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921 SPAWNING, LARVAL REARING AND PRODUCTION OF JUVENILES OF THE TROPICAL ABALONE *HALIOTIS VARIA* LINN.

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Introduction

Abalone, popularly known as sea ear or ear shell, is an economically important marine gastropod mollusc belonging to the genus *Haliotis*. They are usually found attached to the rocks or dead corals in sheltered bays or intertidal rocky shores with good water movement and surf action (Fig. 1). Abalones are herbivores feeding on sea weeds. Some of the abalone species with good growth rate are cultured for meat which has high market value. Abalone sea farming targeted for its meat has spanned nearly half a decade. Research and development projects and hatcheries are in operation in Australia, the British Isles, Canada, France and United States.

Abalones are also known for the production of gem quality pearls having multihued tones of silver, orange, pink, blue and lavender. Abalone pearls are currently being cultured in Canada, the United States and Korea. The shell is used in traditional medicine. The viscera can be made into good quality glue.

Along the Indian coast the tropical species, *Haliotis varia*, is distributed abundantly along the Andaman sea coast and moderately in the Gulf of Mannar and the southeast coast of India. Considering the economic importance of abalone, the CMFRI initiated research on the culture of *H. varia*. Spawning, fertilization, larval rearing, settlement, metamorphosis and production of juveniles achieved in the present studies were done at the Mandapam Regional Centre of CMFRI for the first time in India.

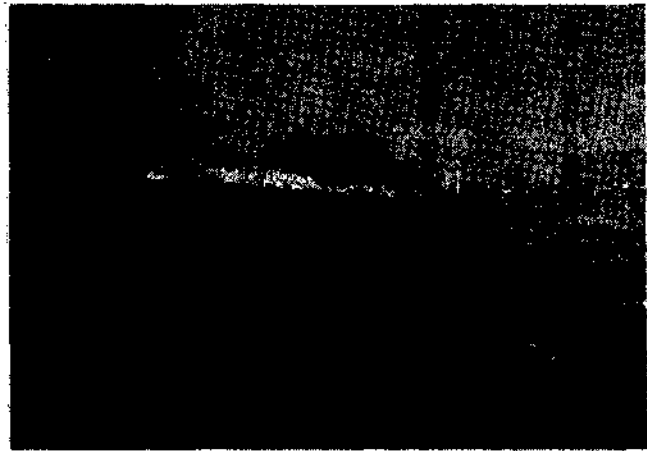


Fig. 1. Intertidal rocky shore—the habitat of abalones.

Broodstock maintenance

Mature male and female abalones of more than 25 mm in length (Fig. 2) were collected from the intertidal rocks inside the Tuticorin harbour basin, mostly during full moon and new moon days. The salinity, pH, dissolved oxygen and water temperature were noted during the collection. The live spawners were then transported from Tuticorin to

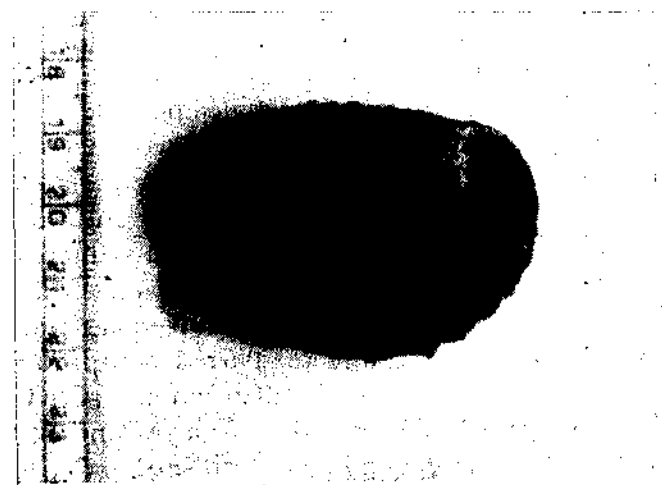


Fig. 2. Adult abalone.

the laboratory at the Mandapam Regional Centre by road during late hours. They were placed on a round perforated asbestos sheet in a bucket along with a wet piece of gunny. To keep them moist sea water was sprinkled on the abalones frequently during transportation. The duration of transportation was about 6-8 hours. More than 80% of survival was achieved by this method. Mortality observed was mostly due to the damage caused to the foot of animals during collection. The transported abalones were stocked in 1.5 tonne FRP tanks filled with filtered sea water. The salinity variation between the site of collection and the tank was kept at less than 5 ppt. Finely chopped thin pieces of freshly collected seaweed *Ulva lactuca* and *Polysiphonia* sp. were given as feed and the waste accumulated in the bottom of the tank was siphoned out.

Spawning and fertilization

For induced spawning, ripe males and females were kept in a plastic basin containing 30 l of filtered sea water of salinity less than 30 ppt. The ripe male gonad is creamy white and in the female it is dark blue in colour. The animals were exposed to air for 2 hours before they were transferred to the spawning container (desiccation method of inducement). Two pairs of abalones in the ratio 1:1 were placed in one container. In general, spawning occurred at late night hours or early morning hours when the temperature was around 25° C. Usually male spawned first followed by the females. The presence of sperm in the container triggered the females to release the eggs. Once the spawning was initiated, the act continued till all gametes were extruded. The eggs were fertilised within one hour of spawning. The fertilised egg was spherical in shape and measured 180 µm in diameter (Fig. 3). After fertilization, the perivitelline space between the outer layer and egg membrane increased in size and settled to the bottom of the container.

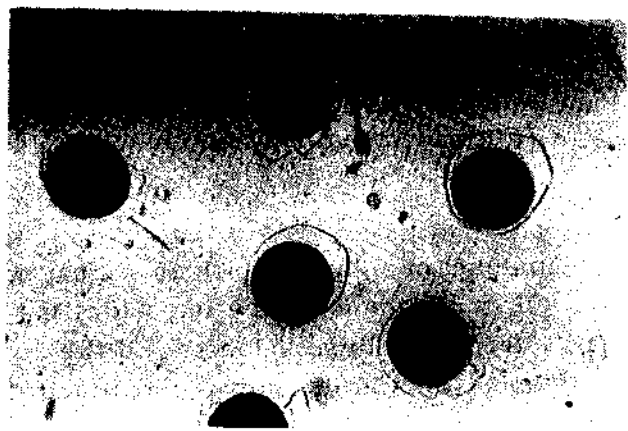


Fig. 3. Fertilised eggs.

The fertilised eggs were collected by siphoning the bottom water through a 50 µm sieve, which was followed by repeated washing with clean filtered sea water. After the estimation of fertilisation percentage the eggs were transferred to another tank filled with filtered sea water.

Early development and larval rearing

Cleavage began after the extrusion of the polar bodies. In about 10 hours after fertilization the trochophore stage was reached. The trochophore larva completed the development inside the egg membrane within which it showed rotatory movement. In about 12 hours, the trochophore larva of 180-200 µm length ruptured the egg membrane and began to swim upward in the water column.

The trochophore larvae were positively phototactic and had a tendency to congregate at the water surface. These swimming larvae were siphoned out to a container with 20 l of filtered sea water. Later the formation of the shell at the posterior part of the larva commenced. Trochophore larva developed further to reach the veliger stage in about 12 hours (Fig.4). The veliger larva had a completely developed velum with a long apical cilia. All the larval stages of *Haliotis* sp. are lecithotrophic and hence feeding was not required.

On day 4, the floating veligers began to



Fig. 4. Veliger larva.

settle on substrates. At this stage they had the cephalic tentacles with four branches and well developed eye spots. The foot was sufficiently developed and the veliger could pull itself upright and also propel itself by ciliary action. This stage is termed as "gliding stage". At this stage the larvae were transferred to the settling containers. Then onwards the larvae required suitable food in sufficient quantities. A mat of benthic diatoms comprising mainly of *Nitzschia* sp. and *Navicula* sp. was found to be the ideal food. For the tropical species, *Haliotis varia*, the larval rearing period ranged from 4 to 5 days when the water temperature was around 27°C.

The settling containers were of 20 l capacity with a thin and uniform layer of the benthic diatoms. On the 5th day of post fertilization, most of the larvae ceased swimming and crawled over the substratum of the diatom mat along the walls of the container. The cilia disappeared and the foot started the exploratory movements. Majority of the larvae settled on the vertical sides of the container. After this the larvae seldom detached themselves from the diatom mat. Peristomial growth, the first step in the metamorphosis, started on the day 6th leading to the transformation of the round tubular shell to resemble the flat abalone shape. It was observed that mortality may occur if the larvae are not provided with the required diatom mat sub-

strate. The process of metamorphosis is completed and the larva transformed into juvenile when the first respiratory pore is formed at the anterior end of the shell (Fig.5). This is reached on the day 26. Three respiratory pores were formed when the juvenile reached the size of 2.6 mm on day 46th after fertilization.



Fig. 5. Juvenile abalone with one respiratory pore.

Diatom culture

The mat of diatom is necessary to the settlement and metamorphosis of the gliding larvae. Benthic diatoms like *Nitzschia* sp. and *Navicula* sp., scraped from the inner walls of containers used to store sea water were used as inoculum. Twenty litres of sea water, in plastic containers enriched with Walne's algal culture medium, was seeded with the scraped out diatom. They were kept in diffused sunlight. After 4-5 days a uniform thin layer of the diatoms was formed along the walls of the container. After the mat formation, the water of the container alone was changed on alternate days to keep the diatom mat healthy.

Prospects

The abalone resource in India is neither surveyed nor exploited. In recent years the demand for small abalones (cocktail size) is increasing in the world market and hence the small sized Indian abalones can also form an

export commodity. Abalone pearls are considered to be superior due to their multihues. The present study on the production of juveniles in the hatchery, may open up a new avenue in the field of abalone culture and pearl production. Mass production of seed and ranching them on intertidal rocky coasts can augment the natural population further.

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