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Studies on the status and feasibility of culturing spiral Babylon, *Babylonia spirata* in Tuticorin, Southeastern India

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Abstract—The fishing villages, Tharuvaikulam, Vellapatti, Thirespuram and Harbour Beach in Tuticorin coast of Southeastern India are identified as *Babylonia spirata* landing centers and studied for a period of 3 years (October 2002–September 2005). The landings were exclusively as by-catches in crab nets and higher landings were observed during the pre-monsoon period. 200 brooders collected from wild for culture experiments and maintained in the laboratory were sexed and measured for their length, width, weight and opercula width. The male : female ratio was observed to be 1 : 1.5. Males had an average length of 45.4 mm and weight of 25.36 g, while the females measured 47.4 mm in length and 28.62 g in weight. The average length of the egg capsules was 18.4±2.7 mm (mean±SD). The adults laid eggs in the laboratory and veliger larvae were hatched. The larvae were fed with different types of algal feeds such as monocultures of *Isochrysis*, *Chaetoceros* and mixed cultures of *Isochrysis* : *Chaetoceros* and *Pavlova* : *Chaetoceros* in 2 : 1 ratio respectively. Better survival of 2.9% was observed in the veliger larvae fed with mixed culture of *Isochrysis* and *Chaetoceros*. Metamorphosis occurred from veligers to juveniles and the initial shell length was 1.7 mm, shell width 1.3 mm and weight 0.01 g. After 390 days, the shell length was 22.5 mm, width 19.6 mm and weight 4.25 g. The survival was 2.3%. The gut contents were analyzed in the animals collected from the wild and the animals cultured in the laboratory. Total Heterotrophic Bacterial count was more in the case of wild compared to the ones cultured (105×10^2 CFU/g and 27×10^2 CFU/g respectively). Vibrios, *Salmonella* spp. and *Micrococcus* spp. were absent in laboratory cultured animals while they were present in wild ones at the levels of 7×10^2 CFU/g (Vibrios) and 3×10^2 CFU/g (*Micrococcus* spp.). Both the samples showed the presence of *Escherichia coli* (3 MPN/100 g). The present study provides suitable hatchery technology for culture of *B. spirata*.

Key words: *Babylonia spirata*, status, intra-capsular development, culture

Introduction

Babylonia spirata (Neogastropoda: Buccinidae) is found abundantly in the Indo West Pacific region. In India this animal is found plenty in both Southeast and Southwest coasts, so also in the Andaman and Nicobar islands (Ayyakannu 1994). The spiral Babylon, as it is commonly known, comes under the family Buccinidae and is locally known as 'Puramuttai chank', which means 'dove egg shell'. They are landed as by catches of trawl nets, push nets and also by skin diving. They inhabit littoral regions in sandy substrate, dwelling in depths ranging from 5 to 15 m. Though many gastropods are exploited either for their aesthetic value or meat, the Babylon snail, *Babylonia spirata* has found a special place in commercial exploitation. Gastropod meats are considered to be on par with other animal foods in terms of nutritional value (Ansari *et al.* 1981), however nutritionally *Babylonia spirata* remains underutilized in the country while the shells utilized for ornamental purposes. The operculum is also having great economic importance, yielding good income to the poor fisher-folk. In general animals in the aquatic environment carry bacterial flora, which is a reflection of the flora in the environment (Chandrasekaran 1985). Works on *Babylonia spirata* in India are very much limited and are of preliminary nature particularly on fishery status (Ayyakkannu 1994), biology (Thirumalavalavan 1987), feeding (Patterson *et al.* 1995a), spawning and larval development (Shanmugaraj *et al.* 1994, Raghunathan *et al.* 1994, Sreejaya *et al.* 2004), and pen culture (Patterson *et al.* 1995b). However considerable work has been done on the spotted Babylon (*Babylonia areolata*), which occurs in Thailand waters, notably on effect of stocking density on growth, juvenile rearing, nursery culture and development of grow out methods (Chaitanawisuti and Kritsanapuntu 1997a, 1997b, 1998, 1999 and 2000). In the present study, the fishery status in Tuticorin coast in Southeast coat of India, laboratory rearing and breeding, intracapsular studies, larval rearing, juvenile rearing and feeding, growth, disease incidents and the gut microflora of *B. spirata* are investigated in order to explore the feasibility of mass culture of this gastropod. It

is also essential to develop suitable hatchery techniques for culturing the seeds of prime importance to reduce the fishing pressure.

Materials and Methods

Fishery status and landing

Survey was conducted along the Tuticorin coast to find out the landings of *B. spirata*. In the survey four landing centers such as Tharuvaikulam, Vellapatti, Thirespuram and Harbour beach were found to land *B. spirata* in considerable quantities. The landings were noted down season-wise such as monsoon (October–December), post-monsoon (January–March), summer (April–June) and pre-monsoon (July–September) seasons during the period between October 2002 and September 2005. The fishermen were interviewed in person to know the details of spiral Babylon fishing.

Laboratory studies

The seawater was pumped from the sea and was stored overnight in an overhead tank for the particulate matter to settle down. Then the water was passed through 2 cartridge filters of pore size 5 μ. The filtered water was passed through a UV filter at a rate of 3 liters per minute. The UV filtered water was finally used throughout the laboratory culture experiments of *B. spirata*.

Two hundred animals were collected from the wild and brought to the laboratory and sexed. Morphological characters of the shell including shell length, shell width and operculum width were taken. Regression equations were calculated using linear equation $y=bx+a$, where x=shell length and y=shell width or operculum width or body weight. The animals were transferred to 250-liter FRP tanks for acclimatization. Filtered seawater was added slowly during acclimatization and the water used during transportation was completely replaced using filtered seawater. The animals were left as such for 24–48 hrs to get adjusted to the new environment. Continuous aeration was provided. Later the animals were transferred to 1-ton capacity tank with clean sand substrate. Water temperature (29–31°C) and salinity (35 psu) were maintained. The animals were fed with fish and cephalopod meat. 90% of water was exchanged daily with filtered seawater. During the spawning the number of egg laying females was observed and the average number of egg capsules laid by one animal was noted down.

The eggs laid by the adults were carefully collected and transferred into small troughs of 5-liter capacity. Water exchange (90%) was done daily and continuous aeration was provided. The length and width of 50 egg capsules were measured. The number of eggs per capsule was counted with the help of a light microscope.

At regular intervals, an egg capsule was taken and preserved in 10% formalin for carrying out the intra-capsular studies till hatching occurred. The different stages were clearly photographed with a Nikon Koolpix camera attached to a Nikon FDX 35 light microscope. The changes in size and shape of the embryos were observed and noted.

After hatching, the veligers were divided into 4 groups and were maintained in plastic troughs of 3 liters capacity. Each group was fed with 10 ml of microalgal culture having (8000 cells/ml) such *Chaetoceros* sp., *Isochrysis* sp., mixed cultures of *Isochrysis* sp and *Chaetoceros* sp in the ratio of 2 : 1 so also *Pavlova* sp and *Chaetoceros* sp at the ration of 2 : 1 per day. The survival rate of veligers fed with different microalgal feed and the time taken by them to settle down were noted. The dirt and dead larvae settling to the bottom were siphoned out daily and 50% water exchange was carried out. As the time of settling approached, mild concentration of potassium chloride (1 g/100 ml) was added to the water to trigger the settlement process. Substrates like porcelain, glass, plastic sheets and baked mud tiles also were introduced into the culture system to induce settlement of the veligers.

The settled veligers metamorphoses into the juveniles, which were maintained in plastic troughs of 3-liter capacity for 2 months and later transferred to glass tanks of 20-liter capacity. 70% of water was exchanged daily and the bottom of each trough was scrubbed and the dirt was siphoned out. The troughs were covered to prevent extraneous dirt entering into the system. The juveniles were fed with fish meat slices. The increase in length, width and weight of the juveniles were monitored once in 30 days. The survival rate was also noted down.

In the veliger rearing system, in order to prevent the entry of parasitic ciliates, the water was chlorinated (15 g/150 l). To prevent the entry of *Zoothamnium* sp. the water was treated using a UV lamp for 10 hours. The algal cultures were filtered through plankton net (50 μm pore size), which selectively allowed only the algal cells and retained the dirt, other filamentous algae and ciliates.

Gut content analysis

Laboratory-cultured and wild *Babylonia spirata* were brought aseptically to the laboratory in live condition. The gut was dissected out and the samples were taken for the microbiological analysis. Total Heterotrophic Bacterial Count (THB) was enumerated in ZoBell Marine Agar (ZMA) and Vibrios by Thiosulphate Citrate Bile Salt Sucrose (TCBS) using the conventional pour plate technique. The plates were inverted and incubated at 37°C for 4–5 days. Plates containing 30–300 colonies were counted. The counts were expressed as Colony Forming Units/g of the sample (CFU/g). *Salmonella* spp. and *Micrococcus* spp. were identified by standard biochemical tests. *Escherichia coli* were calculated using standard Most Probable Number (MPN) technique (USFDA 1998).

Results

Fishery status and landing

In Tuticorin coast, *B. spirata* is landed mainly in 4 fishing villages namely, Tharuvaikulam, Vellapatti, Thirespuram and Harbour beach. These villages mainly use crab nets and the *B. spirata* is obtained as by-catch in the crab nets. Landing of *B. spirata* was high in Tharuvaikulam and Vellapatti during the pre-monsoon period as there was large-scale operation of crab nets during that time. The animals usually are discarded back into the sea while cleaning the nets. Thirespuram fishing village, which lies near to the main fishing harbour of Tuticorin landed the maximum quantity of *B. spirata* during summer. During this period, due to the fishing holiday, the mechanized trawlers are not operated. In the harbour beach area, *B. spirata* landings were almost uniform throughout the year except during June and July, when the catches were nil. This was due to the absence of crab fishing during that time. The total landings of *B. spirata* in Tuticorin coast between October 2002 and September 2005 were 85871 kg. The highest landing, 27951 kg was observed during 2005, followed by 26189 and 25990 kg in 2004 and 2003 respectively. During the monsoon period of 2002, 5741 kg were landed. Both the sexes were landed almost equally in all the landing centers. The landing data are given in Fig 1.

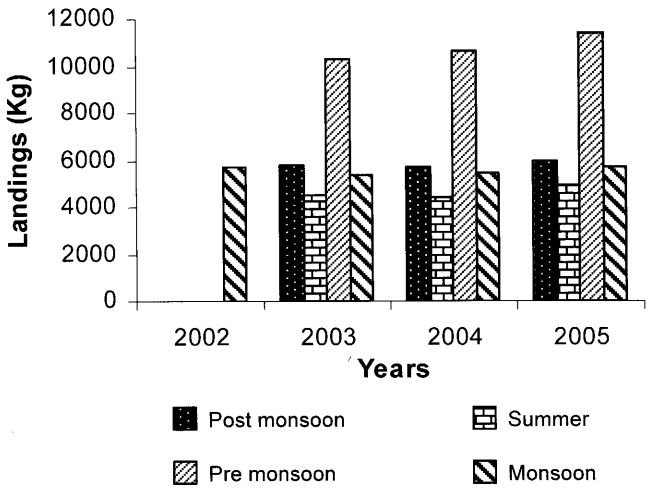

Fig. 1. Landing data of *B. spirata* in Tuticorin coast, Southern India between Oct 2002 and Sept 2005.

Laboratory studies

Of the 200 animals maintained, the male : female sex ratio was 1 : 1.5. The males had an average length of 45.4 mm and weight of 25.36 g. The females measured 47.4 mm in length and 28.62 g in weight. Correlation showed significant positive value between the length and weight of males (r=0.94, P<0.01) and females (r=0.93, P<0.01). Results of statistical analyses suggested that the relationship between length and other morphometric characters like width, total weight and operculum width of female were linear and this was confirmed by their regression value, which was significant at 0.01% level (Table 1). There was no significant correlation between length and operculum width of male. Correlation showed a very high positive value in the case of shell length and weight of males and females. This indicated a very high degree of correlation between total length and total weight (Figs. 2a~f). The animals were found to congregate during mating and spawning (Figs. 3a and 3b). Soon after mating, the females started laying vasiform shaped egg capsules (Fig. 3c), which had a basal disc, connected with a stalk and inside the capsule the eggs were clearly visible (Fig. 3d). The average length of the egg capsules was 18.4±2.7 mm (mean±SD). The basal disc made of mucus and sand enabled the egg capsules to stand upright in the water. Mostly the spawning took place during the nights and early hours of the day. Each female laid 15–20 egg capsules and each egg capsule contained 503.1±84.0 eggs (mean±SD) within. Usually a group of 15–20 females gathered together and laid eggs.

The eggs were spherical in shape and yellowish in colour measuring 300.6 μm after 30 minutes of spawning (Fig. 4). During the third hour, enlargement of one side made the embryo look oval in shape. This was an indication for the two-celled stage to appear (Fig. 4b). During the two-celled stage the embryo measured 400 μm in size. The four-celled stage appeared during the fifth hour of incubation and measured 334 μm (Fig. 4c). Further divisions were not noticeable as the embryo turned into an opaque mass. After 24 hrs, the size was 283.9 μm (Fig. 4d), which increased to 300.6 μm on third day (Fig. 4e). This stage rotated slowly inside the egg capsule due to the presence of marginal cilia. On day 4, the embryo was in the trochophore stage and measured 350.7 μm (Fig. 4f). On day 4, velar lobes bordered with cilia started ap-

Table 1. Results for relationships of shell length to other morphometric measurements.

Parameters	Sex	*n*	Equation	*r*	P
Length vs. Width	♂	200	y=0.534×+4.393	0.89	<0.01
Length vs.Width	♀	200	y=0.502×+6.122	0.79	<0.05
Length vs. Operculum width	♂	200	y=0.490×+4.663	0.58	n.s.
Length vs. Operculum width	♀	200	y=0.523×+3.873	0.88	<0.01
Length vs. Weight	♂	200	y=2.743×−7.302	0.94	<0.01
Length vs. Weight	♀	200	y=2.863×−7.735	0.93	<0.01

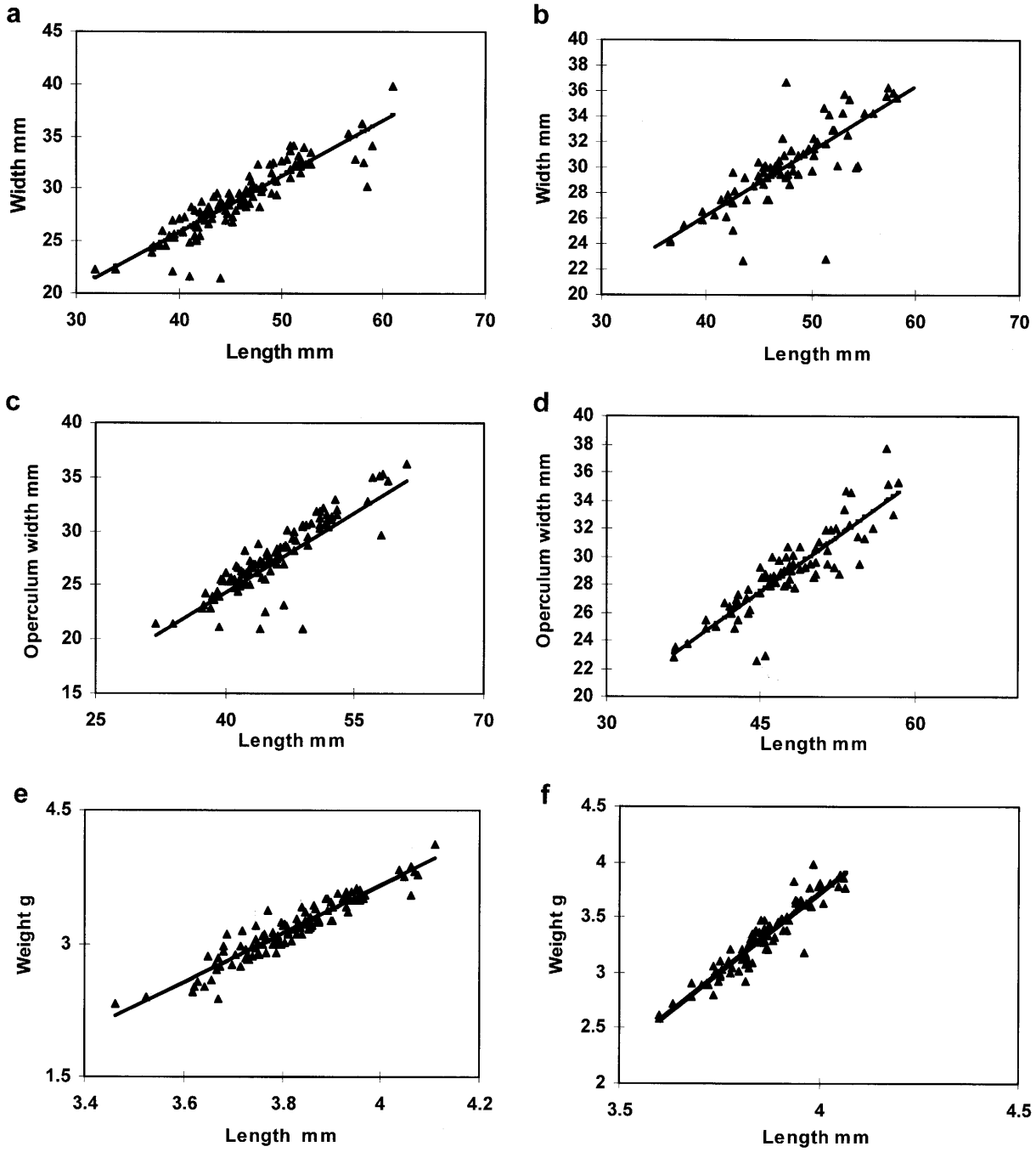

Fig. 2. Relationships between morphological parameters, a) shell length vs. width of male, b) shell length vs. width of female, c) shell length vs. operculum width of male, d) shell length vs. operculum width of female, e) shell length vs. body weight of male, f) shell length vs. body weight of female.

pearing distinctly. On the 5th day, the embryos measured 400.8 μm with well-developed velar lobes lined with cilia (Fig. 4g). The bilobed embryos of day five are shown in Figs. 4h and 4i.

On the 6th day of incubation, the vasiform capsules split to open in the apical region. The veligers hatched out measured 400.8 μm in size (Fig. 5). The larvae were having two broad velar lobes lined with cilia and a translucent shell (Fig. 6). The width between the two velar lobes was 2.5 mm. They were found to be highly sensitive to fluctuation in temperature and salinity. The larvae showed a survival rate of 2.9% when fed with mixed algal culture of *Isochrysis* and *Chaetoceros* at the ratio of 2 : 1 on the 21st day when the veligers settled. Mixed culture of *Pavlova* and *Chaetoceros* in the ratio of 2 : 1 yielded 1.9% survival on the 21st day (Fig. 7). The veligers fed with the monocultures of *Chaetoceros* sp. and *Isochrysis* sp showed a survival rate of 0.1% and 0.2% respectively. 10 ml of microalgal culture with a concentration of 8000 cells/ml were given as feed every day. On the 19th day the veligers started swimming above the bottom of the

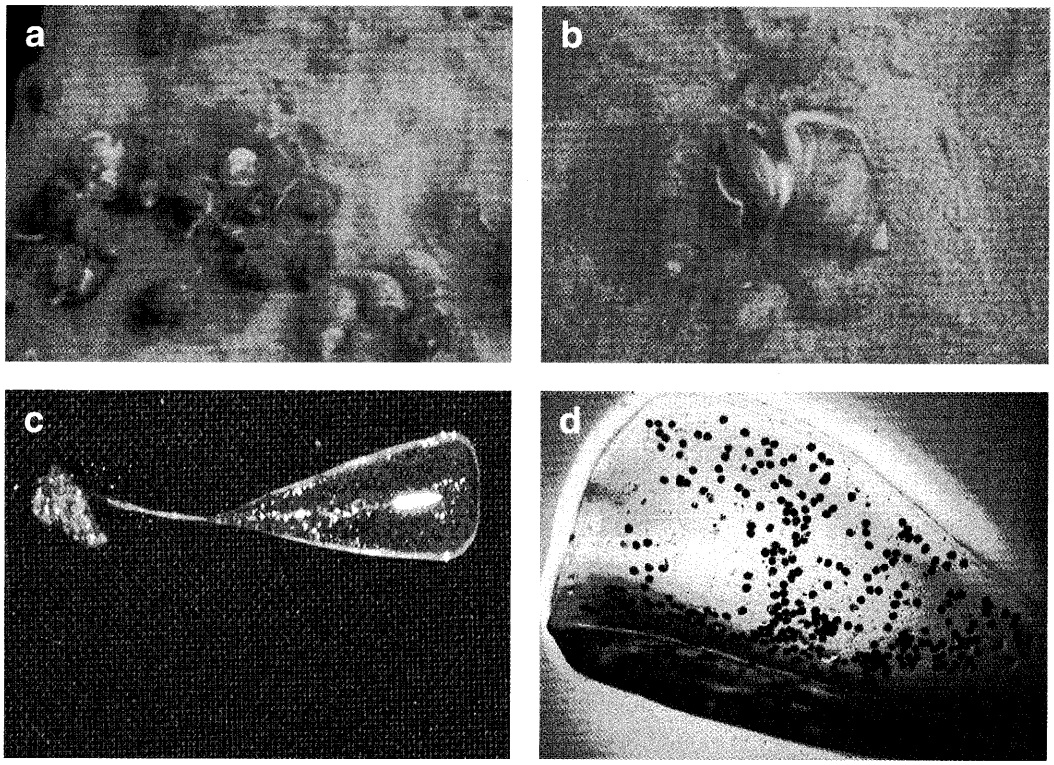

Fig. 3. Photographs of *B. spirata*: a) congregation during mating and spawning, b) mating, c) vasiform shaped egg capsule, d) eggs inside the egg capsule.

troughs. The velar lobes started to disintegrate slowly and foot started to appear. Mild concentration (1g/100 ml) of potassium chloride used to trigger the settlement of the veligers failed to show any impact. Substrates like porcelain, glass, plastic sheets and baked mud tiles were introduced into the culture system for the purpose of inducing settlement did not show any effect on settlement of the larvae.

On the 21st day the veligers settled down to the bottom of the trough, got metamorphosed into juvenile and started the creeping mode of life. When this was fed with fish meat, they exhibit good chemosensory capacity. They detected the food in the environment and moved towards the direction of the fish meat. They fed voraciously on the meat provided.

Two hundred veligers metamorphosed into juveniles, which measured 1.7 mm in shell length, 1.3 mm in width of body whorl and the weight was 0.01 g (Table 2). After one month, the shell length increased to 3.4 mm, width to 2.3 mm and weight to 0.02 g and the survival rate was 54.7%. Mortality occurred often due to desiccated juvenile come out of the water. By the end of 390 days, the length increased to 22.5 mm, whorl width to 19.6 mm and weight to 4.25 g (Fig. 8). The survival rate at this point was 2.3%.

During the rearing of veliger stage problems like ciliate infestation, filamentous algal infestation and *Zoothamnium* sp. infestation were encountered. The processing of seawater for 10 hours under a UV lamp and passing it through a phytoplankton filter reduced this problem. The ciliates consumed the veligers and the shells were left out. Chlorination of the water was not found to be effective as expected. Filamentous algae entangled the free-swimming veligers and a chain of veligers was formed. This chain settled at the bottom leading to ciliate infestation resulting in mortality. This problem was overcome by filtering the water and the algal culture using plankton net. Infestation by *Zoothamnium* sp. was witnessed when the water quality was poor.

Gut content analysis

The results of microbiological analysis of the gut contents of the laboratory-cultured *B. spirata* are shown in Table 3. It was found that the THB level in the wild samples was higher (105×10^2 CFU/g) compared to the laboratory-cultured ones (27×10^2 CFU/g). Also Vibrio spp., *Salmonella* spp. and *Micrococcus* spp. were not present in the laboratory-cultured animals. The wild samples were observed to have Vibrio (7×10^2 CFU/g) and *Micrococcus* spp. (3×10^2 CFU/g). However, *Salmonella* spp. were not present. *Escherichia coli* was present in both the laboratory-cultured and wild animals (3 MPN/100g).

Discussion

The landing of *B. spirata* clearly showed an uniform pattern during the 3-year study period. The slight increase in the landings noticed every year could be due to the increase in the number of crab net operating fishermen. *B. spirata* is

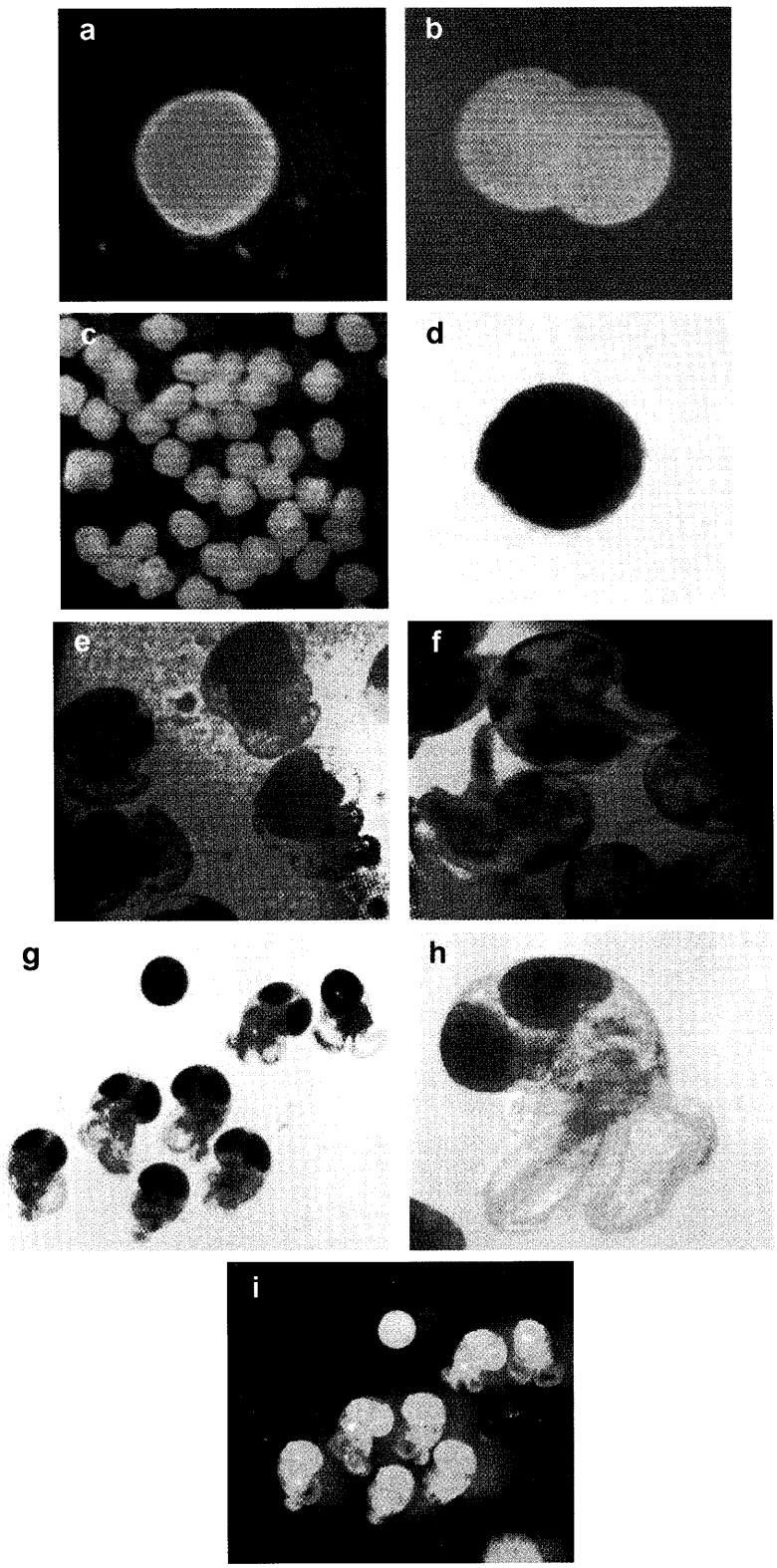

Fig. 4. Development of B. spirata : a) eggs 30 min. after spawning (300.6 μm), b) two-celled stage (400 μm), c) four-celled stage (334 μm), d) 24 h embryo (283.9 μm), e) day 3 embryo (300.6 μm), f) day 4 embryo (350.7 μm), g) day 5 embryo (400.8 μm), h) bi-lobed embryo on 5th day, i) bi-lobed embryo on 5th day.

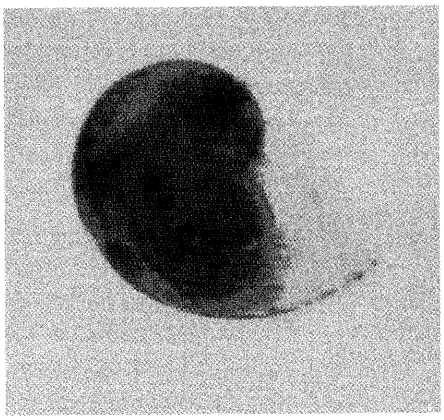

Fig. 5. Just hatched larvae (400.8 μm).

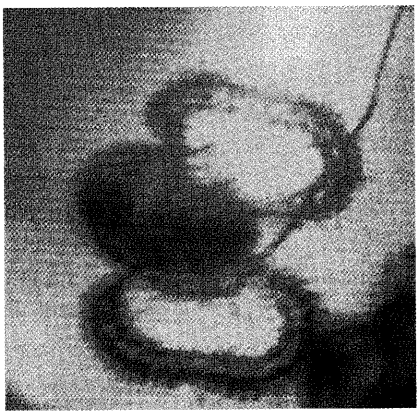

Fig. 6. Free swimming Veliger (width between edge of the velar lobes, 2.5 mm).

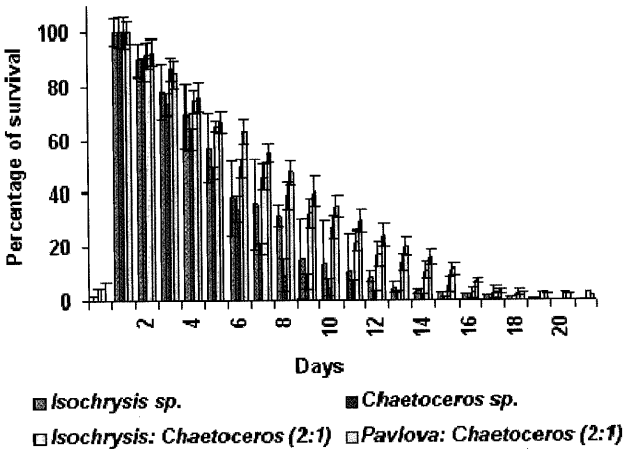

Fig. 7. Survival rate of the Veligers fed with different algal feeds.

landed exclusively as by-catches and no separate gears is used in the fishing villages for catching this whelk as the market price is very low and no buyers in Tuticorin area. However, the opercula of the animals are collected (thousands of opercula form 1 kg) and sold for a price of Rs 1000 per kg. Ayyakannu (1994) stated that the operculam is believed to be used in perfumes and cosmetics. But this is quite

Table 2. Growth increment and survival rate of juveniles of *Babylonia spirata*.

Days	Length (mm)	Width (mm)	Weight (g)	Survival (%)
0	1.7	1.3	0.01	100
30	3.42	2.3	0.02	54.7
60	7.4	5.2	0.11	35.9
90	9.8	8.6	0.27	25.8
120	13.3	9.9	0.61	23.4
150	14.4	10.8	0.93	20.3
180	16.8	12.6	1.60	16.4
210	19.3	14.1	2.29	14.8
240	19.7	14.5	2.42	14.8
270	20.2	15.9	2.71	10.9
300	20.8	17.1	2.89	4.7
330	21.0	18.3	3.06	2.3
360	21.7	18.8	3.63	2.3
390	22.5	19.6	4.25	2.3

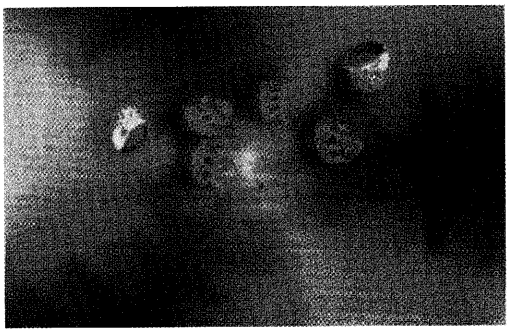

Fig. 8. Juveniles after 390 days.

Table 3. Microbiological analysis of the gut microflora of the wild and laboratory-cultured *Babylonia spirata*.

Microbiological sampling of the gut microflora	Wild	Laboratory-cultured
Total Heterotrophic Bacteria (THB) (10^2 CFU/g)	105	27
Vibrio spp. (10^2 CFU/g)	7	—
Salmonella spp. (10^2 CFU/g)	—	—
Micrococcus spp. (10^2 CFU/g)	3	—
Escherichia coli (MPN/100 g)	3	3

'—' not detected.

contrasting to the scenario in Annappanpettai (Lat. 11° 29′N; Long. 79°46′E) of Cuddalore district where there is an exclusive fishery on the Babylon snail. A special gear called 'Katcha-valai' which consists of a long line with iron ring attached to a bag type net is used to catch the whelk (Ayyakannu 1994). In Quilon of Kerala, targeted fishing for whelks is there using modified trawl net with an increased amount of lead rings for the nets to remain at the bottom and an increased filament strength to withstand the weight of the

shells (Philip and Appukuttan 1997).

Among the 200 randomly selected adult snails from the Tuticorin coastal waters and maintained in the laboratory, the male to female sex ratio was found to be 1 : 1.5. Yulianda *et al.* (2000) had reported male to female sex ratio of 1 : 1.3 in the Pelabuhan Ratu waters, South coast of West Java. Male to female sex ratio 1 : 1.5 agrees with that of Fretter (1984) who said that, generally the neogastropods have a balanced sex ratio.

Yulianda *et al.* (2000) found that shell length of male and female *Babylonia spirata* was not significantly different in Indonesia. In the present study, the average shell length for males was 45.4 mm and for females it was 47.4 mm. The average weight of the males was 25.36 g, whereas, it was 28.62 g for females. Statistical analysis showed highly significant correlation between shell length and weight of male and female.

It was observed during the present study that the females gathered in a particular place in the tank and started laying eggs as a group while the males crept circling the spawning site and sometimes through the site. The reason for this behaviour is not known. The females were found to lay 15–20 egg capsules with 503.1±84.0 eggs (mean±SD) and the average length of the egg capsule was observed as 18.4±2.729 mm (mean±SD). Sreejaya *et al.* (2004) reported the length of egg capsules to be 15–61 mm with 350–800 eggs per capsule in the West coast of India. They had reported that each female laid 35–40 egg capsules per spawning. Shanmugaraj *et al.* (1994) observed 2 females to lay 24 and 28 egg capsules under laboratory conditions in Southeast coast of India. They stated that the capsules having a length of 30–37 mm contained approximately 900 eggs within. The length of the capsules, number of capsules laid per female and number of eggs per capsule are found to vary slightly from area to area and this could be due to the influence of the environmental parameters and availability of food.

The eggs inside the egg capsules were found to measure 300.6 μm soon after they were laid. On the 6th day, the larvae measured 400.8 μm before hatching. Shanmugaraj *et al.* (1994) reported the size of the eggs to be 400 μm at the time of laying and 416 μm at the time of hatching. Sreejaya et al. (2004) found the initial size of the egg to be 275 μm and the final size to be 465 μm. Morton (1986) stated that the residence time and the size at hatching are positively correlated to the nutritional status of the egg capsule content. The lesser time taken for the eggs to hatch as well as the high hatching percentage (90%) and the increased embryonic size of the eggs support this statement.

In the present study the eggs got split open and the free-swimming veligers were released on the 6th day of incubation. Sreejaya *et al.* (2004) reported that this occurred on the 7th and 8th days of incubation. Shanmugaraj *et al.* (1994) stated from Portonovo coast that the hatching took place after 10 days of incubation. However, the stimulus for hatching of the eggs is yet to be fully understood. Tattersall (1920) suggested that the hatching might be due to chemical agents or to an increase in osmotic pressure. Disease outbreaks cause serious threat to any aquaculture system. Sreejaya *et al.* (2004) reported bacterial and protozoan infestations on *Babylonia spirata*, while Shanmugaraj *et al.* (1994) experienced unexpected outbreaks of protozoans, which accounted for 50% mortality of the larvae. Similarly heavy mortality was also observed in the rearing of *Chicoreus ramosus* larvae by Xavier Ramesh *et al.* (1992). Poomtong and Nhongmeesub (1996) reported protozoan infestation during the culture of *B. areolata* in Thailand. Broad spectral antibiotics such as tetracycline and neomycin could counter the bacterial attack but the emergence of antibiotic resistant microbes could hinder long-term application. Therefore, proper maintenance of water quality is the better way to control disease outbreaks.

The reduced pathogenic gut microflora in the cultured animals compared to the wild ones indicates the possibility of culturing *B. spirata* as per the nutritional requirements. However, Anand *et al.* (1996) found that the hind gut of *Telescopium telescopium* harboured more heterotrophic bacteria (13.37×10^3 CFU/g). Watkins and Simkiss (1990) who studied the populations of various snails recorded colonies similar to those found in soil. As in the present study, Rajakumar and Ayyakannu (1995) detected Vibrio, *E. coli* and *Micrococcus* in the gut microflora of *Pleuroploca trapezium* with remarkable differences in the number and composition during various seasons. However, Kanakasabai (1985) observed the dominance of Enterobacteriaceae in the gut of five herbivore neritids from Vellar-Coleroon estuarine complex. The present study reveals that the gut of laboratory-cultured animals harbored lesser heterotrophic bacterial counts compared to the wild ones. This could be due to the good quality of fresh fish meat feed given to the laboratory-reared animals.

This study could not be continued due the tsunami, which lashed on the Indian coasts on December 26, 2004, and caused considerable damage to our culture facility, where the *Babylonia spirata* brood stock and juveniles were maintained. 100% mortality of the animals was observed. The seawater intake facility in the shore laboratory was entirely washed away due to strong waves.

Conclusion

Development of hatchery technique helps in understanding the biology of animals and holds the key to successful mass production of seeds. *B. spirata* could be considered as one of the good aquaculture candidate species among gastropods as it is highly tolerant to the various stresses of the aquaculture process. However, various factors to be looked into and fine tuned during the culture of *B. spirata* are outlined below.

1. Collection of good quality brood stock from unpolluted waters.
2. Proper acclimatization of the brood stock under the laboratory conditions and providing adequate substrata (sand) to burrow in.
3. Sufficient food supply for the brood stock.
4. Environment without any pollution or other mechanical disturbances.
5. Good infrastructure (filter system and aeration) to provide sufficient quantity of good quality and well oxygenated seawater.
6. Continuous availability of ciliates free algal feed for the veligers.
7. Close and constant monitoring of the animals during the metamorphosis from veliger to the creeping juvenile stage.

Good maintenance of the water quality is of prime importance and adequate feed supply could yield a good harvest of the whelk, *Babylonia spirata*. However, advanced facilities like running water facility or re-circulation system would definitely give more encouraging results in the culture of *B. spirata*.

The research and development in the field of culture of molluscs especially on Gastropods and Cephalopods are lacking in India and still we do not have any knowledge about the life cycle of most of the marine gastropods even though these groups form considerable scientific and economic importance.

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