

10. DISCUSSION

10.1 Significance of behavioral study in *Bellamya bengalensis*

Behavior is a complex phenotype, that reflects in such a way that an animal behaves in response to a particular situation or stimulus. Because it is dynamic and changes in response to the environment. Behavior is a pervasive and fundamental property of living organisms, ranging from the simple responses of bacteria to the intricate social interactions of humans. It gathers together questions and methodologies across levels of analysis, across levels of explanation and across diverse taxa. This nature of behavioral studies challenges established boundaries in science. Therefore, animal behavior is the bridge between the molecular and physiological aspects of biology and the ecological matters. Thus behavior, act a link between organisms and environment. Furthermore, behavior which is one of the most important properties of animal life, plays a critical role in biological adaptations. This usually represents how the animal are define within their own lives.

The study of animal behavior, begins with understanding how an animal's physiology and anatomy are integrated with its behavior. Both external and internal stimuli prompt about its behaviors. Understanding how the animal and environment come together to built its (animal) behavior. Some time environmental flexibility gives animals the opportunity to adjust or to changes during their own lifetime or maturation time. Many scientists study about the animal behavior because it sheds light directly or indirectly on human beings. To understand how specific behavioral characteristics influence invasion success, it is necessary to distinguish factors influencing the separate probabilities of colonization, establishment and spread. Behavioral mechanisms play a key role in reproductive isolation in many species. Behavioral changes may even be at

the basis of species formation. Sometimes analysing these processes are important in effective management tool for endangered species in the wild, in maintaining viable gene pools and in understanding the mechanisms underlying biodiversity.

The beauty of an animal includes its behavioral attributes. Basic behavioral studies on different aspect such as feeding, breeding etc led to improve captive breeding techniques regarding sustainable aquaculture. While in this present study of this snail (*Bellamya bengalensis*) was important to get an idea about its physiological pattern by keeping its within captive condition. In present this study referred mainly type of breeding, production rate and sexual maturity level of *B. bengalensis*. This behavior study of *B. bengalensis* may be vital records to provide baseline data for future scientific experiments in the field of malacology.

10.2 The study of behavioral patterns of *Bellamya bengalensis* within a captive environmental condition which reflects its maturation towards the seasonal availability of biochemical parameters

Among our daily consumption, there are three important food parameters i.e. protein, carbohydrate and fat which control a large numbers of physiological activities within the animal body. Beside the change of physiological activities, variation in the percentage of protein, carbohydrate and fat can be observed. Keeping this point in mind a experiment was carried out about the seasonal availability of protein, carbohydrate and lipid. According to that experiment (Chapter II, Table 16 , Fig. 15 to 17), it was noticed that, a variation was happened with the seasonal change. The percentage of protein, carbohydrate and lipid were highest in Pre-Monsoon season and lowest in Post-Monsoon season. This declining trend was observed because as *Bellamya bengalensis*, a viviparous gastropod they need to provide feed to their juvenile to be mature within their body

cavity. In Pre-Monsoon season the percentage of protein, carbohydrate and fat were highest, because that should help to provide nutrition to the genital organ, embryonic pouch as well as gonads, which helped to regulate the increasing rate of fecundity. But after the onset of Monsoon season percentage of protein, carbohydrate and lipid were gradually decreased and it became lowest at the Post-Monsoon season, at that time fecundity gradually decreased (Fig. 18). Basically throughout the breeding season (mainly Pre-Monsoon and Monsoon), when maximum absorption of body fluid was carried out by juvenile from their mother. And in the Post-Monsoon season it creates a lacking in the physiological parameters that's why comparatively lower percentage of protein, carbohydrate and lipid were observed rather than Pre-Monsoon and Monsoon season.

It can be explained in such a way that, the stated nutritional parameters were the main factors, in reduction of fecundity in *B.bengalensis* in Post-Monsoon season. These same observations (seasonal biochemical changes and maturation) were correlated with the study of several authors among the marine and fresh water bivalves, gastropods, crustaceans and also with the fishes which was already discussed briefly in Chapter II (Diwan and Nagabhushanam,1970, Hamdani *et.al.*,2011, Shaikh,2011, Karina *et.al.*, 2013, Pardeshi and Vedpathak,2013, Shafakatullah *et.al.*, 2013, Celek.,2014, Shafakatullah and Krishnamoorthy,2014). In addition to that, regarding these factors less availability of *B.bengalensis* was noticed, which made higher market rate in this season (Post-Monsoon) as per economic point of view. There was a another point to mention that on and after the Monsoon season, when water temperature became reduced, that inhibit to produced juveniles and effect in maturation. The threshold water-temperature for reproduction was found to be about 19-25⁰C and the optimal water-temperature was

over 28⁰C. So, temperature was one of the main constituent that alone control longevity, maturity, gonadal development and fecundity of *B. bengalensis* and other viviparous group (Chen and Sung, 1975). And that's why in our behavioral study, it was observed that on and after February when the environmental temperature was gradually increased (throughout the experimental season) there a sharp improvement in gonadal development was noticed to start in *B. bengalensis*. It was showing peak from April to August (Fig 18), after this it was gradually decreased and lasted at the end of November. There were several points can be raised up from this behavioral study of *B. bengalensis*. Those points are discussed as follows:

- It was cleared from the present experiment that to keep *B. bengalensis* under captive environmental condition a proper water quality parameter could be maintained, where, pH should be near of 8.5, DO level should be over 4.5 ppm, Alkalinity should be 180 ppm, Nitrate and Phosphate both should be over 0.2 ppm, Hardness might be 200 ppm. As *B. bengalensis* is a gastropods so its need alkaline water. So in this experiment good pH , alkalinity, hardness provided a favorable environmental condition to *B. bengalensis* for their survival, maturation, gonadal development and fecundity (Table-17). Whereas in absence of those parameters in controlled tank, high mortality, lower growth rate and non availability of proper feed items were observed (Table 17 and 18). So, here proper water quality parameters were the main threshold factors for *B. bengalensis*.

- In this experiment it can be explained that If anybody or a group want to mass culture first of all they should go for proper water quality parameters through the adequate level of manuring and liming. Because, in this experiment mixture of DAP and Cow dung manure was containing Nitrogen and Phosphorus at proper

concentration, which mainly provide, not only favorable water quality but also helped to produce favorable feed ingredient (here fresh water algae), which was most needed for *B. bengalensis* for survival and maturation. Likewise here lime also helped to provide a favourable, pH and alkalinity in the culture water. Which was needed to maintain proper buffering condition in culture tank, preferable for *B. bengalensis*.

- A scheme of monthly sampling by scarifying method, (through the experimental time period) indicated about the life cycle of *B. bengalensis*. Gestation period was observed to cover a span of three to four months, starting from October-November, and peaking in January-February of the next year. Most of the female snails after these months were gravid, having a shell length of over 20 mm and containing uterine young in a graded series of development. Here it can be mentioned that in this period they almost minimize or stop to lay juvenile. Because at this moment in time, they were observed to suffer from the lack of available biochemical parameters (mainly protein and also carbohydrate as well as lipid). All their stored nutritional parameters (mainly protein and also carbohydrate as well as lipid) were exhausted towards, to build up primary development. Furthermore, less accumulation of nutritional parameters were also noticed in this period of time.

So, here percentage of uterine young gradually decreased and reached its lowest level, during this time (after October), gravid snails expelled almost their uterine young. After the observation of ova and juvenile, it can be said that mating season of *B. bengalensis* could be continued from February to September. In the laboratory, rearing experiments show that there was a noticeably high survival rate in snails, which were

feed with algae and mud. Side by side it can be said that algae which was main feeding source of this snail, help to maintain gonadal development. This mentioned water quality parameter help to create micro algae, which was deposit over the hard shell of *B.bengalensis*, that provide preliminary nourishment to the juvenile snails which were just come out from their mother brood pouch.

However, the present study based on an initiation to gather knowledge about the behavioral patterns of *B. bengalensis*. It could not indicate any conclusive facts, as the data obtained, throughout the experimental seasons. Nevertheless, here, it can be certainly stated that present study can bear quite a few progressive ideas about the fundamental behavioral patterns of *B.bengalensis*. This may lead towards the initiation of large-scale experiments or mass scale culture practices of *B. bengalensis*. At last it can be mentioned according to Odum (1989) that, “Modern aquaculture should adopt a new strategy, a model of community , based ecologically sustainable aquaculture”.