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Mariculture of giant clams

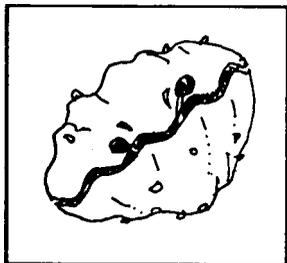
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Mariculture of giant clams



Mariculture of giant clams stems from the need to replenish wild stocks depleted by over-harvesting and to provide an alternative source of protein and a

means of livelihood for fishing communities specifically in the South Pacific and Southeast Asia.

Culture systems and techniques vary from one site to another. These are modified to suit the specific conditions of the locality (water quality and source, available electric power, etc.), the accessible materials and equipment, and the giant clam species available for broodstock. The following techniques were developed at the University of the Philippines Marine Science Institute Marine Laboratory in Bolinao, Pangasinan. Giant clam species cultured so far are *Tridacna maxima*, *T. squamosa*, and *Hippopus hippopus*.

Seawater system

A steady supply of clean, running seawater is essential to any hatchery. The seawater system currently in use provides a 12-h continuous flow of seawater daily.

Broodstock

As a rule, *T. squamosa* greater than 16 cm, *T. maxima* greater than 12 cm, and *H. hippopus* greater than 16 cm in length are used for broodstock.

Broodstock are collected and brought to Bolinao, Pangasinan. Clams intended for spawning are held in raceways, and these are immediately taken back to the field after spawning. All broodstock are tagged and measurements of length and height are taken every 5-6 months or before every spawning.

Biopsy and spawning induction

Before clams are induced to spawn, they are thoroughly scrubbed to remove all dirt and organisms attached to their shells. "Scales" of *T. maxima* and *T. squamosa* are removed to prevent accumulation of dirt, parasites, and other encrustations.

The clams are biopsied using a needle to select only individuals with mature gonads (e.g., with ripe eggs and sperm). Gonads are considered mature if sample shows that there are more than 300 eggs/ml of samples and that greater than 50% of the eggs viewed are slightly oblongate to spherical in shape. Diameters of mature eggs measure about 95-112 μm for *T. squamosa* and *T. maxima*.

Mature clams are transferred to plastic tanks filled with 0.02- μm filtered seawater (FSW) and induced to spawn. Serotonin (2 ml of 0.02 mM) injected intragonadally was used in previous inductions. Lately, gonad slurry (obtained from frozen gonads of clams that died) has been used to induce spawning in mature clams. Gonads of *T. maxima* were able to induce spawning in the same species and in *T. squamosa* and *H. hippopus*. The macerated gonad is dissolved in FSW, and small amounts squirted into the inhalent siphons or injected directly into the gonads. Mature clams usually expel sperm with forceful jets of water after 5-15 min. Eggs are spawned 1 - 1 1/2 h after sperm is released. Sperm is collected from each clam and the tag number noted. As soon as the clam releases eggs, it is transferred to a clean container with FSW and allowed to finish spawning. After spawning, eggs and sperm from different individuals are mixed and counts of eggs per individual are taken. The fertilized eggs are then transferred to the outdoor culture tanks filled with 0.5- μm filtered seawater. Nylon filter bags become necessary to keep out sediments, possible predators, and other eggs and larvae. Filtered seawater is allowed to flow every two days after the eggs have become

veligers, but a nylon sieve is placed at the out-flow to retrieve larvae carried with the waste water.

T. maxima, unlike the other two species, spawns with a gentle stream of water from the exhalant siphon. The eggs usually sink to the bottom of the container or onto the mantle of the spawner.

Larval rearing

Development stages (egg, gastrula, trochophore, veliger, pediveliger, juvenile) are identical for all giant clam species, although developmental and growth rates may vary with species and culture conditions.

The larvae are left untouched (except for daily water samples to obtain counts and to determine the stage of the larvae) until they have become veligers, which is about 2-2.5 days after fertilization. The larvae are fed with the unialga *Isochrysis galbana* at concentrations of 10^3 - 10^5 cells/ml every other day until they metamorphose. At the same time, freshly isolated zooxanthellae (*Symbiodinium microadriaticum*) scraped from the mantles of adult clams are added to the water. The symbiont concentrations used so far have been low ($3-4 \times 10^2$ cells/ml) because only a small portion of the mantle could be obtained at a time, and only once per clam. It was observed that the clam species from which zooxanthellae is taken need not be the same as the recipient as the symbiont would also be accepted. However, zooxanthellae from the same species has been observed to establish symbiosis more readily. From the different batches reared, it seemed that the larvae fed zooxanthellae from the same species of clam

had faster growth rates and settled earlier than those provided with zooxanthellae from a different clam species.

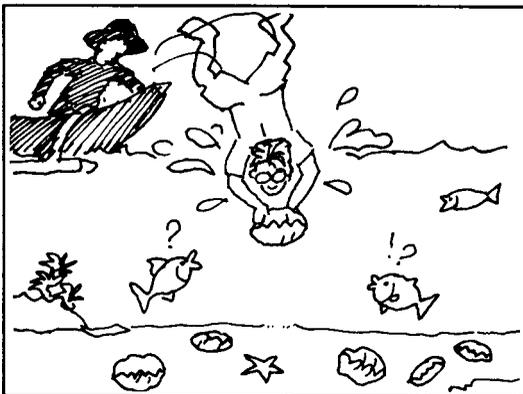
Mortalities are about 99% from egg to juvenile. The greatest number of deaths occur when trochophores develop into veligers, and in the period from the pediveliger stage through metamorphosis into juveniles. Feeding with *I. galbana* and zooxanthellae helps increase survival rates although the addition of nutrients in the water (with *I. galbana*) contributes to profuse algal growth along the sides and bottom of the tank.

Harvest

The juveniles are harvested 3-4 months after fertilization, when they are 1-10 mm in size. Although keeping them longer in the culture tanks will allow them to grow larger and will make harvesting easier, greater mortalities occur. Deaths are caused by a variety of factors such as fouling of the algal mat (an aggregate of diatoms, skeletons of different invertebrates, and debris), predation by pyramidellids, and competition for space and possibly nutrients with other invertebrate larvae that pass through the filters. It was observed that the juveniles crawl on top of the algal mat so that they are not actually smothered. However, as the algal mat thickens, the lower layers decay and cause fouling. Sometimes, gas bubbles accumulate under the mats causing some portions of the algal mat with clams attached to rise to the surface and expose the clams to the sun's heat. If not removed immediately, the clams will die.

Harvesting is done by using a rubber hose to siphon off the bottom of the tank into appropriate-sized nylon sieves. The clams are then separated from the algae and re-settled on pieces of coral rubble in a clean tank with flowing FSW where they are allowed to grow to bigger sizes before being transplanted to the ocean nursery. Spats have been observed to crawl from one place to another in search of a suitable substrate. They appear to prefer rough surfaces with pits, cavities, or edges which is why pieces of coral rubble were chosen for settling "plates". During the grow-out period, the tank and the substrates are cleaned regularly and when necessary, the

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inium. Throughout the Indo-Pacific region, *Pyrodinium bahamense* var. *compressum* is considered the major causative organism of PSP. However, it has been suggested that *Protogonyaulax tamarensis* triggered a few cases of PSP in Thailand in 1983. The toxins isolated from infected molluscs were in general derivatives of saxitoxin, neosaxitoxin, or gonyautoxin. They belong to the class of neurotoxins which cause symptoms such as weakness of the limbs, fatigue, and numbness and tingling in the fingers, toes, lips, and tongue of humans. The toxins are heat-stable, but detoxification down to acceptable levels within 6 to 7 days can be achieved by treatment with ozone or PVP-iodide-iodine complex.

Researchers suggest that standardized toxicity testing be applied such as the standard mouse bioassay technique advocated by the AOAC (Association of Official Analytical Chemists). The toxicity threshold set by the United States Food and Drug Administration for closure of mollusc beds is fixed at 80 µg toxin/100 g mussel flesh. Depending on the method applied, this represents approximately 400 mouse units (MU) per 100 g mussel flesh.

The blooms of dinoflagellates that can pose an increased risk of PSP are usually called "red tide". This phenomenon seems to be, therefore, of primary importance in any monitoring program. Some researchers sug-

gest aerial surveys, flown at an altitude of 300 m, to be most useful in detecting and monitoring red tides. However, PSP can occur, as in Malaysia, without any visible planktonic bloom. This might happen either because the concentration of dinoflagellates can reach toxic levels before their presence is manifest in red tides or because of the long retention period of the toxins in the molluscs, which can last for several months. The possible absence of clearly distinguishable indicators make standard monitoring programs indispensable. Plankton and sediment samples should be collected regularly together with oceanographic data. Their evaluation should enable the timely closing of mussel farming areas and the launching of public awareness programs.

Trace metals

A substantial number of investigations has been carried out to determine concentrations of trace metals in *Perna*. This was born out of concern over the far reaching implications for human health of the mass-culture and marketing of marine organisms that could contain potentially dangerous levels of heavy metals.

So far no generally accepted standards exist for upper limits of heavy metal concentra-

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clams are thinned out to prevent overcrowding. Transfer to the ocean nursery is done as much as possible without detaching the juveniles from the original substrate so that the transition is accomplished smoothly.

In conclusion, culture of giant clams requires a system that can deliver clean flowing seawater to suitable tanks for rearing clam eggs through larval stages to juveniles. The technology itself is relatively easy to learn, although the hatchery aspect may require more equipment and know-how than is available to coastal inhabitants and may have to be provided by better funded government or private institutions. The need for serotonin, which is

expensive, to induce spawning can be dispensed with by using gonad slurry from one or two sacrificed clams.

Future work should focus on improving survival during the larval stages possibly by providing better sources of nutrition, and on inducing early settling and metamorphosis of pediveligers so that the clams grow bigger at an earlier date and can thus be harvested sooner.

Source: MJ Trinidad-Roa and EO Alialy. *Mariculture of Giant clams (Family Tridacnidae) in Bolinao, Pangasinan*. p. 28-35. In: *Proc. Symp-Workshop on the Culture of Giant Clams (Bivalvia: Tridacnidae)*; Silliman Univ, Dumaguete City; March 15-17, 1988. Los Baños, Laguna: Philippine Council for Aquatic and Marine Research and Development and the Australian-Centre for International Agricultural Research; 1989. 131 pp.