# **Commercial Hatchery Produced Queen Conch, *Strombus gigas*, Seed for the Research and Grow-out Market**

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## ABSTRACT

Trade Wind Industries, Ltd. (TWI), operates a commercial conch hatchery and nursery facility in the Turks and Caicos Islands. The 43 tank hatchery cultures veliger conch at a density of 20-30/*l*. Veligers are cultured in ultraviolet sterilized saltwater. They are fed two species of phytoplankton: a local species, Caicos *Isochyrsis* and *Chaetoceros gracili*. On day 28 (average) the veligers are sized and ready for metamorphosis. Metamorphosis is achieved with a 75% success by using a macroalgal extract of *Laurencia poitei*.

Newly metamorphosed conch and juveniles up to 90 days are cultured on algal enriched filters. The mixture of algae is the same as for the veliger food. Juvenile conch kept in high densities show accelerated growth rates using this method. After 90 days, these conch are released into a protected environment in the ocean.

A portion of the TWI's 1985 stock is currently ready to be shipped for research purposes or aquarium trade use. The remaining conch will be grown by TWI for the conch meat market.

## INTRODUCTION

The Caicos Conch Farm was established by Trade Wind Industries Ltd. (TWI) in November 1983, as a commercial queen conch, *Strombus gigas*, farm. It is a local Turks and Caicos, B.W.I. company, which has 14 investors. TWI is located on 5 acres of leased Government land on Providenciales. This location offers: clean water, swift tidal currents, no commercial development, easy access to grow-out areas, availability of materials, and access to local staff. TWI is an outgrowth of its sister company, PRIDE, which, with other research laboratories, have done extensive work on the queen conch during the past ten years.

The TWI hatchery began operation in July 1984. The facility encompasses: egg mass production, veliger and algae culturing, and rearing of post-larval juveniles. For details of the physical plant refer to Table 1 and Figure 1.

The goals of TWI are: 1) to produce food for local consumption and export, 2) to provide seed stock throughout the Caribbean, 3) to aid resource management, 4) to operate a profit making hatchery with the power to sustain itself, and 5) to train islanders to operate and manage the facility.

Figure 1. The Caicos Conch Farm, Turks and Caicos, B.W.I.

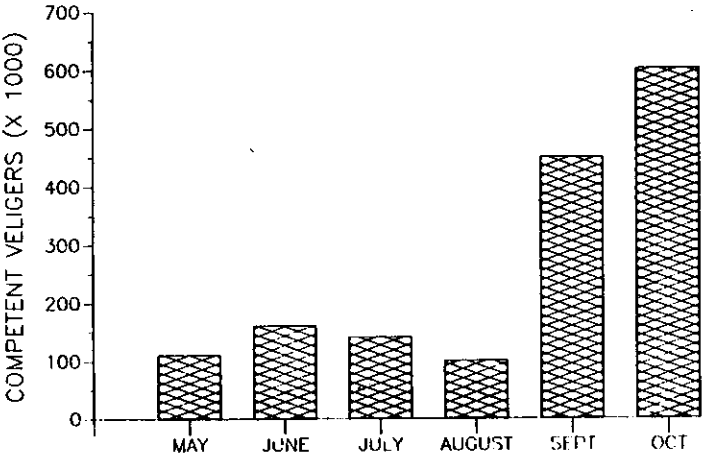


Figure 2. Production of veligers in 1985. Note the increase in production after bacteria were reduced.

## CULTURING TECHNIQUES

### Water Quality

Water quality and control of disease are the most important ingredients of a successful mariculture facility. Bacteria, of which Vibrio spp. are the most significant, constitute the largest problem in intensive culture conditions (Elston, 1984).

All the seawater at the TWI facility, except that used for older juveniles (post 40-days), is 10 micron filtered and ultraviolet sterilized, to kill unwanted bacteria and predators.

The TWI hatchery experienced a bacteria pathogen which caused 100% mortality in the veliger cultures 8-10 days old. The symptoms of this disease, which Elston et al. (1981) classify as Vibriosis, are the following: necrosis of the lobes, breaking of lobe cilia, slowed activity, and mortality.

Shellfish pathologist, Dr. Walter Blogoslawski, was a consultant at the TWI hatchery in early August 1985. He identified 20 species of bacteria, including 5 strains of Vibrio alginolyticus that caused 100% veliger mortality in bioassays. A possible second pathogenic agent, Pseudomonas fluorescens, which produces a pink pigment, was also identified. This bacterium is common in algae cultures and seawater (Brown, 1983). It is present when organic loads are high, and can cause 20-40% mortality (Blogoslawski, pers. com.).

Incoming seawater was the major contamination source of V. alginolyticus. Elston et al. (1982) identified a similar surface coating bacterium, growing on the inside of seawater pipes, that caused shellfish mortality. To reduce bacterial contamination in the TWI facility, the seawater lines are chlorinated (1.5% solution of Chlorox) overnight every two weeks. This procedure kills surface related bacteria on the inside of the pipes. When stress level is high and animals are weak, they are more susceptible to bacterial invasion (Brown, 1983). Genetics may also play a role in the immunity systems of conch at different stages. The increase in production of veligers after bacteria were reduced is shown in Figure 2.

Cleanliness of equipment, tanks, floors and hands is necessary in all aspects of the culturing environment. An epidemic caused by careless cleaning can spread disease and wipe out an entire year of work. All TWI equipment is rigorously cleaned between use with either hydrochloric acid or Chlorox.

Currently, no antibiotics are used at TWI, the inherent philosophy being that they are only necessary as a last resort. If not used wisely, antibiotics can cause resistant strains of bacteria which can result in closing of the facility (Blogoslawski et al., 1978; Elston, 1984).

### Egg Masses

For five consecutive years a conch egg farm has operated in the Turks and Caicos Islands (Davis and Hesse, 1983). Its purpose is to supply a reliable source of eggs for the conch hatchery. The farm is on the barrier reef two miles from the hatchery. It is 4 m deep and covers a 6000 $m^2$ area. A physical boundary of coral reef encloses 75% of the farm and 1 m high nets close off the remaining 25%. The farm is stocked with 200 females and 200 males (1 conch/15 $m^2$). The 1985 egg laying season at the egg farm extended from late March to early September; however, egg masses were collected from other habitats until October 10. Earlier research determined each female lays an average of 8 egg masses/season (Davis et al., in press). The most productive months were April to August, with a peak in July. Egg masses were not a limiting factor to production.

Every other day SCUBA divers collect 5-10 egg masses from underneath females to ensure freshness and to be able to predict hatching in 3-5 days. Sixty egg masses per month assure full production, back-up, and selection. The egg masses are sorted for size, thickness of strands and fertility. The strands are gently teased apart, treated with a 0.5% chlorox solution for 30 sec., and rinsed several times in saltwater (Siddall, 1983). Each egg mass is placed in an individual 15 cm diameter x 15 cm high screen bottom cylinder. Each cylinder is an upwelling unit; the seawater passes through the bottom of the cylinder and leaves through a 0.25 cm hole on the side of the cylinder. This upwelling method permits an even flow of seawater past each egg mass. The cylinders are kept on a shallow table which has a continuous flow of saltwater. The eggs incubate for 3-5 days. Temperature determines day of hatch, the warmer the water the sooner hatching occurs (Davis and Hesse, 1983). On the day of hatch the encapsulated veliger rotates, has orange pigments on the foot and defined lobes (D'Asaro, 1965). On the afternoon of the hatch day each egg mass is put in a screen container and lowered into individual larval tanks. Fifty percent of the egg masses treated were used in the veliger tanks and the remainder discarded into the sea. Repeated observations show that the eggs hatch after sundown, between 7:00-9:00 p.m. Eighty-five to ninety percent of the hatching occurs simultaneously (Brownell, 1977). An enzyme is released to break down the outer protective membranes so that the veliger can forcibly swim through the aperture of the capsule (D'Asaro, 1965; Siddall, 1983).

## Algae

A reliable, inexpensive algae food is vital to conch mariculture. TWI's tropical algae facility consistently yields high quality and nutritious food for the veligers and for the post-larval juveniles in the shore nursery (first 90 days). The two species grown are Caicos _Isochyrsis_ and _Chaetocerous gracile_. Caicos _Isochyrsis_ is a nutritious local isolate that grows extremely well. These algae are grown in batch culture using Guillard's F/1.5 media. Cultures are started in 250 ml erlenmeyer flasks, three of these are then used to inoculate a 20 liter carboy, half of which inoculates a 200 liter fiberglass tube. This process takes 10-12 days until the algae are at the right density to feed the veligers and post-larval conch. Flasks are maintained in a temperature and light controlled room. An air-conditioner keeps the room at 27°C and constant lighting is supplied by cool-white fluorescent lights. Carboys and tubes are housed in the solarium of the dome, where ambient temperature fluctuates between 28-32°C. Six, 200 liter tubes are used daily, two for the hatchery and four for the onshore nursery. Additional algae are being grown in continuous culture in 6000 liter outside tanks. These algae are used exclusively for the older juveniles.

Algae are monitored daily for quality. Bactopeptone and TCBS agar plates are used to determine axenic and xenic cultures. Microscopic observations show health of the algae. Healthy algae should exhibit: cell division, mobility of the motile species, no clumps and no protozoans. The algae cultures should also have no foam on the surface and a sweet smell. To produce the algae needed, requires one staff member working 5 hours per day.

### Veligers

Veligers are raised in forty-three (1100 liter) parabolic tanks. The tanks are organized into 5 modules with 8 or 9 tanks in each. Modules allow the veligers to be categorized by age groups; this increases efficiency of feeding, observing, handling and minimizes spreading of contamination.

Thirty-eight out of the 43 tanks are always full, leaving one tank in each module for rotation. On the average 4-5 tanks in each module are exchanged daily. Water exchanges occur every 48 h for days 1-16 and every 72 h from day 17 onwards. Sieve sizes range from 149-710 microns. This is based on growth of 50-55 microns/day for veligers (Ballantine and Appeldoorn, 1983). A different sieve size is used for each successive water exchange; this culls the dead and slow growers, keeping a healthy and uniform sized batch. Density is 100-150/$l$ at hatch, 20-30/$l$ at metamorphosis. If density is too high then the batch is divided between two tanks. To accomplish water exchanges and monitoring of veligers requires a staff of four for 5 hours per day.

Water flows into each 1100 tank for 20 h at a rate of 2 liter/minute. Ten liters of algae per tank is drip fed for 16 h. Caicos Isochyrsis is the staple food source and Chaetocerous is a supplementary food for veligers 10 days and older. The cell density fed is similar to that used by Siddall (1983) at the University of Miami hatchery.

Daily microscope observations are made on each culture to determine growth, development, amount of food in gut, health and density. The complete developmental biology of the veliger is described by D'Asaro (1965). The larval cycle ranges from 21-40 days with an average of 28 days until metamorphosis. Development is regulated by quality and quantity of food, density of the culture and temperature of the seawater. Temperature is the most significant variable. Rearing temperature ranges from 25°C to 31°C; the warmer the water, the sooner the veligers are competent to metamorphosis (refer to section on Metamorphosis).

Water quality is the key to good survival of veligers. Bacterial infections caused many failures in the first half of the season. Once the bacterial problem was solved, results improved dramatically (refer to section on Water Quality and Figure 2). This season (1985), the hatchery produced one and a half million veligers competent for metamorphosis.

## Metamorphosis

Metamorphosis is the most critical time in the larval cycle. Induction should take place only when the veligers are competent. Competency is defined by: 1) Development of the buccal mass, eyes migrate outward, tentacles become the same length, and dark green pigmentation of the foot (D'Asaro, 1965; Brownell et al., 1977); 2) A "test set" of a small group of animals is used to confirm readiness to metamorphose with a 75-85% level acceptable. The size at metamorphosis is 1100 microns or greater. Health, density, food, proper handling and cleanliness of the culture play an important role in the success of metamorphosis. Delaying metamorphosis can be detrimental to success. The animal has a period of 2-4 days when it is competent for induction.

Metamorphosis is induced by using macroalgae extract. Research at the University of Miami (Siddall, 1983) showed that phycoerythrins and related protein conjugants found in red macroalgae may initiate the onset of metamorphosis. The three extracts used were: *Laurencia obtusa*, *Gracilaria tikvahiae*, and *Laurencia poitei*. The local species, *L. poitei*, proved most successful; *L. obtusa* was marginal; and *G. tikvahiae* caused mortality. Out of the 83 batches induced, the average number of veligers to complete metamorphosis was 75%. Reinduction is only 10% and, therefore,is not recommended.

The liquid macro-algal extract is made by blending the algae with saltwater and then filtering the extract with a 1 micron filter. The extract dosage varies with each batch made, and is determined through "test sets" and ranges from 7-25 ml of extract/liter of seawater. Between 1000-2000 veligers are placed in 15 cm diameter screens in the extract solution. Leaving the veligers in the solution for longer periods of time is preferable to using a stronger dosage. This time period ranges from 3-6 h. This time period varies according to the compensatory levels of the veligers being induced.

Induced veligers are kept overnight in algal enriched seawater filled trays. The following morning the metamorphosed conch are separated from the swimmers. The post-metamorphosed conch have whiter shells with ridges and protruding eyestalks. They are also larger, attach to the substrate and have absorbed their lobes.

## On-Shore Nursery

For 90 days, post-larval juveniles (1-14 mm) are maintained in rectangular wood-epoxy tanks in the on-shore nursery facility. The benthic conch are reared in ultraviolet water enriched with the same mixtures of planktonic algae used in the hatchery.

Animals are fed on a substrate of deep pleated cylindrical filters (d=15 cm, l=50 cm) custom made from 10 micron continuous strand polypropylene. The filters are preconditioned for 15 h by connecting to air lift pumps which circulate the water and "plates" the planktonic algae on the filters for the conch to graze on. This method is a new one for gastropod mariculture. Prior to its use, corrugated fiberglass panels were the state of the art as practiced by abalone farms (Kafuku and Ikenoue, 1983).

The morning after metamorphosis the conch are placed on filters in shallow 180 liter trays at densities up to $7500/m^2$. Animals are washed down and filters are changed at 24, 72 and 120 h to minimize losses due to surface coating bacteria.

After one week, the conch are transferred to 2400 liter tanks on the filters at densities of $2000/m^2$ until 5 mm, $400/m^2$ until 10 mm, $160/m^2$ until 14 mm. Feeding is daily; filters are changed weekly. Growth is limited by high densities and water temperature.

After 40 days the animals are shifted to filters and cylindrical screen (1.4 mm openings) bags in outside tanks containing filtered, non-sterilized water. Survival to 90 days post-metamorphosis is 50%; most deaths occur during the first 10 days. In October 1985 the nursery contained 500,000 conch, ranging in size from 1-14 mm.

Post-ninety day animals are held in suspended Vexar cylindrical bags in 2 m deep seawater in front of the hatchery.

## COST

### Capital Expenses

Capital costs (Table 1) represent actual money expended on physical plant over the construction period January 1984 through October 1985. The TWI facility was designed, engineered and built by company employees. Where possible, equipment was fabricated on site. Expenditures for offshore grow-out equipment are not included in this summary.

### Operating Expenses

The figures for operating expenses (Table 1) are from records of the first full fiscal year of operation, November 1, 1984 through October 31, 1985. The staff consists of 3 full-time and 2 part-time expatriates and 7 full-time and 8 part-time local employees.

### Marketing

The 1985 TWI inventory is 500,000 juvenile conch, and of these, 120,000 are offered for sale this year. The balance of 380,000 will be grown for approximately two years in the grow-out facility for the food market.

Juvenile conch will be sold in three market areas: 1) To the Aquarium Trade. These sales will provide cash flow to continue operation of the facility up to harvesting of the first meat

Table 1. Costs for TWI Caicos Conch Farm (formatted as in Siddall, 1983)

| Item | Cost (US $) |
|---|---|
| I. CAPITAL EXPENSES: | |
| Land Excavation and Road Bldg. | 5,000 |
| Electrical Primary Line and Hook-up | 3,400 |
| Hatchery and Algae Bldg. (3000 sq.ft.) | 110,000 |
| Laboratory and Equipment (1800 sq.ft.) | 70,000 |
| Nursery Bldg. and Equipment (600 sq.ft.) | 15,000 |
| Maint. Bldg. and Fabrication Equip (780 sq.ft.) | 15,000 |
| Visitors Center and Offices (862 sq.ft.) | 25,000 |
| Staff Kitchen, Lunch Rm. & Wash Rms. (350 sq.ft.) | 9,500 |
| Dock, Dive Locker and Equipment | 9,200 |
| SW/Air Pumping, SW Storage (120,000 l) & Plumbing | 39,000 |
| Standby Generator | 5,000 |
| Ultraviolet Sterilization System | 19,500 |
| Forty-five (1100 l) Veliger tanks @ 497.20 | 22,374 |
| Fifteen Algae Tubes (200 l) @ 78.00 | 1,170 |
| Outside Nursery Tanks | 3,000 |
| Boat and Engine | 3,500 |
| Truck | 7,800 |
| TOTAL CAPITAL EXPENSES: | 363,444 |
| II ANNUAL OPERATING EXPENSES (based on 1985 Fiscal Year) | |
| Management Salaries (including benefits) | 49,500 |
| Hatchery and Algae Staff (including benefits) | 58,743 |
| Nursery Staff (including benefits) | 17,654 |
| Consultants | 1,824 |
| Legal Fees and Accounting | 8,100 |
| Work Permits | 2,800 |
| Secretary and Material Acquisition in Miami | 2,000 |
| Rent Miami Office | 2,900 |
| Insurance | 5,187 |
| Government Land Lease | 5,000 |
| Bank Charges | 620 |
| Printing and Publicity | 3,040 |
| Travel and Communication | 10,053 |
| Electricity | 13,600 |
| Mariculture Supplies and Chemicals | 8,800 |
| Fuel | 5,300 |
| Maintenance on Faciliity, Boats and Vehicles | 7,100 |
| 10% per Year Depreciation of Capitol Items | 36,344 |
| TOTAL ANNUAL OPERATION EXPENSES: | 238,565 |

crop. Aquarium animals sell wholesale at US$0.90 to 1.25 each. 2) To Research Laboratories. This market is desirable so as to further knowledge of conch biology. Pre-one year juveniles are impossible to find in large numbers in the wild while the cost of raising juveniles from eggs is prohibitive for most researchers. TWI can perform a valuable service by providing these animals. Juvenile conch prices for 1985 range from US$0.60 to 0.80 (size and quantity dependent). As production volume increases, prices will drop. 3) The Seed Stock market should develop rapidly with the ready availability of healthy hatchery reared juveniles. TWI is prepared to supply animals in the 25 to 45 mm range to grow-out operations once they have the necessary facilities and qualified personnel in place. Presently there are no known diseases that can be spread through transplantation of conch.

Costs for seed stock are negotiable, according to quantity of purchase and merits of the individual project. TWI seed stock pricing is based on true production costs plus a modest profit. Based on 1986 production goals, seed could sell for as little as US$0.15 per animal.

## SUMMARY

1. Water quality is important to the success of the TWI mariculture facility. Routine cleanliness is established at TWI, to keep the surface coating, pathogenic bacterium, *V. alginolyticus*, from causing mortality to conch.

2. An egg farm is a necessity to ensure a continuous supply of eggs.

3. The techniques and routines for operating efficient veliger and algae cultures are established. This year, the conch hatchery produced 1.5 million veligers. Based on the productive months of September and October, 4 million veliger/year can be projected.

4. Metamorphosis is presently 75% with very high survival after induction.

5. Raising high densities of post-larval conch through 90 days on planktonic algae is practical. Presently, 500,000 animals are being reared using this method.

6. Post-nursery inventory is suspended in cylindrical cages offshore.

7. The market for seed conch is for the aquarium, research and grow-out trade. These markets will bring in revenue for the company, aid in the understanding of conch biology, supplement the resource, support an indigenous food source, and keep local people employed. The number of conch seed available in 1985 for sale is 120,000.

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