

Spawning characteristics of *Babylonia areolata* (Neogastropoda: Buccinidae)

Hua Ngoc Phuc, Nguyen Thi Xuan Thu, Mai Duy Minh, Phan Dang Hung & Kieu Tien Yen



Hua, N.P., T.X.T. Nguyen, D.M. Mai, D.H. Phan & T.Y. Kieu. 2001. Spawning characteristics of *Babylonia areolata* (Neogastropoda: Buccinidae). - Phuket Marine Biological Center Special Publication 25(1): 161-165.

The Babylon snail (*Babylonia areolata*) is a gonochoristic, internally fertilized gastropod. Sex ratio of snails with a length of 35-50 mm was 1:1.3 (M:F) and 1:2.6 in the largest snails. Seven months after hatching, snails had reached 35-42 mm in length and began to spawn. Adult snails kept in cement pond deposited egg capsules throughout the year with spawning peaks in March and July. Vasiform transparent egg capsules were laid during the night and attached to the sandy bottom or coarse substratum in pond. Each breeder deposited from 18 to 75 (average 38) egg capsules. Egg capsule measured 30.6 x 9.9 mm on average and contained an average of 743 eggs in jelly-like fluid. About 6 days after spawning, bilobed veliger larvae hatched out. Veliger larvae spent 12-14 days of free swimming stage and metamorphosed to crawling juveniles after 16-18 days. Average fertilization and hatching rates were 83 % and 90 % respectively.

Hua Ngoc Phuc, Nguyen Thi Xuan Thu, Mai Duy Minh, Phan Dang Hung & Kieu Tien Yen. The Third Research Institute for Aquaculture (RIA 3), 33 Dang Tat Street, Nha Trang, Vietnam.

E-mail Nguyen Thi Xuan Thu: thuabmm@dng.vnn.vn
E-mail Hua Ngoc Phuc: hmgphuc@yahoo.com

INTRODUCTION

Babylonia areolata has high economical value as seafood. In Vietnam, babylon snails inhabit the coast of Thanhhoa, Nghean, Hue, Quangngai, and are particularly abundant in Binhthuan. At present, the amount of babylon snails harvested from nature is decreasing rapidly due to increasing demands from domestic and foreign markets. Therefore, studies related to breeding biology and larval development are essential for sustained utilization of this stock. Evolving techniques for mass seed production would encourage fishermen gradually to take up large-scale commercial culture.

MATERIALS AND METHODS

The snail breeders were collected naturally

from the littoral region of Phanthiet. The mean length was 70.5 mm and the weight 51.9 g. The snails were kept in outdoor cement pond at a density of 10 individuals per m². Sea water was changed daily from 50 to 80 %. The snails were fed fish, bivalves and cuttlefish at a rate of 5-8 % of their total body weight. The fecundity of snails was observed monthly by looking at separate clusters of egg capsules. The size of egg capsules was measured and the numbers of eggs in randomly-selected capsules were counted. The fertilization and larval development were observed under a microscope during the period of incubation.

The newly hatched veliger larvae were reared in 0.7-1.0 m³ cement ponds and fed on mixed microalgae. Larval growth was noted. When larvae metamorphosed into the

crawling stage, fish and bivalve flesh was given as food. 50-80 % of the water was changed daily. Snails were cultured at a density range of 3000-5000 individuals per m².

RESULTS

External shell and morphological characteristics. - Spirally conical regular shells of *B. areolata* are step-like forms. The height of the spire is equal to half the total shell length. They show characteristic colour patterns consisting of brownish or violet parallelogram-shaped patches on the white background of the shell. There are three rows of colour patches on the body whorl and one on each whorl of the spire. The operculum is semicircular and the inner shell is porcelain-white. The shell columella is hollow (Nguyen Chinh 1996).

Sex characteristics. - The morphological differences between males and females are as follows: Shells of males when observed thoroughly were coarser than those of female snails. Male snails had a penis at the base of the right tentacle, consisting of a small elastic crease derived from the gonad and with a thin duct. Female snails have a ventral pedal gland under the foot-side, 1/4 of foot length from their heads. The gland is used to mould and harden the egg capsules during deposition.

Sex ratio. - There were 106 females and 64 males among 170 specimens observed. The sex ratio therefore was 1:1.6. It is possible to distinguish sexual features when snails reach a length of 35-50 mm under culture conditions, with a sex ratio of 1:1.3. Therefore, there are more females than males in the population.

Spawning characteristics. - After 7 months of culturing from veliger larvae, snails reached a length of 35-42 mm and began to spawn. However, egg capsules laid on the first occasion were small (average 12.1 x 4.3 mm) and contained few eggs (80-169 eggs per capsule). It was only possible to identify sexual features after that time.

Spawning behavior. - Adult snails often mate in the evenings and at night 2-3 days before spawning. Vasiform transparent egg capsules are usually laid during the night but

sometimes spawning begins in the afternoon or finishes early the next morning. Before depositing, snails group at the bottom of the pond and attach egg capsules to the sandy substrate to make separate clusters of capsules. At the beginning, eggs are nursed in the albuminoid fluid, which is a protein transformed under the influence of water to form egg capsules after being released from the females' bodies.

Fecundity. - The shape of egg capsules of *B. areolata* is inverted triangular. They are attached individually to sand grains by a long slender peduncle with an adhesive basal disc. The average measurements of egg capsules were 30.6 mm in length and 9.9 mm in width. Each capsule contained 170-1850 eggs, with an average of 743 eggs per capsule. By counting separate clusters of egg capsules, fecundity of individual spawners was determined as falling in the range of 18-75 capsules at one time (average 38 capsules per individual per spawning night).

Spawning season. - The largest numbers of egg capsules were found on spring tide nights. However, the relation between numbers of egg capsules and the lunar phase was not clear, since there was no tidal movement of water in the hatchery. Table 1 shows the results of culturing *B. areolata* breeders in the broodstock holding pond. The results of 12 months of research indicated that *B. areolata* laid egg

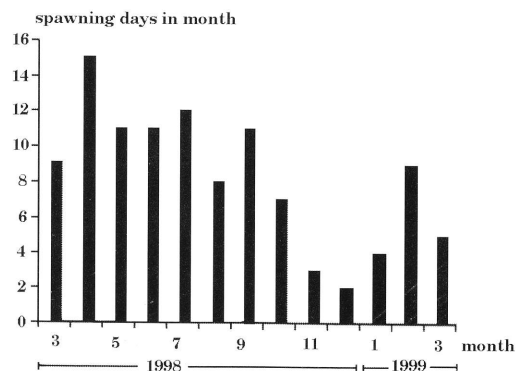


Figure 1. Number of days of spawning per month of *B. areolata* observed in a cement pond over 12 months.

capsules throughout the year with peaks in March and July. The highest spawning frequency was found in April 1998 (Figure 1).

Embryonic and larval development. - The fertilized eggs were spherical and about 242

μm in diameter. Fertilization occurred before laying and embryonic development took place inside the capsule. Cleavage and embryonic stages lasted for 48 hours. Table 2 shows the size of eggs, developing embryos, larvae and

Table 1. Results of culturing *B. areolata* breeders in the broodstock holding pond for 12 months from 19 March 1998.

Month	No. of brood stock	No. of egg capsules	Spawning days in month	Date of peak spawning per month			
				Date	No. of egg capsules	Tide	Lunar phase
Mar/98	104	10770	9	21/3	4897	Falling	2nd quarter
Apr/98	99	4150	15	26/4	987	Rising	1st quarter
May/98	96	5311	11	31/5	2425	Neap	Lastquarter
Jun/98	95	7119	11	11/6	1618	Spring	2 days after full moon
Jul/98	95	13947	12	20/7	4300	Spring	Lastquarter
Aug/98	87	7138	8	15/8	2231	Falling	Last quarter
Sep/98	83	4895	11	14/9	1720	Neap	3rd quarter
Oct/98	78	1611	7	3/10	425	Spring	1 day before full moon
Nov/98	-	573	3	15/11	316	Rising	Last quarter
Dec/98	-	1682	2	10/12	1500	Spring	Last quarter
Jan/99	-	2156	4	23/1	840	Falling	1st quarter
Feb/99	-	4260	9	10/2	1100	Rising	Last quarter
Mar/99	-	3080	5	12/3	1400	Spring	Last quarter

Table 2. Stages of embryonic and larval developments of *Babylonia areolata*.

Age	Developmental stage	Length ($\mu\text{m} \pm \text{s.d.}$)	Width ($\mu\text{m} \pm \text{s.d.}$)
0	Fertilized egg	242 \pm 3.46	242 \pm 3.46
3 to 4 hrs	First and second polar bodies	-	-
5 to 7 hrs	2 cells	-	-
8 to 12 hrs	4 cells	-	-
13 to 18 hrs	Morula	-	-
1 day	Endosperm	303 \pm 2.96	266 \pm 2.92
2 days	Gastrula	355 \pm 6.11	255 \pm 6.91
3 days	Trochophore	369 \pm 7.83	269 \pm 3.81
4 to 5 days	Veliger	419 \pm 3.85	270 \pm 3.79
5 to 6 days	Newly hatched veliger larvae	441 \pm 4.80	288 \pm 6.43
11 to 16 days	Metamorphosis	779 \pm 14.20	515 \pm 13.9
18 to 20 days	Juveniles	1160 \pm 18.31	860 \pm 15.52
22 days	Young snails	1660 \pm 17.29	1210 \pm 16.08

juveniles. The gastrula was oval in shape, of average diameter 355 μm . Fertilization rate was 83 % on average. After 60 hours, embryos changed into trochophores. Their bilobed vela were thick with short cilia and slowly revolved. As they developed the shells became longer, with rounded apices. The ciliated vela were large and thin like butterfly wings. The larvae were active with long transparent moving cilia. They measured 336 to 396 μm in length.

Veligers had shell lengths of 395 to 419 μm . They were characterized by colourless ovate, thin shells with opercula (apex and aperture was on one plane) and bilobed vela with dark yellow pigment spots. Eye spots and small feet were clearly visible. The internal organs formed and evolved asymmetrically. Larvae were very active with fast continuous movement inside the capsule. In conditions of water temperature of 26-27 °C, and salinity of 33-35 ‰, 6 days after spawning, larvae hatched out. Average hatching rate was rather high (90 %). When water temperature increased during incubation (29-31 °C), larvae hatched out after only 5 days, but many of them became heteromorphic and the hatching rate was lower.

Larval development. - Newly hatched larvae measured 435 to 440 μm in length. They were phototactic and planktotrophic. Digestive organs began to function and they could be fed on microalgae such as *Chlorella* sp., *Chaetoceros* sp., *Nanochloropsis* sp., and *Platymonas* sp. The movement of cilia on the velar lobes not only helps larvae to swim but also creates water currents, which bring food into their mouths. About 6-7 days after hatching, tentacles were visible and shells were thicker with one whorl of about 659 μm in length. On the 11th day, veliger larvae started to metamorphose with a spire of 2 whorls, elongate feet, disintegrated velar lobes and developed siphonal canals. After 18-20 days of swimming stage, larvae metamorphosed into juveniles which measured about 1160 μm . They settled to the bottom of tank and changed their diet of phytoplankton to

that of a carnivore.

Larval density and water temperature were 2 factors that greatly affected growth rate and duration of swimming stage. Provision of proper materials as substrate also stimulated larvae to metamorphose sooner and more synchronously.

DISCUSSION

Gonochorism is a common characteristic of most gastropods. The present study shows that *B. areolata* breeders mate 2-3 days before depositing egg capsules. The size at the first spawning and time from mating to depositing egg capsules have not been mentioned in previous studies and thus we have not been able to come to a clear conclusion.

Spawning of *B. areolata* in culture conditions occurred throughout the year with the largest numbers of egg capsules in March and July but very small numbers in rainy months. (In Vietnam these are from October to December, with low water temperatures and decreased salinity). Our description of spawning behaviour, egg capsule shape and larval morphology does not conform with the studies of Poomtong & Nhongmeesub (1996) on *B. areolata* in Thailand and Patterson *et al.* (1994) on *B. spirata* in India. The fecundity of snails increased with size of breeders and depended on their health and feeding. According to Poomtong & Nhongmeesub (1996), data on measurements of egg capsules, number of eggs in each capsule, and egg capsules laid by one female at one time were 27.8 x 8.3 mm, 400 and 25 respectively, lower than present results. This difference may be due to smaller breeders being used in their experiments (40.2-55.8 mm shell length), which were perhaps at their first spawning time. In addition, the egg diameter of *B. areolata* is smaller than that of *B. spirata*.

Among tropical species of family Buccinidae, indirect larval development is the dominant pattern (Patterson *et al.* 1994). It is characterized by large numbers of small eggs, small sized planktotrophic pelagic larvae and short period before metamorphosis into the

juvenile stage. According to Middelfart (1996) the muricid species *Thais tissoti* and *Morula granulata* exhibit the same developmental mode, and one female of *Chicoreus capucinus* deposited 24-28 egg capsules at one time and each capsule contained only 13 eggs and 786 yolk-spherules. Veliger larvae settle after 38 days. Our study also showed that the length of the swimming stage depends greatly on the larval density used in rearing experiments. Larvae metamorphosed completely into the crawling stage after 8-11 days at a density of approximate 100 individuals per litre while the process lasted more than one month at a density of 300 individuals per litre. Similar results were reported in Poomtong and Nhongmeesub's (1996) study where the larval density was 500 veligers per litre.

CONCLUSIONS

- *Babylonia areolata* is a gonochoristic marine gastropod. The sex ratio in a 35-50 mm size group was about 1:1.38 and 1:1.65 in larger sized snails. The appearance of the sexes can be identified when snails reach a range size of 35-42 mm long and spawn the first time.
- Snails often mate or deposit egg capsules in the evenings and at nights, especially on spring tide nights. Separate vasiform transparent egg capsules are attached to a sandy bottom. Each female lays about 38 egg capsules with about 743 eggs per capsule on average. Spawning occurs throughout the year with 2 peaks of egg numbers in March and July.
- Egg division, embryonic development to trochophore and veliger stages take place inside the egg capsules. Veliger larvae hatch out 6-7 days after spawning. Average fertilization and hatching are 83 % and 90 % respectively.
- Newly hatched veligers with bilobed vela measure 435 to 440 μm and are phototactic and planktotrophic. After 16-18 days of the

swimming stages, larvae begin to metamorphose into juveniles. They crawl at the bottom of tanks and feed as typical carnivores.

ACKNOWLEDGEMENTS

This study was carried out at Research Institute for Aquaculture No. 3, Nha Trang, Vietnam with financial support from the Vietnamese Ministry of Fishery. We wish to thank Dr. Alan Kohn, Professor of the University of Washington, U.S.A. for help in improving the manuscript, and Dr. Tan Koh Siang, Singapore, for comments to the first draft. We would also like to thank TMMP Director Dr. Jorgen Hylleberg for editing and the chance to attend the eleventh workshop in India.

REFERENCES

- Nguyen, Chinh, 1996. Some economical species of molluscs in coastal waters of Vietnam. - Technology-science publication, p. 44-45.
- Middelfart, P. 1996. Egg capsules and early development of ten Muricid gastropods from Thai waters. - Phuket Marine Biological Center Special Publication, 16: 103-130.
- Patterson, J., T. Shanmugaraj & K. Ayyakkannu, 1994. Salinity tolerance of *Babylonia spirata* (Neogastropoda: Buccinidae). - Phuket Marine Biological Center Special Publication, 13: 185-87.
- Poomtong, T. & J. Nhongmeesub, 1996. Spawning, larval and juvenile rearing of Babylon snail (*Babylonia areolata* L.) under laboratory conditions. - Phuket Marine Biological Center Special Publication, 16: 137-142.
- Shanmugaraj, T. & K. Ayyakkannu, 1996. Spawning and larval development of *Murex tribulus* L. (Prosobranchia: Muricidae) under laboratory conditions. - Phuket Marine Biological Center Special Publication, 16: 131-136.