MASS CULTURE OF *CHICOREUS RAMOSUS* (L., 1758) (GASTROPODA : MURICIDAE)

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ABSTRACT

Mass culture of the giant muricid snail *Chicoreus ramosus* was performed at Prachuap Khiri Khan Coastal Aquaculture Development Center using egg capsules collected from nature as well as from spawning in broodstock holding tanks. Larval development, growth and survival rates of the larvae and juveniles from different sources of eggs were studied. Veliger larvae began metamorphosis on the third week, with a survival rate ranging from 1.75 to 99.5 % from hatching. The average rate of survival from settlement to 2 months old juveniles was 5.12 %, and the size ranged between 1.3-10.9 mm. High mortality occurred after settlement due to heavy cannibalism. From several thousand egg capsules collected from September 1992 to January 1993, approximately 50,000 juveniles of 5-10 mm shell length have been produced. Provided with flowing sea water and sufficient food , juveniles reared in concrete raceways could attain the maximum size of 2.84, 10.9, 40.1, 77.0, and 100.0 mm shell length at the ages of 1, 2, 4, 7, and 12 months old, respectively. Culture techniques leading to a successful mass production of the juveniles are described.

INTRODUCTION

Chicoreus ramosus L., 1758 has been successfully cultured in Thailand by Tropical Marine Mollusc Programme (TMMP) researchers since 1991 (Steenfeldt and Bussarawit, 1992; Nugranad, 1992). The results obtained showed that the species had potential in aquaculture or sea-farming. Therefore, based on the previous success in larval and juvenile rearing, mass culture of *Chicoreus ramosus* was performed at Prachuap Khiri Khan Coastal Aquaculture Development Center to produce a number of juveniles for further research on sea-farming of the snails under the TMMP project.

This report describes the culture methodology and results on larval and juvenile rearing accomplished during the period from September 1992 to January 1993.

MATERIALS AND METHODS

Broodstocks and Egg Capsules

Egg capsules used in this culture experiment were spawned in natural habitats or in broodstock holding tank. The natural spawned egg capsules were collected from Phuket areas on the Andaman coast, and from Bangsapan, Prachuap Khiri Khan, in the Gulf of Thailand. They were transported in filtered sea water provided with aeration in fibreglass tanks, and delivered to the hatchery in Prachuap Khiri Khan.

Eggs collected from spawning in broodstock holding tank were attained from adult *C. ramosus*, which were collected from nature and kept in concrete raceways. The snails were provided with flowing sea water and sufficient food for several weeks or months prior to spawning.

Egg capsules were cleaned in filtered sea water and soaked in fresh water for 30-60 seconds to get rid of microorganisms contaminating the egg capsule surface. The capsules were put in plastic basket placed in 300 l fibreglass tanks filled with 1 μm filtered sea water provided with adequate aeration. Development of the eggs was observed macroscopically every day. Abnormal or decaying eggs, observed by abnormal change in capsule colour, were discarded. The sea water in the hatching tanks was

replenished every day until hatching began. Thereafter, daily changing of sea water was performed simultaneously with collecting of veliger larvae.

Larval rearing

Newly hatched veligers were collected using nylon mesh sieves with a pore size of 200 μm. The number of hatched veligers was determined by sampling and counting. The veligers were then suspended in clean rearing tanks filled with 1 μm filtered sea water, 32-34 ppt salinity. Larva rearing was performed in either fibreglass tanks of 300-1000 l capacity, or 5 tons concrete raceways.

Larvae were fed with mixed unicellular microalgae, *Isochrysis galbana*, *Chaetoceros calcitrans* and *Tretraselemis* sp. at a total density of 10,000-20,000 cells/ml. Mixing ratio of the algae was approximately 2:2:1 respectively.

Development and growth of the larvae were observed under the microscope. Growth of the larvae and juveniles were determined by measuring the total shell length (the length from apical to the end of the siphonal canal). Survival rate was determined once a week.

Settlement and juvenile rearing

When the veligers have developed into "ready-to-set stage", they were handled in 3 different ways:

A. Being left in the fibreglass rearing tanks provided with gentle aeration, and sea water replenished every other day.
B. Being transferred to the 300 l double layers fibreglass rearing tanks, provided with flowing sea water.
C. Being reared in raceways, where slightly running sea water was provided.

The larvae were left to settle on the surface of the rearing tanks. No other substrate was provided particularly for settlement, except the collectors for bivalve spats and barnacles, used as food.

Live food was used in all culture trials. Microalgae was provided daily in the rearing tanks until no swimming veliger was observed. Newly settled bivalves and barnacles were used for feeding the newly settled juveniles, following the method explained by Steenfeldt and Bussarawit (1992). The bivalve spats and barnacles were collected on pieces of old PVC pipes or plates, tile plates and oyster shells which were submerged in the sea at Prachuap Khiri Khan Bay. The collectors were washed and soaked in fresh water before entering the rearing tanks.

After complete metamorphosis, juveniles were reared in sand filtered sea water and fed young bivalves, such as small natural collected pearl oyster (*Pinctada* spp.), rock oysters (*Crassostrea* and *Saccostrea* spp.) and flat oysters (*Isognomon* sp.). Rocks and PVC shelters were provided in the rearing tanks to reduce cannibalism.

RESULTS AND DISCUSSION

Thousands of egg capsules were employed in the mass culture trials. Natural egg masses collected from the Phuket area were obtained in late September 1992, and the one from Bangsapan was obtained in December 1992. Spawning in broodstock holding tank began October 1992 and continued until January 1993. Timing of larval and juvenile rearing for each group is shown in Table 1.

Table 1. Sources and collecting periods of *Chicoreus ramosus* eggs used in mass culture trials.

Source of eggs	Date obtained	Hatching initiated	Start of settling
Phuket	Sep. 1992	28/9 92	12/10 92
Bangsapan	Dec. 1992	2/1 93	12/1 93
Raceways	Oct. 1992 - Jan. 1993	8/11 92	20/11 92

Larval Development

There were no sharp differences in larval development among the larvae hatched from egg capsules from different localities. After hatching, the veliger larvae spent 12-18 days to reach settlement. Metamorphosis was accomplished within 3 weeks in every batch, which was about 1 week faster than the previous experiment in 1991 reported by Nugranad (1992). This improvement could be due to the more appropriate rearing techniques, especially proper feeding during settlement.

Survival rate

Survival rates of the veligers ranged from 1.75% to as high as 99.5%, with an average rate of 36.56% from hatching to settlement. Although most of the larvae were reared very densely, they were able to survive very well in many batches provided with careful handling and proper conditions, *i.e.* good water quality, good food, good larvae and right rearing methods. However, several rearing batches suffered bacterial infection which led to mass mortality of the larvae. Antibiotic, sulfamethazine 35 ppm, was applied to reduce bacterial number during the early larvae stage.

The average rate of survival from settlement to 2 months old juveniles was 5.12%, with sizes ranging between 1.3-10.9 mm. Mortality after settlement was rather high due to cannibalism. Throughout these mass culture trials, a production of approximately 50,000 juveniles, 5-10 mm shell length, was obtained.

Survival of the larvae from different sources of eggs.

Lowest survival existed in the group obtained from Phuket, while the highest was in the raceway samples. Mean survival rates of the veligers from eggs collected from nature, both from Phuket and Bangsapan, were lower than the ones collected in the broodstock maintaining raceway (Table 2). This difference is probably due to stress on the embryonic development from the transportation of the egg capsules. The longer the distance was, the more stress the eggs would undergo.

Survival of the larvae in different stocking densities.

In this present mass culture, the stocking densities of the veligers were not tested experimentally due to a limited number of rearing tanks. The veligers were reared in various stocking densities according to the number hatched each day. In the fibreglass rearing tanks, the initial densities ranged from 47.5 to 294.7 larvae/l. Most of the larvae were subjected to high stocking densities in the rearing tanks (> 100 larvae/l). However, high survival rate was accessible in many batches, and the larvae could obtain good growth compared to previous culture trials (Nugranad, 1992; Steenfeldt and Bussarawit, 1992). Data on stocking densities of *Chicoreus* larvae in 300-1000 l fibreglass rearing tanks, and the result on survival rates in each trial is shown in Table 3.

In 5 tons concrete raceways, the larvae were maintained at lower densities (30-50 larvae/l), but they encountered rather low survival compared to the ones reared in the fibreglass tanks. It was not possible to measure the survival rate in the raceways accurately, but it was estimated to be 20 -30% from veliger 1 day old to settlement 15 days old.

The results from Table 3 show that survival rate might not depend primarily on the stocking density. The lowest survival (1.75%) occurred with very high density of larvae (274.6 larvae/l), but batches with higher densities, 281.0 and 294.7 larvae/l yielded better survival rates of 12.87 and 12.67 respectively. To determine whether survival was related to stocking density, the data was compiled into 3 groups based on stocking densities: <100 larvae/l, 100-200 larvae/l, and >200 larvae/l (Table 4). The mean survival rate was not significantly different between the groups.

Table 2. Survival rates of *Chicoreus ramosus* larvae from various sources of eggs.

Source of eggs	No. of Batches*	No. of veliger day 1	No. settling day 12-18	% survival min.	max.	average
Phuket	6	566,400	49,500	1.75	54.40	8.90
Bangsapan	3	116,400	21,080	11.95	45.65	18.10
Raceways	21	1,739,100	811,100	19.92	99.50	46.63
Total/Avg.	30	2,411,900	881,680			36.56

Note: * The batches with mortality higher than 75% during the first week were discarded, thus, those numbers are not included in the Table.

Table 3. Data on larval rearing of *Chicoreus ramosus* with different stocking densities in fibreglass tanks.

Trial No.	Start date	Tank Capacity (l)	Stocking density (Larvae/l)	Survival rate (%)
1	29/9 92	300	94.7	32.02
2	2/10 92	500	47.5	22.31
3	6/10 92	300	294.6	12.67
4	7/10 92	500	210.9	7.97
5	8/10 92	300	174.9	21.34
6	12/10 92	1000	146.9	20.94
7	13/10 92	500	170.6	6.56
8	13/10 92	500	281.0	12.87
9	16/10 92	1000	97.0	4.95
10	18/10 92	1000	274.6	1.75
11	13/12 92	500	61.6	59.18
12	17/12 92	300	130.7	20.07
13	18/12 92	500	89.6	50.50
14	21/12 92	300	93.3	20.00
15	29/12 92	500	154.2	89.65
16	2/1 93	500	68.6	65.93
17	3/1 93	300	73.5	96.13
18	3/1 93	300	52.5	45.65
19	6/1 93	300	128.5	91.61
20	7/1 93	300	126.7	49.30
21	7/1 93	1000	59.7	11.95
22	8/1 93	300	81.9	75.94
23	9/1 93	500	130.9	16.93
24	11/1 93	300	226.8	22.93
25	12/1 93	500	272.0	28.29
26	14/1 93	300	136.5	16.47
27	15/1 93	500	128.7	26.67
28	19/1 93	1000	257.8	26.38
29	20/1 93	300	105.5	99.56
30	21/1 93	300	144.7	24.52
31	23/1 93	1000	160.7	55.53
32	24/1 93	1000	138.3	46.81
33	26/1 93	300	253.6	87.40
Average			147.6	38.51

Growth

Growth of the juveniles depended mainly on available food. Provided with enough food, the juveniles raised in concrete raceways could attain the size of 100 mm within 1 year. Growth of the juveniles from mass culture is shown in Tab. 5.

Table 4. Comparison of larval survival in different stocking densities.

Stocking density	No. of Batches	% survival, day 1 to settlement min.	max.	mean
< 100	11	4.95	96.13	44.05
100-200	14	6.56	99.56	41.85
>200	8	1.75	87.40	25.03
Total/mean	33			38.51

Table 5. Growth of juvenile *Chicoreus ramosus* from mass culture.

Age (months)	Shell length (mm) min.	max.	mean	Growth increment mm/month
1	1.28	2.84	2.09	-
2	1.35	10.90	4.69	2.60
3	17.75	40.10	32.22	27.53
4	21.00	52.70	43.13	10.91
5	35.00	65.90	52.39	9.26
6	44.30	71.90	59.58	7.19
7	50.70	77.00	66.77	7.19
8	52.00	89.30	71.04	4.27
9	60.50	96.50	75.12	4.08
12	62.40	100.00	78.15	1.01

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