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2. Annual Reproductive Cycle of Freshwater Edible Female Crab, *Barytelphusa cunicularis*

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Abstract

Annual reproductive cycle of *Barytelphusa cunicularis* freshwater edible female crab was studied for period of two consecutive years from October-2004 to September-2006. Gonadosomatic Indices and ovarian colour were considered as tools for studying the ovarian maturation. During October- 2004 to September-2005 high ovarian index (4.80 ± 0.14) was evident in the month of July, low (0.74 ± 0.12) was recorded in the month of February. For the next consecutive year i.e. during October- 2005 to September- 2006 highest ovarian index was recorded in (4.94 ± 0.27) July while low (0.75 ± 0.65) was recorded in the month of February. Annual reproductive cycle exhibits continuous reproductive activity from June to July having distinct single peak.

Key words: - Annual reproductive cycle, Gonadosomatic Indices, Ovary, *Barytelphusa cunicularis.*

Introduction

Crustacea is a dominant and successful group, represented by a high number of species, exhibiting a great array of life styles and occupying quite dissimilar habitats. This diversity is a result of their life patterns and reproductive strategies. Especially crabs are important components of many ecosystems worldwide, modifying the flow of materials and energy as ecosystem engineers or through their activities as predators or prey. Crabs are delicious in food, rich in proteins and some other organic constituents, easily available & affordable by common people makes it commercially important, hence it is in good demand among them. Considering this it is necessary to understand their reproductive biology, reproductive cycle, percentage of biochemical constituents and induced ovarian maturation for maintaining natural and fishing stocks. Reproduction in many crustaceans has a marked annual periodicity & most organisms grow well and reproduce successfully under normal environmental conditions.

Female reproductive activity is seasonally programmed in several groups of crustaceans, but in the brachyuran decapods it is often sandwiched between other major physiological events such as moulting and regeneration. Reproduction and moulting are two high-energy demanding processes in crustacean, in which reproductive cycles involves a series of events in a population which begins at the end of the juvenile phase, and includes gonad development, gamete differentiation, growth and reproductive behavior. There are two different patterns of reproduction in crustaceans, continuous breeding in which the reproductive process is not interrupted, and restricted breeding, which is usually correlated with favorable environmental conditions in certain months. In *M. rosenburgii* and some other species of decapod Crustacea, reproduction is thought to be under the control of various hormones, including vitellogenisis inhibiting hormone (VIH) and vitellogenis stimulating hormone (VSH). The presence of VIH in the eye stalk has been well established, but less is known about VSH which thought to originate in the brain and thoracic ganglion. Thus, many aspects of reproductive function in Crustacea, including regulatory mechanism of vitellogenesis, remain unclear. This is due in great part in the fact that the biochemical nature of vitellogensis is not fully known.

Many workers have studied reproductive cycle in decapod crustaceans using gonadal indices as criteria to assess the reproductive periodicity. Notable studies were Nagabhushanam and Kulkarni (1982), Pillai and Subramoniam (1984), Kulkarni (1989), Reigada and Negreiros-Fransozo (2000), Costa *et al.*, (2006). Similarly, Tapella *et al.* (2002) studied the reproductive biology of the crab, *Munida subrugosa* in the Beagle Channel, Argentina. Sigana (2002) observed the breeding cycle of *Thalamita crenata* and reported that species exhibits continuous breeding according to the percentage of ovigerous female crabs. Since the reproductive cycle influences the status of a number of physiological processes and consequently the animals ecology and behavior, it is useful to study and relate all these aspects. In invertebrates the gonadal growth during maturation involves active mobilization and synthesis of organic substances (Giese *et al.*, 1958). The nutrient reserves stored in other organs will be transferred to gonadal synthetic centers during gametogenesis. In decapod crustaceans hepatopancreas appears to serve as storage organ and organic material stored here is transferred to sites of gametogenesis at the time of gonadal growth. Adiyodi and Adiyodi (1971a) reported that hepatopancreatic reserves are mobilized to meet metabolic requirements in physiological process. During annual reproductive cycle the organic constituents were mobilized from hepatopancreas to the ovary during reproductive phase for the development of gonad and maturation of the oocytes (Shejule and Zambare, 2003). Yamaguchi (2004) also observed changes in the hepatopancreas index in *Uca lactea* due to seasonal biochemical variations in hepatopancreas.

Considering the importance the present study was undertaken to determine the annual reproductive cycle of freshwater female crab, *Barytelphusa cunicularis.*

Materials and Methods

Female freshwater crabs, *Barytelphusa cunicularis* were collected monthly from the Kham River near Aurangabad for period of two consecutive years from October-2004 to September-2006. Collection of animals was carried in the first week of every month on fixed date and time to avoid fluctuations if any. Other parameters like temperature, pH, salinity, and photoperiod etc. we're not considered. From the collection only healthy female crabs were selected and brought to the laboratory and immediately sacrificed to calculate the gonadal index. For more accuracy and relevant results proper record was maintained of their body weight, gonad weight and gonad colour. The gonadal index was calculated according to the formula given by, Farmanfarmaian *et al.* (1958). The mean values of the indices for 10 female crabs were calculated for every month.

G.I. = (Wet weight of gonad) / (Wet weight of animal) X 100

Results and Observations

The gonadal indices for female crabs for period of two years from October- 2004 to September- 2006 are represented in Fig. 1, 2 and table-1. During October- 2004 to September- 2005 high ovarian index (4.80 ± 0.14) was evident in the month of July, low (0.74 ± 0.12) was recorded in the month of February. For the next consecutive year i.e. during October- 2005 to September- 2006 highest ovarian index was recorded in (4.94 ± 0.27) July while low (0.75 ± 0.65) was recorded in the month of February. It was evident from the annual reproductive cycle evaluated by gonadal index criteria, during June to July breeding activity was distinct indicating single peak of breeding activity in the annual reproductive cycle.

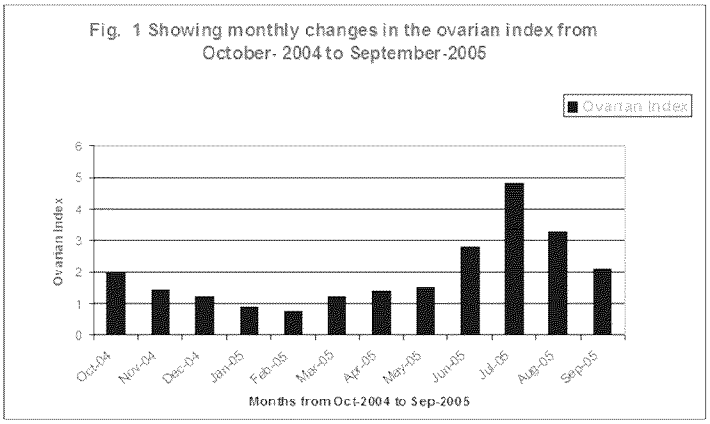
Table 1: Showing monthly changes in the ovarian indices and ovary colouration in the freshwater female crab, *Barytelphusa cunicularis* from October-2004 to September-2006.

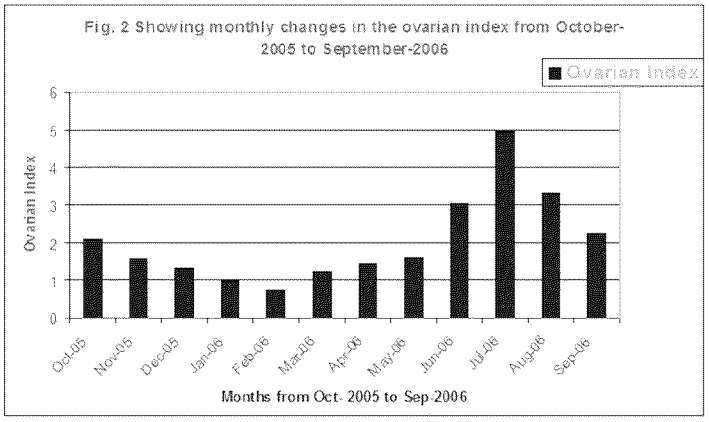
Month and year (2004-2005)	**Ovarian Index ± S.D.**	**Month and year (2005-2006)**	**Ovarian Index ± S.D.**	**Ovary colour**
4-Oct	1.99 ± 0.12	5-Oct	2.09 ± 0.46	Yellowish
4-Nov	1.44 ± 0.15	5-Nov	1.54 ± 0.34	White
4-Dec	1.23 ± 0.14	5-Dec	1.33 ± 0.52	White
5-Jan	0.89 ± 0.16	6-Jan	0.99 ± 0.08	White
5-Feb	0.74 ± 0.12	6-Feb	0.75 ± 0.65	Yellowish
5-Mar	1.21 ± 0.21	6-Mar	1.24 ± 0.25	Pale yellow
5-Apr	1.42 ± 0.17	6-Apr	1.45 ± 0.38	Yellow
5-May	1.53 ± 0.25	6-May	1.58 ± 0.58	Dark yellow

5-Jun	2.81 ± 0.13	6-Jun	3.04 ± 0.15	Orange
5-Jul	4.80 ± 0.14	6-Jul	4.94 ± 0.27	Dark orange
5-Aug	3.26 ± 0.36	6-Aug	3.31 ± 0.41	Yellowish brown
5-Sep	2.11 ± 0.73	6-Sep	2.24 ± 0.56	Yellowish

± S.D. – Standard Deviation

On the basis of gonadal index and colour of the ovary during reproductive cycle the stages of ovarian development were grouped in three stages (Table – 1). During December to February ovarian colour observed white to yellowish and this stage was termed as immature stage of the ovary. Whitish ovaries suggests, not prepared for maturation. Observations during March to July showed changes in ovarian colour from pale yellow to orange & dark orange shows maturing to matured stage. Dark orange colour of the ovary indicated highest maturation stage.





Discussion

In marine and freshwater invertebrates the annual reproductive cycle can be assessed by various methods like observations of spawning, the percentage of ovigerous female against time

and presence of ripe gametes in gonad, occurrence of larvae in the plankton etc. Three standard methods for determination of the reproductive cycle in crustacean decapods were used; (1) gonadosomatic index (GSI), (2) oocyte diameter and (3) proportion of ovigerous females. Benett and Giese (1955) were the first to report the gonadal index as a function of reproductive cycle of aquatic invertebrates. Gonad index is the ratio of gonad size to body weight and considered it to be a measure of the average stage of reproductive population. The ratio of gonad size to body weight gives a relation to gonad maturity and gonad development. This method has been widely used in other invertebrates like molluscs and echinoderms (Giese, 1969) and in crustacean (Shih *et al.*, 1997 Kyomo, 1999).

Similar method was used in present investigation to assess the annual reproductive cycle in *Barytelphusa cunicularis*. In the present study female crab, *B. cunicularis* exhibits continuous reproductive activity with single peak during annual reproductive cycle and continuous breeding pattern (Kale, 2007). Subrahmanyam (1963) noticed continuous breeding activity in *Penaeus indicus* using gonad indices as criteria. Earlier studies of Kunju (1968) also suggested continuous breeding in prawn, *Solenocera indica*. His observations were based on the record of female prawn in different stages of maturity in the monthly samples. On the basis of monthly gonadal index it was possible to state that fluctuations observed in the gonadal index of the crab, *B. cunicularis,* represented true seasonal fluctuations. It was observed that *B. cunicularis* exhibited maximum breeding activity during March to July, as it showed significant increased ovarian index during these months over remaining period of the annual reproductive cycle. This view was further strengthened by morphological study of ovarian colour. Stephenson (1934) found that the species inhibiting the tropical water exhibits several types of breeding cycles; (1) continuous breeders around the year, (2) discontinuous breeder in relation to lunar phase, (3) two spawning periods and (4) one single breeding season. Boolootian *et al.* (1959) studied the reproductive cycle in the three species of the crab, *Pachygrapsus crassipes*, *Emerita analoga* and *Hemigrapsus nudus* and found that these crabs showed distinct annual cycles, the first and third showed maximum breeding in summer while the second showed maximum breeding in winter. The factors, which induce breeding in invertebrates, may be endogenous or it could be influenced by different exogenous factors kike food, temperature, light, rainfall and salinity etc. or a combination of all (Giese, 1969).

In the present study low breeding activity was observed during August to February, it might be due to some environmental factors that may be inhibiting the gametogenic cycle in the present crab. Possibly, food may not be available in abundance during the observed low breeding activity. However, higher breeding activity during March to July correlates with heavy

planktonic blooms, which appear during these months in Kham river waters near Aurangabad. Goodbody (1965) attributed availability of food for adults as an important factor controlling breeding in tropical marine invertebrates. He suggested that continuous breeding species are relatively unspecialized in their food requirements and are either suspension feeders for browsers often with an abbreviated plankton larval stage.

Crab ovaries are bilobed structures with two antero-lateral lobes, which fuses posteriorly with paired reproductive oviducts connecting the ovary to a pair of external genital opening of the sixth thoracic sternite. In invertebrates ovaries undergo colour changes as they mature. Ovarian size and colours are related to histological changes in *Callinectes sapidus* and *Geryon quinquedens* (Wild, 1983; Sigana, 2002). Pillay and Ono (1978) grouped the developing ovaries of grapsid crabs based on colour and size of the ovaries. Sethuramalingum *et al.* (1982) identified on the basis of colour of ovary and suggested three stages of ovarian development (immature, mature and spent) in *Portunus sinipes* and in *Thalamita chaptali*. In the present study colour changes in the *Barytelphusa cunicularis* ovaries similar to that observed by Prasad and Neelakantan, (1989) who identified developmental stages of the ovary in *Scylla serrata*, which were recognized using colour changes in the ovary and the oocyte diameter. Considering morphological observations in *B. cunicularis*, three ovarian development stages were recognized based mainly on changes in ovarian colour and gonadal index during the annual reproductive cycle, (1) Immature- White and translucent, (2) Mature- Dark orange, extending into hepatic region, (3) Spent- After extrusion of ova ovary turned to early stage like immature and whitish in colour. Such morphological stages were associated with ovarian development as Vitellogenesis is an important physiological process associated with female reproduction, because the primary source for the developing crustacean embryo is yolk protein. Vitellogenesis is the synthesis of yolk protein that is necessary for maturation of the oocytes, the process of preformation of energy rich precursors stored in oocyte prior to ovulation. In crustacean this uptake of yolk protein by the developing egg has been studied extensively (Laufer *et al.*, 1998).

In conclusion annual reproductive cycle in freshwater female crab, *Barytelphusa cunicularis* shows two phases; non-reproductive phase from December to February while reproductive phase from March to July having a single peak of maturation.

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