

## Growth of Florida Fighting Conch, *Strombus alatus*, in Recirculating Systems

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### ABSTRACT

With the increased interest in water conservation and the need to reduce the discharge of effluent from aquaculture production systems, there has been a shift from open, flow-through systems to recirculating aquaculture production systems. In 2001, Harbor Branch Oceanographic Institution developed the first recirculating conch aquaculture program. Two important aspects of conch aquaculture are determining the stocking density and water quality parameters in growout systems that yield the fastest growth rate and the highest survival. An experiment was conducted from March 11 – June 3, 2003 at two Florida sites, Harbor Branch Oceanographic Institution and Mote Marine Laboratory, to compare survival and growth of juvenile conch in a recirculating growout system. The recirculating system consisted of raceways troughs with an elevated sand substrate. The three replicate raceway troughs at each site were stocked with juvenile ( $16.9 \pm 1.9$  shell length) Florida fighting conch, *Strombus alatus* at 75 conch/m<sup>2</sup> (109 and 140 conch per replicate at Harbor Branch and Mote, respectively). In 12 weeks, the conch grew 18.8 mm or 0.22 mm/day at Harbor Branch and 22.5 mm or 0.27 mm/day at Mote. There was a significantly faster growth rate at Mote, which appeared to be due to a lower stocking density throughout the experiment. There was an 83 % and 70 % overall survival rate at Harbor Branch and Mote, respectively. Temperature, salinity, and pH averaged 26.7°C, 31.6 ‰, and 7.9, respectively at Harbor Branch, and 26.4°C, 34.9 ‰, and 8.2, at Mote. The feed conversion ratio was 1.3 at Harbor Branch and 2.2 at Mote. The recirculating aquaculture systems utilized at each site had optimal stocking densities and water quality for growing juvenile conch.

KEY WORDS: Aquaculture, conch, *Strombus*

## Crecimiento del Caracol Florida Fighting Conch, *Strombus alatus*, en Sistemas de Recirculación

Con el interés aumentado a la conservación de agua y la necesidad de reducir la descarga de aguas residuales de sistemas de producción de acuicultura, hubo un cambio de sistemas que eran abierto, flujo - por sistemas de circulación producción. En 2001, la Harbor Branch Oceanographic Institution desarrolló la primera sistema por concha que es recirculante. Dos aspectos más importantes de la acuicultura de concha es determina la densidad de media y parámetros de calidad de agua en sistemas maduración que ceden el índice de crecimiento más rápido y la supervivencia más alta. Un experimento fue conducido des del 11 de Marzo hasta el 3 de Junio de 2003 en dos sitios en Florida, Harbor Branch Oceanographic Institution and Mote Marine Laboratory, comparar la supervivencia y el crecimiento de la concha juvenil en una nueva sistema de circulación de maduración. El sistema recirculante consistió en artesas raceways con una arena elevada. Los tres se reproducen las artesas raceway en cada sitio fueron abastecidas de Florida juvenil ( $16.9 \pm 1.9$  longitud del concha) luchando contra la concha, *Strombus alatus* en 75 concha por los  $m^2$  (109 y 140 concha por se reproducen en Harbor Branch and Mote, respectivamente). En 12 semanas, la concha creció 18.8 mm o 0.22 mm/días en Harbor Branch y 22.5 mm o 0.27 mm/días en Mote. Había un índice de crecimiento considerablemente más rápido en Mote, que pareció ser debido a una densidad de media inferior en todas partes del experimento. Había un precio de supervivencia total del 83% y del 70% en Harbor Branch y Mote, respectivamente. Temperatura, salinidad, y pH hecho un promedio 26.7°C, 31.6 ppt, y 7.9, respectivamente en Rama de Puerto, y 26.4°C, 34.9 ppt, y 8.2, respectivamente en Mote. La proporción de conversión de comida era 1.3 en la Rama de Puerto y 2.2 en la Mote. La nueva circulación acuicultura sistemas utilizados en cada sitio tenía densidades de media óptimas y calidad de agua para cultivar la concha juvenil.

**PALABRAS CLAVES:** Acuicultura, concha, *Strombus*

### INTRODUCTION

Conch aquaculture has been of interest to biologists since the early 1960s, when the commercial queen conch, *Strombus gigas*, fishery began to show signs of decline (Appeldoorn 1994). Since that time, many experiments have been conducted to determine the optimal culture conditions of queen conch (Berg 1976, Davis 1994, 2000, Spring In press). Some of the factors that influence the growth rate of captive conch include water quality, stocking density, and nutrition.

One of the more recent additions to conch aquaculture has been the use of recirculating growout systems. Marine laboratories and aquaculture facilities are shifting from open, flow-through systems to recirculating systems in an effort to conserve water and reduce the discharge effluent. In 2001, Harbor

Branch Oceanographic Institution developed the first recirculating conch aquaculture program to culture Florida fighting conch, *S. alatus*, and queen conch, *S. gigas*. The recirculating systems have proven to be successful, however, there are still many growout parameters that need to be studied to improve growth, survival, and to lower culture costs (Davis and Shawl In press).

The purpose of this study was to compare growth rate and survival of juvenile Florida fighting conch in recirculating systems at two Florida sites. The results from this experiment can be applied to growing other conch species such as queen conch.

### MATERIALS AND METHODS

The experiment was conducted from March 11 – June 3, 2003 at two sites: Harbor Branch Oceanographic Institution (Harbor Branch) in Ft. Pierce, FL and Mote Marine Laboratory (Mote) in Sarasota, FL. A recirculating growout system with an elevated sand substrate bottom was used at both sites. At Harbor Branch, the system consisted of three 2.5 m x 0.5 m fiberglass troughs, a 1.5 m diameter round fiberglass sump, and a 3/4 horsepower Haywood pump (see Spring In press). The Mote system consisted of three fiberglass troughs (2.4 m x 0.7 m), a sump, and a 1/2 horsepower pump. Approximately 5 cm of crushed coral aragonite sand was placed on an elevated platform. The sand served as the biofilter for the system.

The water used in the Harbor Branch system was natural sea water drawn from a saltwater well, and the water used in the Mote systems was fresh well water mixed with Instant Ocean™ artificial sea salt. The water entered each trough through spray bars. To aid in the removal of wastes, water also entered from beneath the sand substrate. Makeup water was added as necessary at no more than 10 % Exchange of total system volume per day. The systems at both sites were drained twice per month, to spray the sand clean and to scrub the troughs. Water quality parameters were measured throughout the experiment. Temperature was measured daily at both locations. Salinity, pH, and dissolved oxygen (mg/L) were measured weekly at Harbor Branch and daily at Mote. Ammonia, nitrite, and nitrate were measured once every two weeks at both sites. Calcium (mg/L as CaCO<sub>3</sub>) was measured three times at Harbor Branch and once at Mote.

Each of the three replicate troughs were stocked with juvenile Florida fighting conch, cultured at HBOI, at 75 conch per m<sup>2</sup>. There were 109 conch per replicate in the Harbor Branch troughs, and 140 conch per replicate in the Mote troughs. At the beginning and termination of the experiment the shell length (mm) and total weight (g) of meat and shell were measured. A sub-sample of 50 animals per replicate (150 total conch) were used for each data point throughout the experimental time period. The shell length was measured to the nearest 0.1mm twice per month, and the wet weight was taken once per month (to the nearest 0.1 g). Mortalities, defined by an empty conch shell, were recorded and, when possible, these animals were replaced by others of a similar size from the same batch of juveniles.

The conch were fed a diet that consisted of *Ulva*, koi chow and an

alginate binder which is manufactured exclusively by Bonney, Laramore, and Hopkins at Harbor Branch. The conch food was weighed prior to each feeding, and the conch were fed to satiation. The total amount fed to each replicate was recorded for the duration of the experiment to determine a feed conversion ratio (FCR).

A t-test was run at the end of the experiment to determine if there were statistical differences between sites. Both the length and weight measurements were transformed using a log transformation to normalize the data.

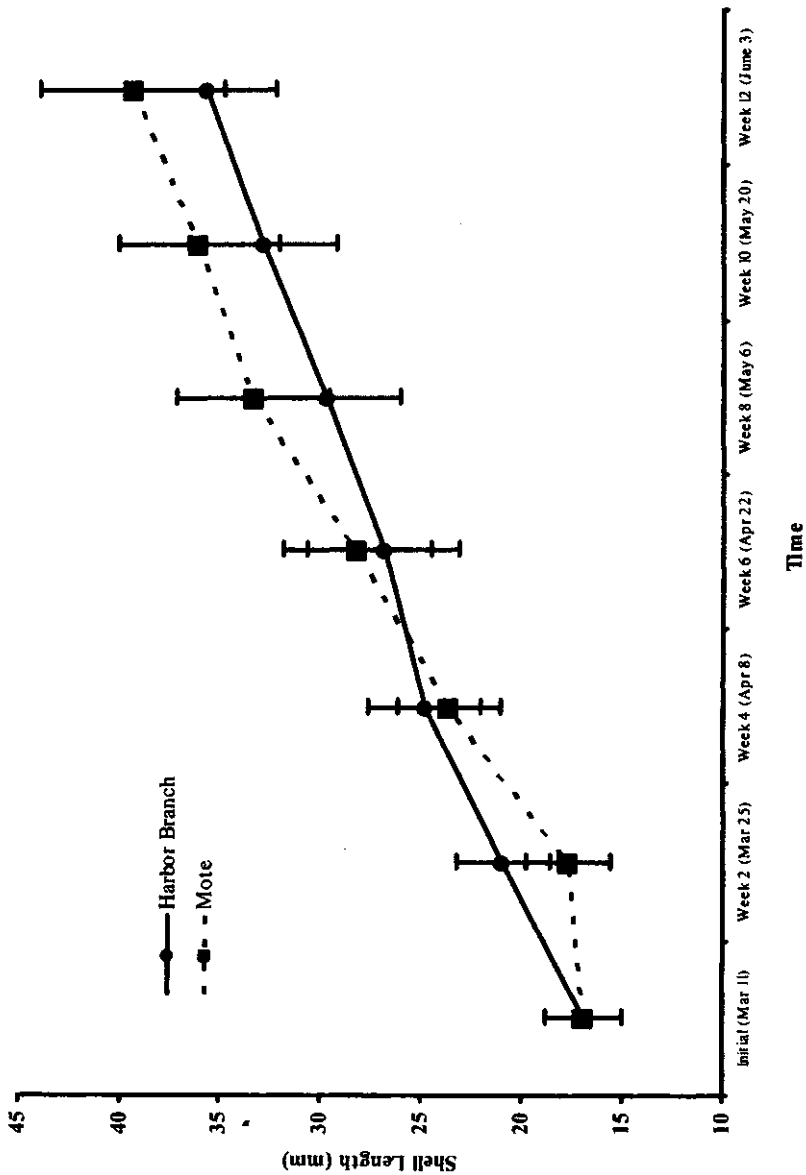
## RESULTS

The initial shell length of the conch was  $16.9 \pm 1.9$ , and the final length was  $35.7 \pm 0.4$  at Harbor Branch and  $39.4 \pm 1.5$  at Mote (Figure 1). The overall growth rates during the 12 week study were high at the two sites: 0.22 mm/day at Harbor Branch, and 0.27 mm/day at Mote. The conch grew significantly faster at Mote ( $p < 0.0001$ ) and the survival was higher at Harbor Branch (83 % compared to 70 % at Mote). The initial density in all replicates at each site was 75 conch/m<sup>2</sup>. The final density at Harbor Branch was 75 conch/m<sup>2</sup> (all dead conch were replaced), and the final stocking density at Mote was 55 conch/m<sup>2</sup> (not all dead conch were replaced).

Water quality parameters remained stable at both sites (Table 1). Temperature remained relatively constant throughout the experimental period, and therefore did not appear to influence the growth rates (Figure 2).

The initial wet weight of the conch was  $0.4 \pm 0.1$  and  $0.4 \pm 0.0$  at Harbor Branch and Mote, respectively (Table 2). The final weight of the conch (meat and shell) in the Harbor Branch troughs was  $5.2 \pm 0.1$ , and the final weight was  $7.2 \pm 0.8$  in the Mote troughs. At the end of the experiment, the conch grown at Mote were significantly ( $p < 0.0001$ ) heavier than the conch grown at Harbor Branch.

The total amount of food fed to all of the replicates at Harbor Branch was 2,043 g, which resulted in a feed conversion ratio (FCR) of 1.3. There was a total of 4,434 g fed to the conch in the Mote troughs, which resulted in an FCR of 2.2 (Table 2).



**Figure 1.** Juvenile Florida fighting conch shell length growth curve from March 11– June 3, 2003 at Harbor Branch Oceanographic Institution in Ft. Pierce, FL and Mote Marine Laboratory in Sarasota, FL (mean  $\pm$  sd, n = 3)

**Table 1.** Water quality parameters during the experimental period, March 11 - June 3, 2003 (mean  $\pm$  sd, n = sample size).

	Harbor Branch	Mote
Temp ( $^{\circ}$ C)	26.7 $\pm$ 2.7 (85)	26.4 $\pm$ 1.0 (85)
Salinity (ppt)	31.6 $\pm$ 1.3 (39)	34.9 $\pm$ 2.0 (85)
pH	7.9 $\pm$ 0.1 (39)	8.2 $\pm$ 0.1 (85)
Dissolved Oxygen (mg/L)	6.73 $\pm$ 0.41 (29)	6.2 $\pm$ 0.6 (85)
Ammonia (mg/L)	0 (6)	0 (6)
Nitrite (mg/L)	0 (6)	1.4 $\pm$ 1.5 (5)
Nitrate (mg/L)	2.2 $\pm$ 1.9 (6)	0.6 $\pm$ 1.3 (5)
Ca <sup>+</sup> ion Concentration (mg/L as CaCO <sub>3</sub> )	784 $\pm$ 325.6 (3)	482 (1)

**Table 2.** Weight gain and feed conversion ratio for juvenile Florida fighting conch during the experimental period, March 11 - June 3, 2003 (mean  $\pm$  sd, n = sample size).

	Harbor Branch	Mote
Initial wet weight (g)	0.4 $\pm$ 0.1 (327)	0.4 $\pm$ 0.0 (420)
Final wet weight (g)	5.2 $\pm$ 0.1 (327)	7.2 $\pm$ 0.8 (306)
Total wet weight gained (g)	4.8	6.8
Rate of wet weight gain (g/day)	0.06	0.08
Initial no. of conch	327	420
Final no. of conch	327	306
Total amount of food (g)	2043	4434
Feed conversion ratio	1.3	2.2

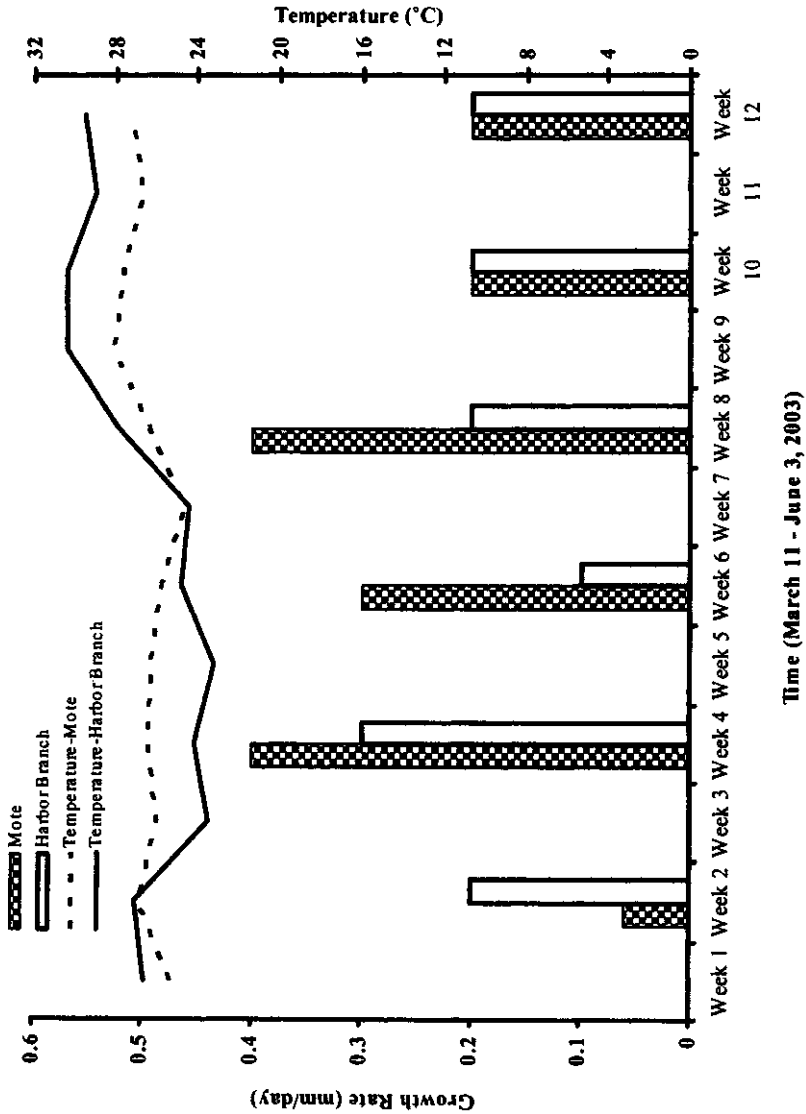


Figure 2. Growth rates at both sites are shown in comparison to water temperature for the 12 week experiment (March 11 – June 3, 2003)

## DISCUSSION

The overall growth and survival rates of the Florida fighting conch were high in the recirculating systems at both sites. It appears that the type of water, natural or artificial seawater, does not influence growth and survival as long as the major parameters (temperature, salinity, pH, and dissolved oxygen) are maintained.

However, stocking density does play a role in growth rate. Conch grew significantly faster at 55 conch/m<sup>2</sup> at Mote (0.27 mm/day), as compared to conch stocked at 75 conch/m<sup>2</sup> at Harbor Branch (0.22 mm/day). A previous experiment with juvenile Florida fighting conch resulted in a 0.16 mm/day growth rate when stocked at 125 conch/m<sup>2</sup> (Gordon Unpub. data). These growth rates are faster than the growth rates for queen conch (0.13 mm/day) grown in the same recirculating system at 75 conch/m<sup>2</sup> (Spring In press).

This experiment supports that Florida fighting conch can be grown in recirculating systems at different sites with different water sources. Experiments are continuing at Harbor Branch with juvenile queen conch to establish growout criteria that aid in shell strength and faster growth rates for food and restocking purposes.

## ACKNOWLEDGEMENTS

The authors would like to thank the Disney Wildlife Conservation Fund for their financial support for this experiment. This is Harbor Branch Oceanographic Institution contribution number 1537.

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