Algae Production for Commercially Grown Queen Conch (*Strombus gigas*)

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ABSTRACT

Desde julio de 1984, se han cultivado algas marinas tropicales, en grandes cantidades, para servir de alimento al carrucho durante sus primeras etapas de vida, desde veliger hasta llegar a la post-larva. Estos cultivos se llevaron a cabo en las facilidades de Caicos Conch Farm, localizadas en Provinciales en las Islas de Turks y Caicos. El alga planctónica de Caicos Isochrysis (Ciso), es el alimento principal del veliger, la cual se suplementa con Chaetoceros gracile (Chgra). Usando el método de cultivo de grupo y una versión modificada del medio, F/2 de Guillard, el alga se cultiva bajo un techo abovedado transparente a manera de invernadero. Los tanques que contienen la etapa de veliger son alimentados con un sistema de goteo contínuo durante la noche.

Para las etapas subsiguientes en el desarrollo del carrucho, el alimento debe estar disponible de forma que pueda ser consumida por estos organismo. El alga Ciso, en su forma no planctónica, continúa siendo la fuente principal de alimento para los carruchos en su etapa de metamorfosis. Cilíndros opacos hechos de fibra de vidrio con un enrejillado adentro, se sumergen en un baño denso del algas, permitiendo que las células formen una placa que cubra la superficie y produzca el alimento adecuado para estos organismos, luego de transcurrida la metamorfosis.

El agua del mar, que contiene diatomeas bénticas, se convierte en una fuente de alimento vital para los carruchos después de cumplirse una semana de su metamorfosis. La superficie que provee el "astroturf", hace de este material, uno apropiado para colectar este alimento. Las planchas de "Astroturf™" previamente "acondicionadas" por dos semanas, en el mar, se utilizan como agente inoculado para el cultivo de diatomeas bénticas. Los organismos en etapa post-larval que viven en las planchas verticales, se alimentan con este cultivo y el mismo se suplementa con Ciso.

Cuando los carruchos juveniles alcanzan un tamaño de 3mm son colocados en el mar dentro de las placas de "Astroturf™" previamente acondicionadas. De esta etapa en adelante, se descontinúa la producción de alimento cultivado y solo dependen entonces de alimentación natural.

PLANKTONIC ALGAE

Culturing Techniques

The Caicos Conch Farm produces 800 liters of "Ciso," a local planktonic isolate, and 40 liters of *Chaetoceros gracile* (Chgra) daily from its two-story geodesic dome greenhouse. Ciso has been so-called because it exhibits characteristics similar to those of Tahitian *Isochrysis* (Tiso), a food commonly used by other mariculture facilities (Guillard, 1975). It is cultured as a staple food source for three reasons:

1. It has proven nutritionally valuable to veligers at all stages.
2. It was isolated from local waters and therefore could be available as a food source to conch in the wild.
3. It is highly-resistant to bacteria of the genus *Vibrio*.

Chaetoceros gracile is grown and fed in smaller quantities as a supplementary food. It grows well in a tropical environment and adds additional nutritional value to the veliger diet.

Algae is cultured in F/1.5 media, a modified version of Guillard's F/2 media (1975) using batch culture techniques. All salt water is filtered to 10 microns and ultraviolet sterilized. From flask transfer day to feeding day, the growth cycle is 14 days for Ciso and 12 days for Chgra. Ciso and Chgra flasks (175 ml) are transferred under a sterile hood and maintained in a temperature controlled cool room for five days. Three flasks are used to inoculate 20 l carboys. After four days, half a carboy is sufficient inoculum for 200 l clear fiberglass tubes (46 x 152 cm). Twenty-four of these tubes are arranged around the outer edge of the second floor of the dome. The triangular panels that form the dome roof are made of transparent fiberglass which allow for photosynthesis. Greenhouse shade cloth (50%), a ceiling extractor fan, and an oscillating fan allow algae temperatures to be maintained between 28° C and 34° C on the hottest days.

Cisco tubes are fed at four days old, when cell densities are approximately 1.5 x 106 cells/ml. Chgra is fed from the carboy after four days. Cell densities are determined by use of a colorimeter.

Algae quality is determined daily. Ciso and Chgra are healthy and feedable if they have few clumps and protozoans, and if 24 hour TCBS plate readings are negative, indicating absence of the bacteria *Vibrio*. Ciso should exhibit 70-100 percent motility, and Chgra should be actively dividing.

Veliger Feeding

On the first floor of the geodesic dome, veligers are maintained in 43 egg-shaped tanks (1,000 l) at a mean density at metamorphosis of 20-30/l. The tanks are organized into five modules with eight or nine tanks in each. The module arrangement allows veligers to be grouped by age, increasing feeding efficiency.

Algae on the second floor is siphoned into five food tubes, one per module, set into the floor. Half inch hosing extends from the bottoms of the food tubes to each of the hatchery tanks.

Food is drip-fed from these lines for 12 hours and each tank receives 10-12 l. Food is continuously diluted by flow-through (2 l/min) and evenly distributed by gentle aeration.

Veligers are examined daily to make sure they ate enough food the previous night. Algae in the gut is visible through the veligers' transparent shells. From the first day after hatching to day 14, veligers are fed only Ciso. The feeding density per tank is 8,500 to 10,000 cells/ml. From day 14 to metamorphosis, Ciso is supplemented with Chgra (15% of the total food volume) at a feeding density of 12,000 to 15,000 cells/ml per tank. At the hatchery's maximum holding capacity of 3 million veligers, 400 l of Ciso are required daily.

Post-Metamorphosis Feeding

The algae greenhouse provides up to 450 l of Ciso and 40 l of Chgra for newly metamorphosed conch. Algae is pumped from the dome to the

metamorphosis building. There it is inoculated with nutrients in 650 l tanks (86 x 91 cm) and gently aerated. Round upwelling units are suspended in the algae. The outer shell of the units (diameter = 81 cm; height = 91 cm) is opaque fiberglass with a 250 μ screen bottom. It supports three vertical, circular screen (250 μ) inserts which comprise a food collection surface area of 3 m^2. After two days of soaking, a layer of matted algae cells coats the screens; all suspended algae is then removed by upwelling. This screened Ciso and Chgra is food for benthic-feeding conch.

Veligers competent to undergo metamorphosis (mean = 28 days) are transferred from the hatchery to the metamorphosis building. They are induced to metamorphosis by exposure to extract from *Laurencia poitei*, a locally found macroalgae, for three to six hours. Seventy-five percent of the veligers complete metamorphosis (Davis *et al.*, 1987).

Newly metamorphosed conch are placed on the surface of the algae coated screen units at a density of 50,000/unit (1.7 conch/cm^2). Upwelling flow is continuous at 2 l/min. They are maintained in this manner for one week and are moved to new screens once during this week.

Food provided in this manner is sufficient to meet the nutritional requirements of the newly metamorphosed conch. After one week's growth, they are 1,100 μ long and are transferred to the post-larvae division. Sixty percent of the conch from the hatchery are alive at this point.

BENTHIC DIATOMS

Culturing Techniques

Wild benthic diatoms completely replace Ciso and Chgra as food eight days after metamorphosis. Naturally occurring diatoms are collected on sheets of Astroturf™ anchored offshore 30 cm below the water line. After 14 days in the sea the Astroturf™ is brought ashore, and the diatoms are removed by pressurized salt water. The resulting diatom mixture is filtered through 15 μ bags to remove silt, organic debris, and predators. The yield of 150 l is nutrified with F/1.5 media with doubled silicates and cultured for five days in a fiberglass tube (46 x 122 cm).

After five days the diatom culture is used as an innoculum for 300 l screen-conditioning tubes. Six 400 μ screens (38 x 91 cm each) supported on PVC frames are suspended in these tubes, and forceful aeration is applied. In 24 hours most of the diatoms have been removed from the water column and deposited on the screens. These screens are then placed in a nutrient enriched salt water tank. This secondary conditioning allows the benthic diatoms to continue to divide and form a dense grazing surface. The screen units are then ready for use as food for post-larvae conch.

Post-Larvae Feeding

Conch are known to be epiphytic feeders (Randall, 1964; Orr, 1975). The diatoms in cultivated cultures are similar to those growing on *Batophora* sp. and *Laurencia* sp. These macro-algaes grow on the sandy sea bottom where conch are found grazing. Species commonly cultured are *Navicula* sp., *Nitzschia closterium*, *N. frigida*, and *Licmophora* sp.

Conch up to 5 mm are maintained in post-larval tanks (750 l) on the conditioned screen units (collection surface area = 2 cm^2). Stocking density during the first week is 30,000 post-larvae/unit (1.5 conch/cm^2); for the second

week, 15,000 post-larvae/unit (0.7 conch/cm^2); and for the third week, 7,500 post-larvae/unit (0.4 conch/cm^2). They consume the food material in five days and are transferred to newly conditioned units four to six times during their growth in the post-larvae tanks for 20 to 30 days.

From May through August 1986, conch were fed directly on Astroturf sheets conditioned at sea for two weeks and then suspended in postlarvae tanks. This method produced 30 percent survival. Mortality was attributed to starvation; growth in survivors was minimal. The conditioned-screen method has yielded 75 percent survival and produced healthier, faster growing conchs. Growth with this method is 1.5 mm/week (number of conch measured = 3,195; Figure 1).

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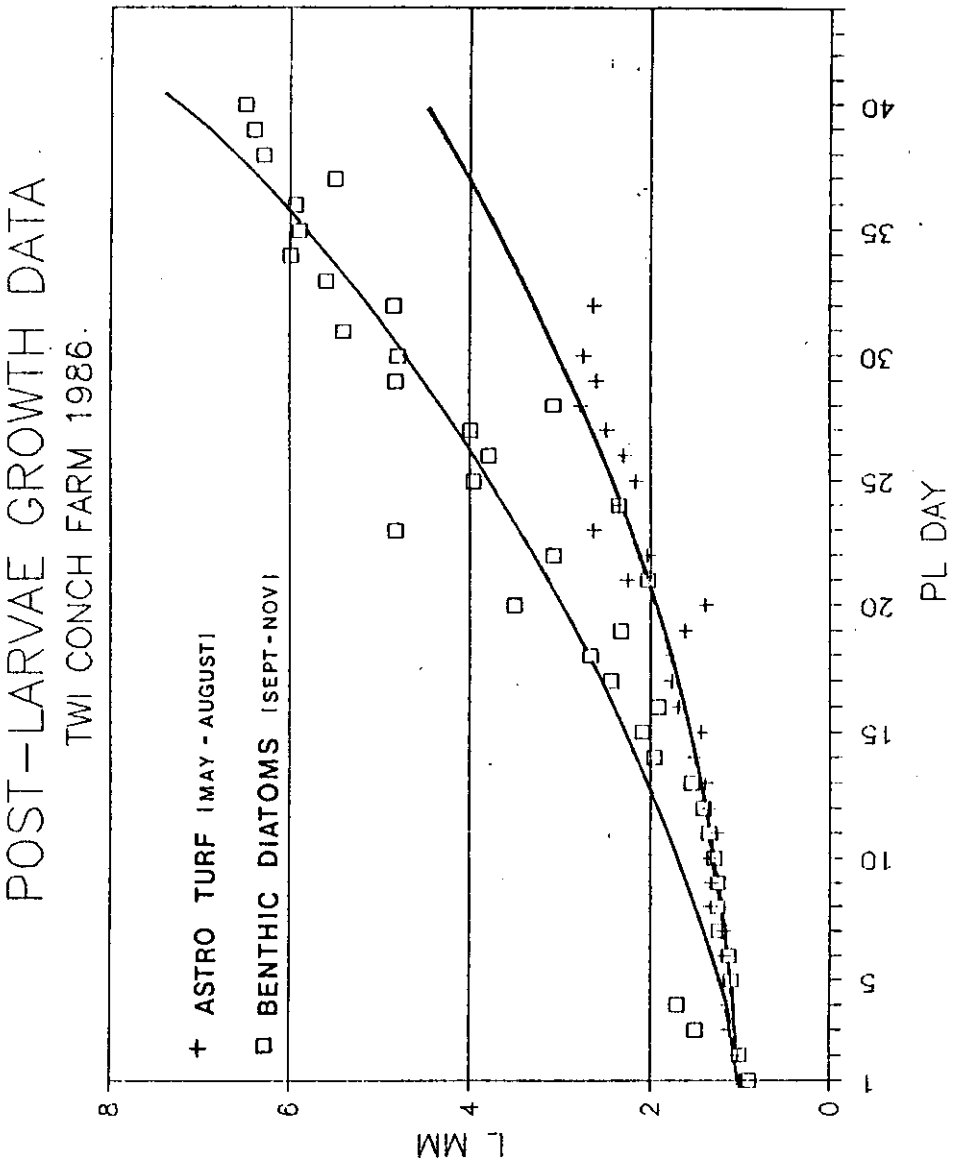

Figure 1. Post-larval growth data, comparison of two types of food sources.