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Aquafarmer Information Sheet

Lagoon Farming of Giant Clams (Bivalvia: Tridacnidae)

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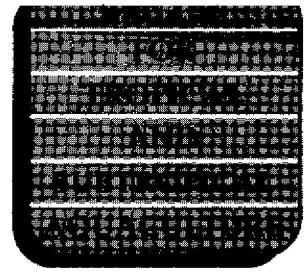

Introduction

Giant clams have long been a culturally important resource throughout the tropical Indo-Pacific. Their meat has been traditionally used as a subsistence food source. The shell also has many uses for both practical and decorative purposes, being used to make dishes, tools, jewelry and ornaments. In more recent times, the meat has become a delicacy and is even considered an aphrodisiac in some Asian and Pacific markets. The most recent use for the more brightly colored species of giant clam is as a living decoration in home and public aquariums.

The purpose of this fact sheet is to alert prospective farmers to the economic benefits of giant clam farming and also to describe the sites, equipment, and commitment needed to become a successful clam farmer. In addition, there are sections that provide a general description of giant clam farming and information on where to obtain seed clams and get further help in starting a farm.

Description

The initial interest in farming giant clams began in the 1970s when it was noticed that global populations of giant clams were rapidly declining. Increasing coastal populations, pollution and improved harvesting efficiency (power boats and diving gear) were some of the factors that were contributing to this collapse, and in some cases extinction, of local stocks of giant clams throughout their geographical range. Hatcheries were initially developed with the intent of reseeding depleted reefs and growing clams as a food source to relieve pressure on wild stocks. Today, giant clams are also grown specifically for sale as aquarium specimens. Government and commercial hatcheries exist in most tropical Pacific nations and island groups where giant clams occur. With the present level of infrastructure and technology, giant clam farming for food or for aquarium specimens presents an excellent income-generating opportunity for coastal-based populations throughout the U.S. Affiliated Pacific Islands.

Giant clams belong to the family Tridacnidae and there are nine species occurring in two genera, *Tridacna* and *Hippopus*. Clams of importance in the U. S. Affiliated Pacific Islands are as follows:

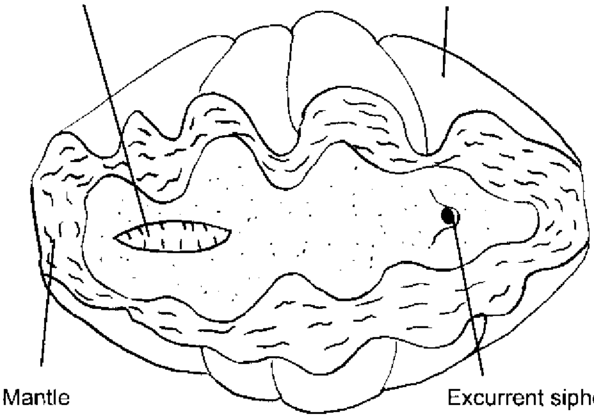

Figure 1. Schematic diagram of a giant clam.

a. *Tridacna gigas* is the true giant clam, growing to greater than 1.4 m in shell length. *T. gigas* is easily identified by its size and the triangular projections of the upper margins of the shell. The mantle is brown/green with blue or green dots (Figure 1).

b. *Tridacna derasa* (smooth or southern giant clam) is the second largest species with a shell length of up to 60 cm. The shell is smooth, and the mantle has elongated brown, green and blue patterns.

c. *Tridacna squamosa* (fluted or scaly giant clam) is easily identified by the large fluted scales on the shell. The mantle is generally mottled in blue, brown and green. Sizes reach up to 40 cm.

d. *Tridacna maxima* (rugose or small giant clam) is the most wide-ranging giant clam species, being found from the east coast of Africa to as far east as the Red Sea and eastern Polynesia. It is recognizable by its brightly colored mantle (blue, green and brown) and boring habit.

e. *Tridacna crocea* (crocus or boring giant clam) is similar to *T. maxima* in that it is a boring species and has a brightly colored mantle. This species is generally smaller and more triangularly ovate in shape than *T. maxima*.

f. *Hippopus hippopus* (horse's hoof or strawberry giant clam) has a heavy, thick shell composed of triangular

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valves with sharp, jagged teeth. The mantle is a dull yellow-brown and does not extend over the margin of the shell.

g. *Hippopus porcellanus* (China clam) differs from *H. hippopus* by having a lighter, less ribbed shell although the mantle color is similar. The **incurrent siphon** of the China clam is lined with fringing **papillae.** *H. porcellanus* has a very limited range in the region of Indonesia, the Philippines and Palau.

While all species of giant clams can be farmed, certain species are selected for particular traits. *T. maxima*, *T. crocea* and *T. squamosa* are most commonly farmed for sale to the aquarium trade. These species are relatively small and are often brightly colored. *T. derasa* is also grown for sale as aquarium specimens, but because of its fast growth rate and high palatability, is most commonly cultured for food. The *Hippopus* clams are also farmed for food and are highly prized for their attractive shell.

Biology and environmental requirements

Giant clams are well-suited for aquaculture because they derive a substantial portion of their nutrition from a **symbiotic** relationship with millions of photosynthetic algae called **zooxanthelle** *(Symbiodinium microadriaticum)* that live in their fleshy, prominent mantle. While zooxanthelle produce mainly complex sugars, they can also produce amino acids and fatty acids, a portion of which are released through the algal cell wall directly into the bloodstream of the clam. The direct benefit of this symbiotic relationship to clam farmers is that giant clams can be grown through their entire life cycle with clean seawater and sunlight as the only sources of input. A schematic diagram of the giant clam life cycle is shown in Figure 2.

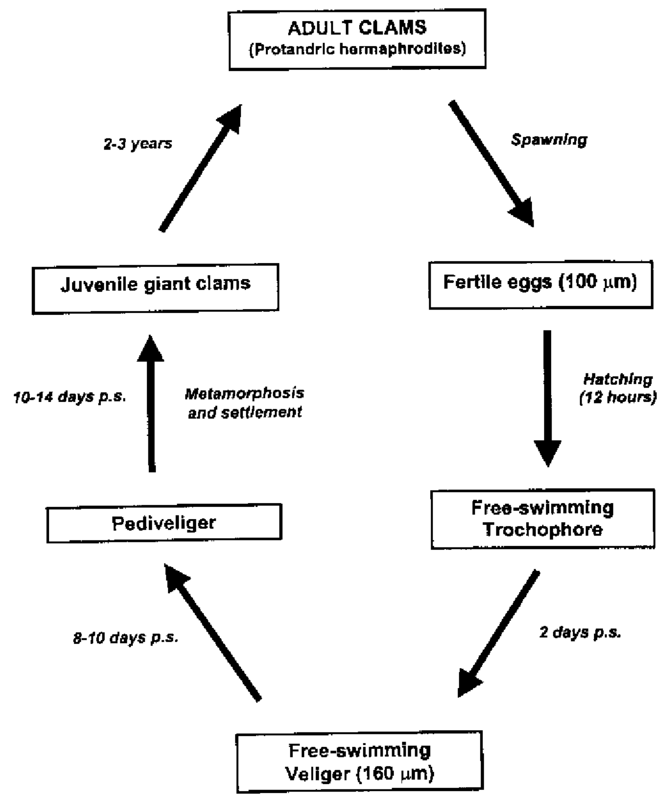

Figure 2. Life cycle of the giant clam.

Farm site selection

Many areas of the U.S Affiliated Pacific Islands are characterized by large, sheltered, relatively pollution-free lagoons that are perfect for giant clam farming. Even islands that have limited lagoon areas usually have deeper holes and depressions in the reef flat where farming can take place. A typical farm site would be located in 1-5 m of clear ocean water and should be away from point sources of pollution such as dredge sites, garbage dumps, marinas and sewage outfalls. Giant clams prefer full strength seawater and will quickly die if exposed to brackish water or freshwater for long periods. For this reason sites should be located away from freshwater sources such as river mouths. Light is important for clam growth and only mild water cloudiness can be tolerated.

A good water exchange rate is important for bringing fresh nutrients to the clams but this must be balanced against providing adequate shelter for the clams during storms. Ideal sites are those that are close to reef islands or located on the back side of the barrier reef in sand or coral rubble areas. These sites provide some protection from wave action but also have a good water exchange. Depth is also an important factor to consider when placing a farm site. Shallow sites are easier to work on but are more likely to be damaged during a storm.

A final, but extremely important, factor to consider in farm siting is security. Throughout many areas of the U.S. Affiliated Pacific Islands anything left unattended in the water is considered public property and can therefore be taken. Sites should be chosen that are close to the farmer's house or the house of people who are willing to watch over the farm.

Clam seed sources

Clam seeds are the young clams that are obtained from a hatchery to stock the farm. The minimum size for stocking any species of clams into a lagoon-based farm is 2-3 cm. Clams smaller than this do not survive well and can make the farm unprofitable. The following lists the hatcheries in the U.S. Affiliated Pacific Islands that currently produce giant clam seed.

In the Republic of Belau:

Palau Mariculture Demonstration Center
P.O. Box 359
Koror, Palau 96940, Belau
Tel. 680-488-2266
Fax 680-488-3322

In the Federated States of Micronesia:

National Aquaculture Center of the FSM
P.O. Box 807
Kosrae, FM 96944
Federated States of Micronesia
Tel. 691-370-2069
Fax 691-370-2651
e-mail: NAC@mail.fm

Lenger Island Clam Hatchery
Pohnpei State Department of Marine Resources
P.O. Box 1958
Kolonia, Pohnpei, FM 96941
Federated States of Micronesia
Tel./Fax 691-320-6204

In American Samoa:

Department of Marine and Wildlife Resources
P.O. Box 3730
Pago Pago, American Samoa 96799
Tel. 684-633-4456
Fax 684-633-5944

In the Republic of the Marshall Islands:

Marshall Islands Marine Resource Authority
P.O. Box 860
Majuro, MH 96960
Republic of the Marshall Islands
Tel. 692-625-8262
Fax 692-625-5447

When ordering clam seeds it is important to specify the size and species required. Not all hatcheries will have different species of all ages on hand so it is important to make contact well ahead of time and be prepared to wait for clams of the correct size. Off-island shipments of clams are air freighted in plastic bags inside insulated cardboard boxes. Local shipments of clams are usually transported using ice chests filled with clean seawater.

Farm management

Small giant clams are vulnerable to attack by predators such as fish, octopus and snails and must be protected by cages placed on the ocean floor. Cages can be made from local materials such as bamboo and mangrove wood but are more commonly made from vinyl-coated wire such as the security wire used on houses. Regardless of the material used, mesh size should 10-25 mm (1/2 to 1 inch). A typical wire cage is shown in Figure 3. Cages are cheap and easy to construct and have a life span of 5-10 years in the ocean.

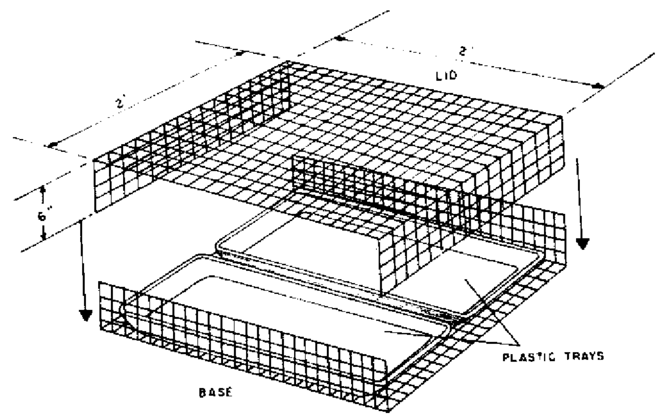

Figure 3. Typical wire cage used for holding giant clams (from Calumpong, 1992).

Cages are sometimes raised off the sea floor on legs to help stop predatory snails from entering the cage and to protect the clams from sand and silt that may be washed up by wave action (Figure 4). Cage legs are usually made from local wood such as mangrove or steel re-bar.

Clams are placed into the cages on plastic nursery trays that have been filled with a thin (1 cm) layer of concrete. The concrete acts as a base for the clams to attach to and helps to weigh down the cage structure.

Cages should be constructed before seed clams are received at the farm. One 3 ft x 3 ft cage can accommodate about 150 seed clams. This will allow adequate space for the clams to grow for 6-12 months without being moved. A general rule of thumb is that clams should not be touching each other. When clams grow so that they are touching then they must be thinned out by removing all the clams from the cage. Half the clams are then moved to a new cage and the rest are redistributed within the old cage.

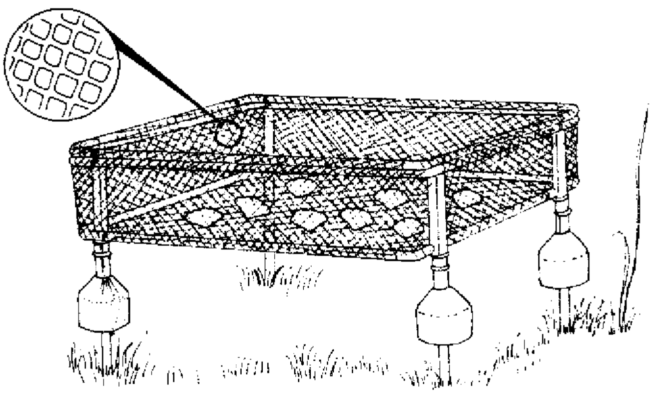

Figure 4. Cages are sometimes raised on legs to limit predation (from Calumpong, 1992).

Growout time to harvest for aquarium clams is from 12-18 months and for food clams is 2-3 years. Maintenance of a clam farm requires very little time but must be done regularly. Every week the cages should be scrubbed with a brush to remove fouling. Build-up of fouling cuts down on light to the clams and slows their growth. Time required to maintain a farm of 3,000 aquarium clams (30-40 cages) is approximately 4-6 hours per week. During cleaning, dead shells should be removed and the clams checked for predators. The cage should also be examined for tears or damage. Not visiting and maintaining the cages regularly leads to slower growth, excessive mortality and overall lower profits for the farm.

Predators and pests

Small giant clams have many predators and it is important for the farmer to protect the clams through regular maintenance. Fish with strong mouths such as trigger and puffer fish can easily bite through a giant clam shell as well as some cage materials. It is important to ensure that the cage can withstand these attacks and that there are no holes in the cage. Octopus are also dangerous predators for giant clams and can get into cages if the mesh is too large or the cage is holed.

One of the worst predators of giant clams are snails. These settle into the trays of clams from the water and crawl inside the clam to eat it. During regular maintenance of the cages the farmer must look for dead shells or clams that look weak as these are signs of snail attack. Weak clams often loose their color or gape open. The trays of clams must be carefully inspected for snails and any found must be removed and killed.

Costs of operating the farm

There are many different formulas for determining the operating costs and potential profits from giant clam farming and each case will be different. Cages and stands have a life span of about 5 years and it costs approximately US$65 ($13 per year) to make a stand and cages to grow 300 aquarium clams. After 12-18 months of growing, the farmer can then sell these 300 clams for between US$600 and US$1,800. Price will depend on the color of the clams and whether they are being sold to a local wholesaler or shipped overseas.

Clam seed is another expense to consider. Many hatcheries will provide clam seed free-of-charge or at a reduced rate to first-time growers but may charge more as the farm starts to make money. Average charges for one-year-old seed will be in the range of US$0.50-1.00 each.

Transportation to the site is the third expense to consider. Cages that are close to the farmer's house can be serviced by paddling a canoe or swimming to the site. Sites that are more remote may require the use of a motor boat.

The following example is intended to give an idea of the potential profits from giant clam farming. It must be remembered that costs and profits will vary with each individual situation.

This example is a farm that has 3,000 aquarium clams stocked into 30 cages. The following assumptions are made: growout time of 12 months; cost of each clam seed is $0.80; final sales price for the clams is $2.50 each; 90% of the clams stocked will survive to harvest; the farmer is providing all the labor; the farm is serviced by a canoe.

Initial cage costs for 3,000 clams will be $650. (Cages and stand for 300 clams is $65.) As the cages last five years, the cost per year will be $130 ($650/5). Three-thousand clam seeds will cost $2,400 (3,000 x $0.80). Total cost per year will be $2,530.

Approximately 2,700 (90%) of the 3,000 clam seeds will survive until harvest, which with an average sales price of $2.50 will give an income of $6,750 ($2.50 x 2,700).

If the cost of seed and cages is removed this gives a net profit to the farmer of $4,220 per 3,000 clams raised ($6,750-$2,530). Time required to maintain 30 cages is approximately 4-6 hours per week.

Marketing

Where a farmer markets the final product will be dependant on the type of clam grown. Clams grown for food are best marketed locally through restaurants, grocery stores and fish markets. Depending on volume of tourists and local demand, it may be possible to market hundreds of clams every month.

Clams grown for the aquarium trade must be marketed overseas. Small farmers should look toward local wholesalers of tropical fish or other exporters to make sales for them. This can remove the problems associated with overseas airfreight of live animals. Larger farms may need to market their product directly to wholesalers in the USA, Japan and Europe. Assistance and training for this can be given by local marine resource departments and aquaculture extension agents.

Further information

For more information and assistance, contact your local marine resource agencies or hatcheries at the addresses listed on page 3. The Center for Tropical and Subtropical Aquaculture (CTSA) and Hawaii Sea Grant also operate an aquaculture extension network in the U.S. Affiliated Pacific Islands designed to provide information and assistance in giant clam farming. They can be reached at the following addresses:

Simon Ellis
CTSA/Sea Grant Regional Aquaculture
Extension Agent
College of Micronesia Land Grant
P.O. Box 1179
Kolonia, Pohnpei, FM 96941
Tel. 691-320-2728
Fax 691-320-2726
e-mail: sellis@mail.fm

CTSA
The Oceanic Institute
41-202 Kalanianaole Hwy.
Waimanalo, HI 96795, USA
Tel. 808-259-7951
Fax 808-259-8395
e-mail chenglee@hawaii.edu

University of Hawaii
Sea Grant Extension Service
2525 Correa Road, HIG 237
Honolulu, HI 96822, USA
Tel. 808-956-2862
Fax 808-956-9106
e-mail aorcutt@soest.hawaii.edu

Further reading

Braley, R.D. (editor). 1992a. The giant clam: hatchery and nursery culture manual. ACIAR Monograph No. 15. 144 pp.

Calumpong, H. P. (editor). 1992. The giant clam: an ocean culture manual. ACIAR Monograph No. 16. 68 pp.

Heslinga, G.A. 1996. Clams to cash: how to make and sell giant clam shell products. Center for Tropical and Subtropical Aquaculture, publication No. 125. 71 pp.

Heslinga, G.A., T. C. Watson and T. Isamu. 1990. Giant clam farming. Pacific Fisheries Development Foundation (NMFS/NOAA), Honolulu, Hawaii, USA. 179 pp.

Knop, D. 1996. Giant clams: a comprehensive guide to the identification and care of Tridacnid clams. Dahne Verlag, Ettlingen, Germany. 255 pp.

Lucas, J.S. 1996. Mariculture of giant clams. In: Friend, K. (editor). Present and future of aquaculture research and development in the Pacific Island countries. Proceedings of the international workshop held from 20th November - 24th November 1995 at Ministry of Fisheries, Tonga. 423 pp.

Glossary

Byssal opening: area underneath the clam where it puts out threads that attach it to the substrate. This is area where predatory snails can enter the clam. The byssal opening is particularly large in *T. maxima, T. crocea* and *T. squamosa.*

Cilia: small hairs that can be moved in conjunction with other cilia to allow the larva to swim.

Incurrent siphon: opening where water is drawn into the clam.

Mantle: portion of the animal responsible for secreting the shell; in the case of Tridacnids it is also the colored fleshy tissue that houses the zooxanthelle.

Papilla: a small projecting part of the body or skin of a plant or animal.

Photosynthetic: pertaining to the ability to convert sunlight into energy, as in the case of plants.

Symbiotic: pertaining to the intimate living together of two different species, which is generally mutually beneficial to both parties.

Valve: one side of the shell of a bivalve.

Zooxanthelle: group of symbiotic dinoflagellate algae that live inside the cells of other animals especially reef building corals, soft corals and giant clams.

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