

Effects of Different Types of Substrate on Growth and Survival of Juvenile Spotted Babylon, *Babylonia areolata* Link 1807 Reared to Marketable Size in a Flow-through Seawater System

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Abstract

Hatchery-reared juvenile spotted babylon, *B. areolata*, with initial mean shell length of 12.7±0.4 mm (n = 20), were cultured to marketable size for 180 days in a flow-through seawater system. Five types of substrates namely; fine sand, coarse sand, mud, small shell fragments, and no substrate as control were used to examine their effects on the growth and survival of juvenile spotted babylon. No difference in growth and survival was observed among juveniles reared with the four substrates treatments except those under the control of no substrate treatment. Survival exceeded 90% in all treatments.

Introduction

The spotted babylon *B. areolata* is a gastropod mollusk cultured in Thailand. It is abundant and widely inhabits the littoral regions in the Gulf of Thailand, especially muddy sand areas not exceeding 10 to 20 m in depth. *B. areolata* spawns year-round, with a maximum peak from March to May. Size and age at maturity are 40.0 mm and 1 year old, respectively (Singhagraiwan 1996). The life history of this species is characterized by the presence of eggs contained in capsules laid on sand substrates; embryos develop inside the capsules, emerging as planktonic veligers seven days after the capsules are deposited. Larvae are competent to metamorphose within 18 days after hatching. The metamorphosed larvae are benthic and spend most of their time immobile and partially buried in the sand, although they are capable of movements when offered a prey or confronted by a predator (Chaitanawisuti and Kritsanapuntu 1997).

Spotted babylon spend much of their life buried in sand and their distribution is limited by the substrate in their natural habitat (Panichasuk 1996). Several methods have increased the per unit production (no./m²) of babylon: increased size at stocking, increased stocking densities, size grading animals prior to stocking and selective harvesting during growing-out. Therefore, one variable that may result to optimum growth and survival within the rearing tanks is the substrate. However, adding substrate to the nursery system may increase maintenance time and therefore increase production costs. This research was designed to evaluate the effects of different types of substrate on growth and survival of juvenile spotted babylon *B. areolata* reared to marketable size in a flow-through seawater system.

Materials and Methods

Preparation of animals

Hatchery-reared juvenile spotted babylon *B. areolata* were produced from a single batch of larvae cultured according to methods described by Chaitanawisuti and Kritsanapuntu (1997). Broodstock spotted babylon with a mean shell length of 60.0 ± 0.3 mm (n = 25) were held in 2.0 x 0.5 x 0.8 m spawning tanks supplied with flow-through ambient seawater (10 l-min). Egg capsules were collected and placed in plastic baskets of 0.5 cm mesh size and submerged in 500 l cylindrical hatching tanks containing filtered (1 mm pore size) ambient aerated seawater. Water temperature and salinity ranged from 28 to 29°C and 30 ppt, respectively. Water was replenished daily until hatching. After hatching, the veligers were fed twice daily with a 1:1 mixture of 2.0×10^6 cells-ml of a mixture of *Isochrysis galbana* and *Tetraselmis* sp (09:00 and 17:00 h).

Spotted babylon larvae were competent to metamorphose within 18 days after hatching. They settled on the clear bottom of the larval rearing tanks at a mean shell length of 1.52 ± 0.04 mm (n = 30). Newly settled juveniles were then harvested and placed in 500 l cylindrical nursery tanks supplied with flow-through ambient natural seawater (5 l-min). The bottom of the nursery tank was covered with a 1 cm layer of fine sand (100 to 150 mm mean grain size) as substrate. Juveniles were fed with fresh meat of the carangid fish *Selaroides leptolepes* once daily (09:00 h) and reared until they averaged 10 to 15 mm shell length. They were then used for the growth experiment.

Substrate experiments

The experiment was conducted for 180 days from January to June 1998 at the hatchery of Sichang Marine Science Research and Training Station, Chulalongkorn University, located on Sichang Island, the inner part of the Eastern Gulf of Thailand. The snails used for the experiment were graded to an average shell length of 12.7 ± 0.4 mm (n = 20) and divided into three replicate batches of five substrate treatments. They were reared in 1.5 x 0.5 x 0.3 m (L:W:H) indoor rectangular rearing tanks supplied with flow-through ambient natural seawater (5 l-min⁻¹). The bottom of

the nursery tank was covered with a 5 cm layer of five substrate treatments as follows: fine sand (100 to 150 mm mean grain size), coarse sand (500 to 1000 mm mean grain size), mud, small shell fragments (>1.0 mm mean grain size), and no substrate as control. The substrate was changed at 60-day intervals for all treatments and rearing tanks were then cleaned with natural seawater jet flushing after removing snails from the rearing tanks. The animals were placed in clean rearing tanks during this period. Water temperature and salinity ranged from 28 to 29°C and 30 ppt, respectively. The initial stocking density was 100 juveniles per m² to minimize effects of crowding on growth and survival. The juveniles were fed *ad libitum* with fresh meat of the carangid fish, *S. leptolepis*, once daily (09:00 h). Monthly measurements; total body wet weight and shell length (maximum anterior-posterior distance) were made individually for all animals in each substrate treatment. The absolute growth rates in shell length (G) were calculated from the average monthly increments in shell size according to the formula:

$$G = (L_1 - L_0) / (t_1 - t_0)$$

where L_1 and L_0 = shell length at times t_1 and t_0 , respectively. Final individual body weight gain and shell length increment was calculated from the differences in mean body weight and shell length between the beginning and the end of the experiment. The number of dead individuals was recorded at monthly intervals, and an average monthly survival rate was calculated.

Statistical analyses

All statistical analyses were performed using the SPSS/PC + Statistical Package for the Social Sciences. Differences in shell length, body weight, survival and growth rate of all treatments were determined by a one-way analysis of variance (ANOVA) at $\alpha = 0.05$. Turkey's studentized range test ($\alpha = 0.05$) was used to determine statistical differences among treatments in length and weight.

Results

The average monthly absolute growth rate in shell length and body weight of juvenile *B. areolata* did not differ significantly ($p > 0.05$) throughout the 180 days in any treatment. Growth patterns showed similar trends among the five treatments (Figs. 1 and 2). No difference in growth of shell length or body weight of juvenile *B. areolata* was observed when cultured with the four substrates and no substrate but the fine sand seemed to show the best results, followed by coarse sand, small shell fragments, mud and no substrate, respectively. The average growth rate in shell length ranged from 3.58 mm·mo⁻¹ for no substrate to 4.15 mm·min⁻¹ in fine sand, and 1.06 g·min⁻¹ for no substrate to 1.15 g·min⁻¹ in fine sand for the body weight.

At the end of the experiment, the final mean shell length of spotted babylon ranged from 34.20 mm in no substrate to 37.59 mm in fine sand, and 6.37 g in no substrate to 10.08 g in fine sand for the body weight (Table 1). The average monthly survival rates of juvenile *B. areolata* did not differ significantly ($p > 0.05$) throughout the six month period in any of the treatments. The average monthly mortality gradually decreased over the first two months and thereafter, no mortality took place in any of the treatments throughout the culture period. At the end of the experiment, final survival of spotted babylon equaled or exceeded 90% for all treatments (Table 1).

Discussion

The results showed no difference in growth of shell length or body weight of juvenile *B. areolata* when cultured with the four substrates and no substrate. Final survival of spotted babylon equaled or exceeded 90% for all treatments. These data indicate that substrate type may not be a critical factor for spotted babylon growth and production. If substrate types are taken into consideration, the coarse sand and small shell fragments look practically very interesting. The fine sand substrate was more difficult to clean than those of treatments 2 and 4. The coarse sand substrate would be preferable for a large-scale production of spotted babylon culture. Chaitanawisuti ad Kritsanapuntu (1998) reported that the highest growth rate in shell length and body weight of juvenile *B. areolata* was obtained

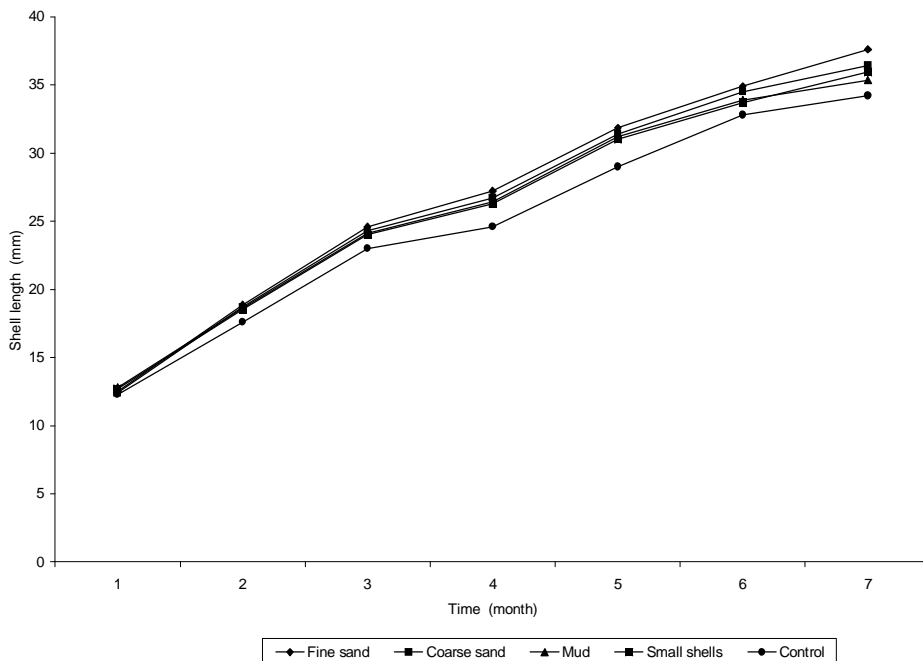


Fig. 1. Growth in shell length of juvenile spotted babylon *B. areolata* cultured with four types of substrates in flow-through seawater system.

from the culture system with sand substrate and flow-through seawater, whereas the lowest growth was in the no sand substrate and static seawater. The mud substrate may have potential for the polyculture of spotted

Table 1. Average growth parameters of juvenile babylon, *B. areolata* cultured under five types of substrates in flow-through seawater system; there were no significant differences ($p > 0.05$) in any of growth parameters as determined through analysis of variance.

Growth parameters	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Control 5
Initial shell length (mm)	12.50 ± 0.3	12.40 ± 0.4	12.80 ± 0.1	12.70 ± 0.2	12.20 ± 0.2
Initial body weight (g)	0.35 ± 0.1	0.32 ± 0.2	0.30 ± 0.1	0.36 ± 0.4	0.34 ± 0.3
Final shell length (mm)	37.59 ± 1.8	36.40 ± 2.3	35.33 ± 1.2	35.95 ± 3.2	34.20 ± 2.4
Final body weight (g)	10.08 ± 1.0	9.47 ± 0.8	8.25 ± 1.3	9.12 ± 1.5	6.37 ± 0.6
Final length increment (mm)	24.89 ± 2.3	23.70 ± 1.7	22.63 ± 2.6	23.25 ± 2.1	21.50 ± 2.8
Final weight gain (g)	9.78 ± 2.1	9.17 ± 1.6	7.95 ± 2.3	8.82 ± 1.9	6.07 ± 2.0
Growth rate (mm·mo ⁻¹)	4.15 ± 0.6	3.95 ± 1.1	3.77 ± 1.4	3.89 ± 0.6	3.58 ± 1.5
Growth rate (g·mo ⁻¹)	1.68 ± 1.2	1.58 ± 0.8	1.38 ± 1.2	1.52 ± 1.1	1.06 ± 1.8
Final survival (%)	98.00 ± 1.6	94.00 ± 2.0	92.00 ± 1.8	94.00 ± 1.4	90.00 ± 1.3

Treatment 1: fine sand
Treatment 2: coarse sand
Control: no substrate

Treatment 3: mud
Treatment 4: small shell and gravel

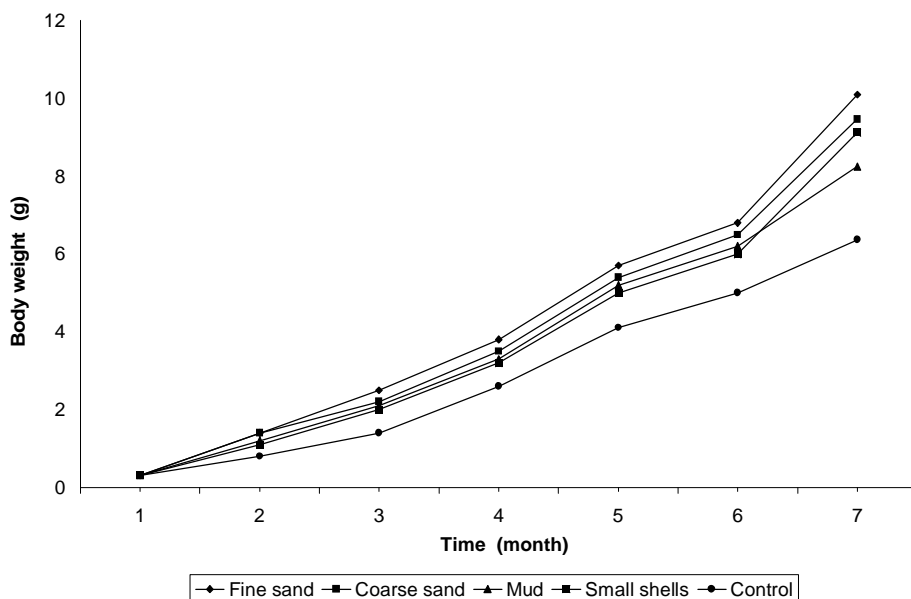


Fig. 2. Growth in body weight of juvenile spotted babylon *B. areolata* cultured with four types of substrates in flow-through seawater system.

babylon in marine shrimp (*P. monodon*) and fish (*L. calcarifer*) ponds. This may allow the reuse of many abandoned shrimp farms along the coastal areas of the Gulf of Thailand. This study obtained good results in growth and survival compared to the studies of Raghunathan et al. 1994, Singhagraiwan 1996, and Chaitanawisuti and Kritsanapuntu 1999. Raghunathan et al. (1994) reported that the average growth rate of juvenile *B. areolata* fed with clam *M. meretrix* was $0.43 \text{ mm}\cdot\text{mo}^{-1}$ under hatchery condition. Singhagraiwan (1996) reported that the growth rate of juvenile *B. areolata* fed with carangid fish meat for one year was $3.14 \text{ mm}\cdot\text{mo}^{-1}$ in shell length while food conversion ratio was 1.27:1 through 120 days from an initial length of 16.50 mm. Chaitanawisuti and Kritsanapuntu (1998) reported that shell growth rate in shell length and bodyweight of juvenile *B. areolata* fed with fresh meat of carangid fish *S. leptolepis* were $2.9 \text{ mm}\cdot\text{mo}^{-1}$ and $1.9 \text{ g}\cdot\text{mo}^{-1}$, respectively. This compares with 3.84 to 3.98 and FCR of 1.53 in this experiment. More information related to the energy requirements, nutritional requirements, water quality, digestibility, assimilation, metabolic rate, and feeding cost of spotted babylon must first be developed before commercial aquaculture can proceed.

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