first to be published on the larval rearing and spat production of this species.

MATERIALS AND METHODS

The clams (length 34.3–88 mm) were collected from the Korampallam creek in the vicinity of the Shellfish Hatchery Laboratory, Tuticorin and 20 of them at random were kept in the conditioning room (temperature 24°C–26°C) in 50 l FRP tank containing sea water. They were fed intensively with the haptophycean flagellate *Isochrysis galbana* once a day. After 10–15 days they were transferred to 100 l perspex tank in the hatchery and subjected to thermal stimulation by raising the water temperature 4–5°C above the ambient level. This was achieved by operating a heating element with porcelain coating and controlled by a thermostat. Since spawning did not occur in the hatchery tank they were transferred back to the conditioning room and the experiment repeated after 15 days. In all, four spawnings occurred on 20–8–1987, 8–3–1988, 21–4–88 and 7–5–88 and all were in the conditioning room on bringing back from hatchery tank after thermal stimulation. Spawning of males made the females to lay eggs. After spawning, the parent clams were removed. The fertilized eggs settled at the bottom. The supernatant water containing sperms and debris was decanted 4 to 5 times and fresh filtered sea water was added. The free swimming morula larva developed in 2–4 hours and they were siphoned out into 100 l FRP tank for rearing the various larval stages and spat.

I. galbana was given as food for the larvae and spat after determining the concentration of algal cells with haemocytometer.

Periodically 20 larvae/spat were fixed in 1% formalin and measured for length in antero-posterior axis and for height in dorso-ventral axis. The average of these measurements is given for different growth stages unless otherwise stated. The sea water used in the larval/spat rearing experiments was drawn from the Tuticorin Bay into a well, passed into a sedimentation tank and filtered through surgical cotton at the delivery end (Nayar *et al.*, 1984). Neither the water was sterilised nor antibiotics used. In the rearing tanks the sea water was completely replaced on alternate days and half the sea water was changed on the day preceeding the full replacement. Gentle aeration was provided. In the hatchery the water temperature varied from 30.5 to 32.5°C and salinity ranged from 33 to 34.1 ppt.

The first spawning was feeble and only few spat were raised while the fourth spawning was profuse but due to the shortage of rearing tanks the larvae were released into the natural bed. Though the results obtained in the second and third spawnings are comparable, those pertaining to the second spawning are given in this paper.

Results

Embryonic and larval development is similar to that observed in other bivalves where the development is planktotropic (Loosanoff and Davis, 1963; Nayar *et al.*, 1984; and Alagarswamy *et al.*, 1983a, 1983b) and hence a detailed description of the various stages is not given here.

Larval rearing: The fertilized eggs are spherical and measured 75.9 µm average (Plate 1 a); cleavage began 10–15 minutes after fertilization (Plate 1 b, c) and the morula stage (Plate 1 d) was reached after 2–4 hrs. Trochophore larvae (Plate 1 e) of size 101 x 81 µm developed in 9 hrs and the larvae started moving by lashing the terminal flagellum. The larvae reached straight hinge stage (Plate 1 f) with a well developed ciliated velum in 20 hrs. These D-shaped larvae measured 116.4 x 91.3 µm. They were fed with *I. galbana* at 5,000 cells/larva. The larvae passed into umbo stage (Plate II a) on day 4 but the umbones are not prominent; the average size was 147.2 x 126.1 µm and the feeding was increased to 8,000 cells/larva. The pediveliger stage (Plate II b) was reached on day 6 and some of the larvae developed foot even at the size of 161.9 x 141.7 µm but, in majority the foot was well developed at 172 x 151.8 µm size. The algal food was increased to 10,000 cells/larva/day at pediveliger stage. The eye spot or any other distinctive mark was not observed when the larvae are about to set. On day 8 the larvae measured 183.7 x 161.9 µm and this can be taken as the average size before the commencement of the metamorphosis. In the second spawning experiment settlement began on day 7 and was mostly completed by day 9 whereas in the third spawning experiment the metamorphosis began on day 10 and was almost completed by day 12.

The relationship between length and height of the larvae is linear and is described by the equation

$$H = -21.3529 + 1.0\,L$$

Where L and H are length and height in microns (Fig. 1) and for the parameters the correlation coefficient r is 0.9828.

On day 1 the larval density in the second spawning experiment was 0.45/ml while in the third it was 2.98/ml.

Spat rearing and growth: On day 13 the size of the post-set clams was 224.2 x 196.8 µm, on day 18 it was 328.4 x 303.8 µm and on day 27, 596.1 x 553.1 µm (Fig. 2). The feed concentration was increased from 10,000 cells to 12,000 cells/spat from day 10 to 24. On day 35 the maximum size of the spat was 1.06 x 1.01 mm, minimum 526 x 485.7 µm with an average of 819.5 x 761.2 µm (Plate II c). On day 42 the spat measured 1.213 x 1.16 mm, on day 64, 2.18 x 1.956 mm and on day 75 the clam seed attained a minimum size of 1.9 x 1.5 mm, maximum of 3.8 x 3.1 mm with an average of 2.89 x 2.475

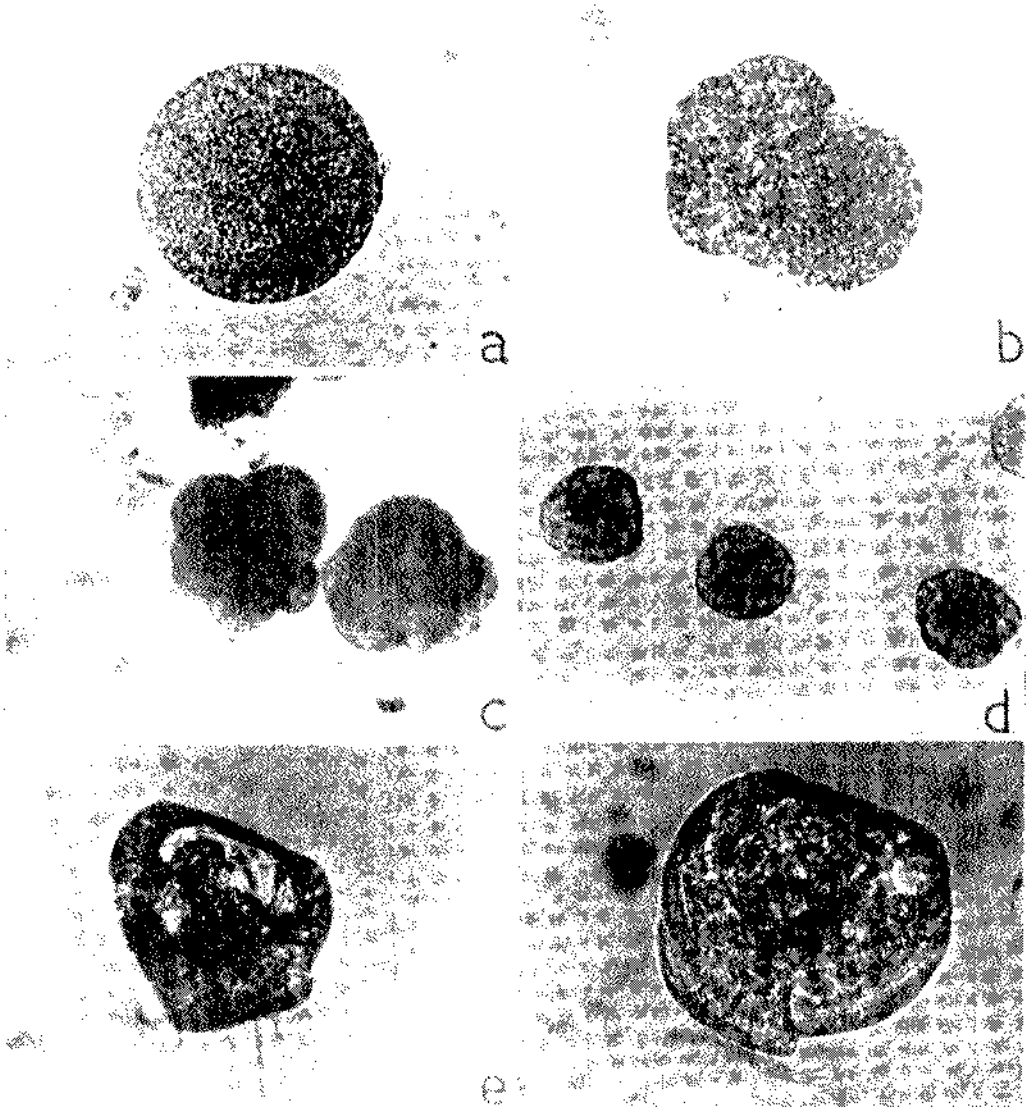

PLATE I. Larval development of *M. meretrix*.
a) Fertilized egg (75 μm).
b & c) Cleavage stages.
d) Morula stage.
e) Trochophore larvae showing terminal flagellum length 101 μm, height 81 μm.
f) Straight hinge stage. Length 111.3 μm; height 91.1 μm.

mm (Plate II d). The feeding was increased to 15,000 cells of *I. galbana* from day 25 to 42 and to 25,000 cells from day 43 onwards.

The following exponential equation was fitted to the growth data of the post-set clams

$$Y = aT^{b}$$

Where Y = length in mm at time T in days. The growth of the spat is described as

$$Y = 0.004332\ T^{1.5046}$$

with r = 0.996 indicating high degree of correlation between the parameters studied (Fig. 2).

In the rearing experiments the protozoan, *Vorticella* sp. was found attached to the shell of the spat measuring $\geq 600\ \mu$ m. About 25% of the clam spat harboured this fouling organism.

The normal colour of the seed of hatchery produced *M. meretrix* was light yellow with brown markings. In 12.1% of the seed produced in the hatchery, the periostracum of the shell was white with brown markings. This colour variation is probably genetic.

Spat production: In the second spawning experiment, from an estimated 36,000 straight hinge larvae on day 1, 5,630 spat were produced by day 75 giving a survival rate of 15.64%. In the third spawning experiment, from an estimated 3,72,380 straight hinge larvae on day 1, an estimated 27,500 spat

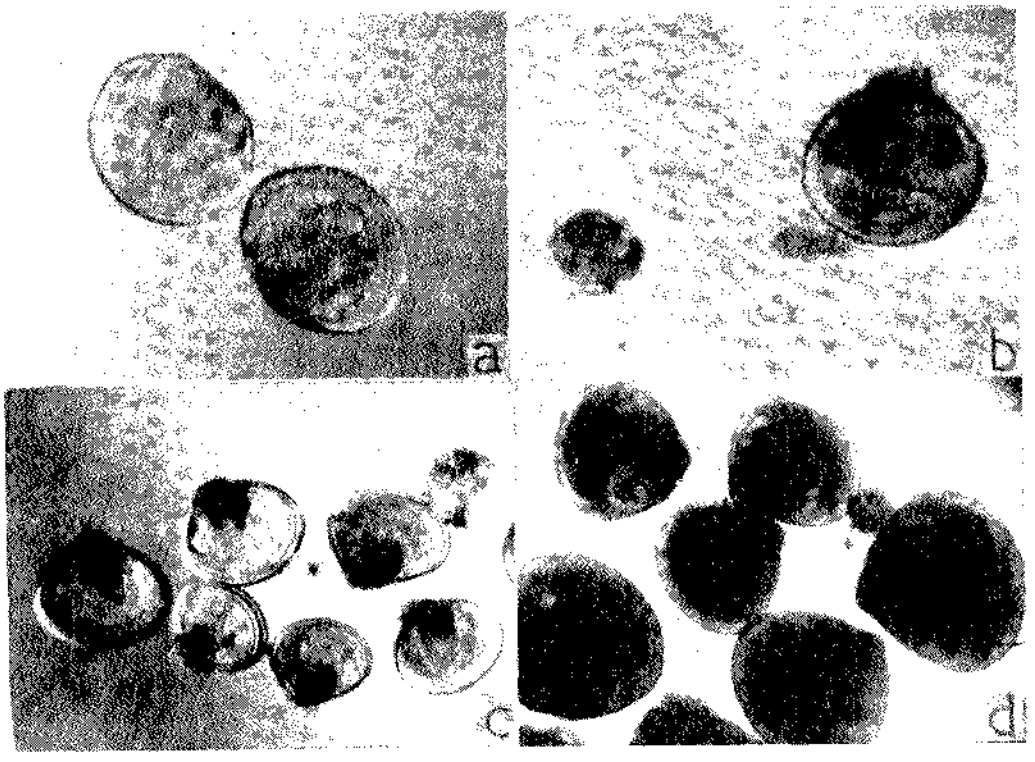

PLATE II. Larval development and hatchery grown seed of *M. meretrix*.
a) Umbo stage length 143.1 μm x height 126.3 μm.
b) Pediveliger stage 163.4 μm x height 143.2 μm.
c) 35 day old seed.
d) 75 day old seed.

were produced on day 75 which gives a survival rate of 7.38%.

Discussion

In the larval development of *M. meretrix*, eyed stage was not observed by us. Although eye spot is usually present in the larvae of a number of bivalve species, there are many instances wherein eyed larval stage is absent.

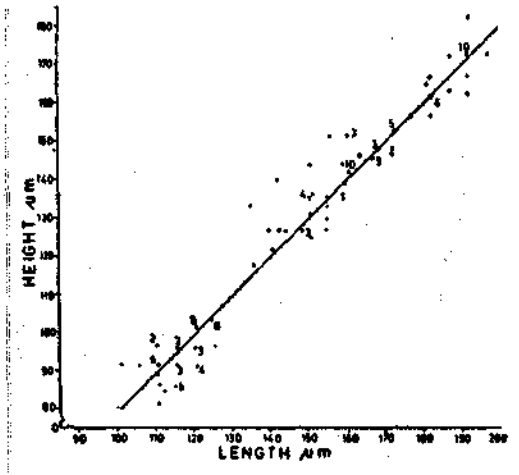

Fig. 1. The relationship between length and height in the larvae of *M. meretrix*. The numbers indicate the number of observations.

Loosanoff *et al.* (1966) mentioned about the absence of eye spot in the larvae of the dwarf surf clam *Mulinia lateralis*, venerid clam *Pitar morrhuana* and the cockle *Laevicardium mortoni*, while Chanley (1965) stated that eye spot was absent in the larvae of the mactrid clam *Rangia cuneata*.

The number of days required for larvae of a particular bivalve species to reach metamorphosis stage depends upon a combination of ecological factors of which temperature and food are critical. Loosanoff and Davis (1963) observed that in the venerid clam *Mercenaria mercenaria*, the larvae undergo metamorphosis earliest on day 16 at 18°C and on day 7 at 30°C after fertilization. In *M. meretrix* the duration of the larval life is short with earliest setting on day 7 and 10 respectively in the two experiments at a temperature range of 30.5–32.5°C which compares well with the setting time in *M. mercenaria* at higher temperature.

Although obtained from the same batch spawning, considerable disparity in the growth of the larvae was observed in this study and it became more pronounced in spat growth. Similar observation was made by Loosanoff and Davis (1963) and Alagarswamy *et al.* (1983b) in the bivalve larvae studied by them. Also the former authors observed considerable variations in the individual growth of larvae obtained from the same parents.

Though success was achieved in this study in the larval rearing and spat production of *M. meretrix* there are a number of problems in the critical areas which require solution in order to standardise the hatchery techniques for mass production of the clam seed. Under the static hatchery conditions at Tuticorin where the water is changed daily either partly or wholly, Alagarswamy *et al.* (1987) found that for larval rearing, a density of 2 larvae per ml is the optimum in the pearl oyster *Pinctada*

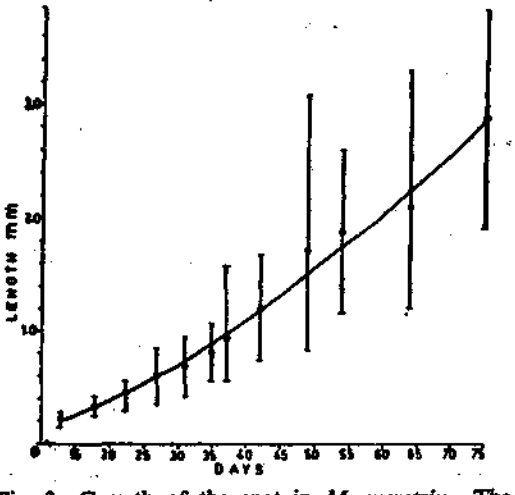

Fig. 2. Growth of the spat in *M. meretrix*. The horizontal line represents the length range and the solid circle the mean length. The curve obtained by fitting the growth equation is also shown in the figure.

fucata whereas Nayar *et al.* (1987) recommended 25 /ml for eggs and D-shaped larvae, 5/ml upto umbo stage and 2/ml to the eyed larva in the edible oyster *Crassostrea madrasensis*. In *M. meretrix* the larval densities used by us were 0.45/ml and 2.98/ml. While the lower density resulted in higher percentage of spat production, it may not be close to the optimum as the works by Alagarswamy *et al.* (1987) and Nayar *et al.* (1987) indicate for other bivalves. To achieve optimum growth and survival rate, planned experiments are called for by taking into account the density factor at different growth stages in the hatchery operations.

Regarding the feeding protocol, Alagarswamy *et al.* (1983b) have given a daily ration of *I. galbana* cells at 12,000–25,000/larva/day and Nayar *et al.* (1984) increased the cell concentration from 3,000 to 12,000/larva/day from D-shaped stage to early spat. In the present study, *I. galbana* was fed at 5,000 cells/D-shaped larva/day and the ration was increased to 10,000 cells/pediveliger larva/day. In none of the above studies the actual consumption of *I. galbana* cells was determined. The food requirements of the clam larvae are to be evaluated taking into account the clearance of algal cells from the water during different larval stages for optimising growth and survival.

Laing and Millican (1986) have shown that for *Ostrea edulis* spat, mixed phytoplankton feed gave better growth rate than the unialgal diet of *I. galbana*. In the present study the spat were fed with *I. galbana* alone and one can reasonably expect faster growth rate by a switch over to suitable mixed phytoplankton feeding. Further work is in progress on the above lines.

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