The Role of Spermatheca in Ovarian Maturation of the Fiddler Crab, UCA TRIANGULARIS BENGALI (CRANE, 1975)

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***Abstract*-** In Uca triangularis bengali, when mating occurs, the spermatophores get stored in the spermatheca which in turn induces the maturation of the ovary. The sperm plug prevents further mating and the spermatophores are released in batches. By the time the spermatheca is empty, the ovary reaches the advanced stage of maturation and mature eggs are released for fertilization.

Index Terms- Fertilization, Ovary, Spermatheca, Sperm plug, Triangularis Bengali

I. INTRODUCTION

Among the non-insectan arthropods , the reproduction of crustaceans has received maximum attention (Adiyodi and Adiyodi, 1974).Male members of the crustaceans do not possess an elaborate array of accessory sex glands. However, the vas deferens in many forms is highly specialized and compartmentalized for the production of spermataphore and mucous substance of the nature of gelatin (Spalding, 1942; Mathews ,1956; Berry and Heydon,1970; Malek and Bawab,1974). From this, it is evident that the vas deferens in the crustaceans serves the main function of the accessory sex glands of insects. However , Artemia salina (Wolfe,1971), Squilla oratoria (Komai ,1920) and Dolops ran arum (Fryer,1960) stand out significantly from other crustaceans by possessing accessory reproductive glands. A histological study of the development of the ovary and accessory organs of the blue crab, Callinectes sapidus was reported by Cronin,1942.

Unlike the males, the female crustaceans possess well developed accessory sex glands such as cement glands and sternal glands , secreting dense mucous substances for the agglutination of the eggs and their maintenance thereof (Yonge,1937).Deecaraman and Subramonium(1983) had demonstrated in Squilla holochista that the elaborated secretions composed of sulphated and non-sulphated acid mucopolysaccharide substances of the cement gland were used for the agglutination of the eggs and the maintenance of the embryos.

In female Paratelphusa hydrodromus, the spermathecal gland is considered to be the main accessory reproductive gland providing ideal fluid medium for the inseminated sperm survival(Anilkumar and Adiyodi,1977).The oviduct of some anamuran crustaceans ,viz.,Diogenes pugilator, Emerita asiatica had also been reported to secrete substances that dehisee the spermatophore(Mouchet ,1931; Bloch ,1935 ; Subramanian,1977).

Gallo (2012) has elaborated the storage of spermatophores in female spermatheca regulated by sinus gland extracts in Penaeus semisulcatus .Jensen (2012) has studied on the functional anatomy of the male reproductive system and female spermatheca in the snow crab,Chionocetes opilio.C .Jeyalectumie (1991)focused on the biochemistry of seminal secretions of the crab,Scylla serrata with reference to the sperm theca of the unmated female crabs which are poor in organic nutirents.B.S. Sant'Anna(2007) has worked on the histological and histochemical aspects of spermatheca of the mangrove crab Ucides codatus .C.Becker (2012) has studied about the two distinct regions of the spermatheca by function and storage in brachyura.J .Lu(2006) reported the structural changes of the oviduct of the shrimp, Macro brachiumfrom that of the wall of the spermatheca of the snow crab,Chinocetea opilio.

There is no much information on the histological and histochemical aspects of the ovary, sperm theca, oviduct ,vagina and sperm plug during maturation in crabs expect on the spermathecal activity and ovarian maturation in Scylla serrata and therefore, it has been presently attempted to investigate morphological, histological and histochemical aspects of ovary, sperm theca, oviduct, vagina and sperm plug of fiddler crab Uca triangularis bengali of Pulicat lake, Tamilnadu to fill up the lacunae.

II. MATERIAL AND METHODS

The live specimens of fiddler crab Uca triangularis bengali (Crane,1975)were collected from the Pulicat lake of Tamilnadu.The specimens were collected by hand picking and also by digging the mud below up to a depth of one meter with the help of a shovel. They were washed and cleaned of mud. Females alone were selected and the immature,mature-mated,and berried females were isolated.Further,the specimens were carefully examined for the presence or absence of mating plug in the vulval openings and then fixed in 1% neutral buffered formaldehyde, Later they were brought to the laboratory for various analyses. For studying the morphology, anatomy of reproductive system and spermatheca,crabs of different sizes (immature, mature-mated and berried) were dissected and the viscera was exposed, and examined under dissecting binocular microscope after sprinkling 1% neutral buffered formaldehyde(for hardening).Different stages of ovarian tissues, sperm theca, oviduct, vagina and sperm plug were carefully

dissected out and transferred into different glass vials containing 1% neutral buffered formaldehyde and aqueous Bouin's fluid separately.

For the routine histological preparations, the tissues viz.(1) spermatheca (immature, mature-mated and berried stages), (2) ovaries (immature, mature-mated and berried) stages, (3) oviducts, (4) vagina and (5) mated specimens' sperm plug were fixed in 1% neutral buffered formaldehyde and Bouin's fluig independently.

III. RESULTS

The ovaries in Uca triangularis bengali are paired and 'H' shaped. They occupy the anterio-lateral regions beneath the carapace and asymmetrical in nature in which the right limb is longer the left. Both the limbs are connected by the ovarian bridge. They are situated above the alimentary canal and intermingled with the hepatopancreas. They contain many ovarian lobes which are uneven in shape particularly in mature stages. The ovaries exhibit different colours depending upon the stage of maturation The ovaries are classified into the following four maturity stages(I, II, III and IV) depending upon the colour, nature and size of oocytes.

The spermatheca is an enlarged appendix of the oviduct and varies much in size and condition depending on the degree of reproductive status of the individual.

In Uca triangularis bengali, the spermatheca is enlarged on the right oviduct, whereas the spermatheca on the left oviduct is reduced considerably. Interestingly, the sperm plug is always found only on the right vulval opening. This obviously indicates the deposition of sperms in the right vulval opening and their consequent storage in the right spermatheca of the oviduct. In the present investigation, the spermatheca of female is morphologically categorized into (I) immature spermatheca as the stage-I spermatheca , (II) mated spermatheca as the stage-II spermatheca and spent spermatheca as the stage-III spermatheca. Oviduct and vagina are not observable in any one of the ovarian and spermathecal stages but seen distinctly only on the histological analysis.

The sperm plug is distinctly visible only in the recently mated females on the inner margin of the right vulval (genital) opening of the sixth thoracic segment, whereas in the left genital opening it is absent. This indicates that during mating spermatophores are deposited only in the right vulval opening. Further it is also proved by the presence of bulged right spermatheca, and the normal (not bulged) left spermatheca. The shape of the sperm plug resembles the stopper of a reagent bottle.

In Uca triangularis bengali while the ovary exhibited four stages of development in a progressive manner, the spermatheca did not show a synchronized development. The ovary, over a phase of time elaborates oocytes ,accumulates ooplasmic contents and empties them (spent stage) by the time the female becomes berried. On the other hand the spermatheca is merely a pouch and combines its own secretions with the sperm received during mating. Therefore, the sperm theca does not show a phase of development over a period of time as exhibited by the ovary but only represents three phases ,viz.,(I) ready receptacle, (II) full receptacle of sperm and (III) an emptied receptacle. However, the onset of maturation of ovary is triggered by the deposition of spermatophores during mating, which are stored in the spermatheca.

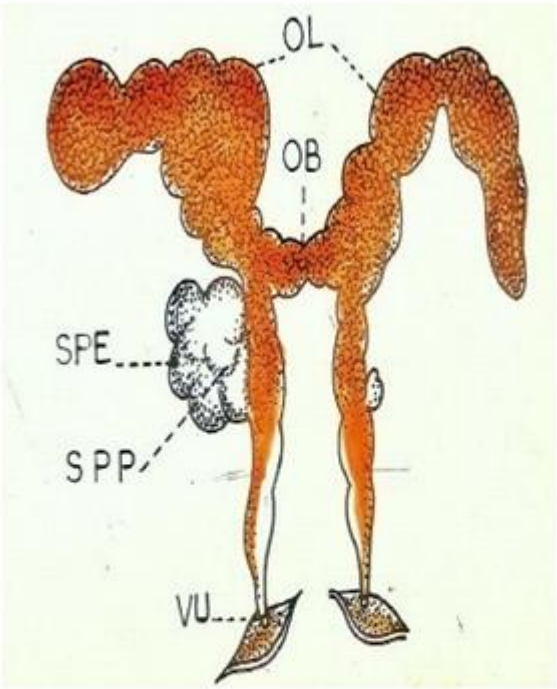
In Uca triangularis bengali , the order of events in the ovary and in the spermatheca can be described as follows. When the ovary is immature ,the spermatheca is a small pouch with thick muscular and epithelial layer, ready to receive the spermatophores. When mating occurs, the spermatophores are received and stored in the spermatheca and the latter becomes enlarged. At this stage, the sperm plug ensures maturation of ovary and also prevents further mating. Now the sperms are liberated in batches from the spermatophores, from the spermathecal pouches, by the spermathecal secretions and by the time the sperm theca becomes fairly empty, the ovary attains advanced stage of maturation. At this time, the matured oocytes are liberated from the ovary and they are fertilized by the sperms, when they reach the junction of the opening of spermatheca into oviduct. Thus, the fertilized eggs, find their way exterior facilitated by the disintegration of sperm plug. Now ,the eggs are deposited on the ventral surface and at this stage, the females are called 'berried females'.

It is evident that in Uca triangularis bengali the role of spermatheca is associated with the reception, retention and release of sperms during the process of maturation of the ovary. In other words when the ovary exhibit's a process of development in terms of cellular differentiation, the spermatheca does not show any characteristic cellular differentiation but remains only as a mere receptacle.

As the maturation of the oocyte is in progress, histological investigations have revealed significant changes in the oviduct. Initially , the oviduct is inconspicuous but as maturation progresses, the oviduct becomes distinct and forms a clear duct with a thick outer cuticular layer and an inner chitinous layer staining deep blue and red respectively with Mallory. Now, the oviduct is ready for the mobilization of unfertilized ova. Along with the oviduct, the vagina becomes conspicuous. Histological studies also reveal the process of fertilization in the vagina.

The role of sperm plug needs some special mention. Its presence on the vaginal orifice indicates that the female has undergone mating. Non-mated females are conspicuous by the absence of sperm plug. The sperm plug is a device to retain the spermatophores in the spermatheca so as to ensure complete fertilization of the ova. Microscopic observations reveal that the sperm plug is a bilayered structure and peg in shape.

In the present investigation ,it is interesting to note that in Uca triangularis bengali the spermathecal secretion is glycolipoprotein complex as evidenced by its heterogeneous composition of proteins, carbohydrates and lipids associated with tyrosine and ss-sh reactive sites.



OL - Ovarian Lobe; OB - Ovarian Bridge;
Stage II
SPE - Spermatheca; SPP - Spermathecal pouches
VU - Vulva
Figure 1. Female Reproductive System of Uca Traiangularis bengali

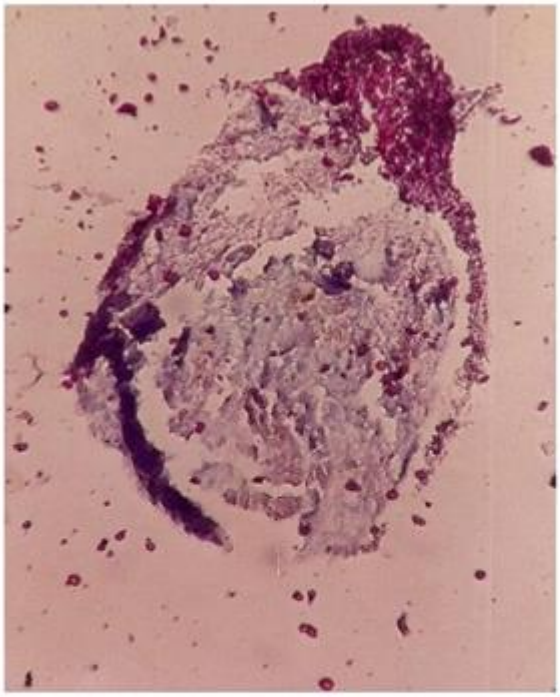


Figure 2. Longitudinal Section of Spermatheca

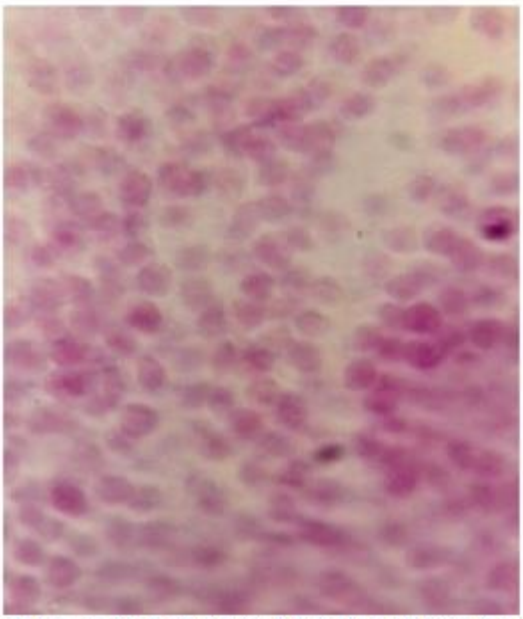
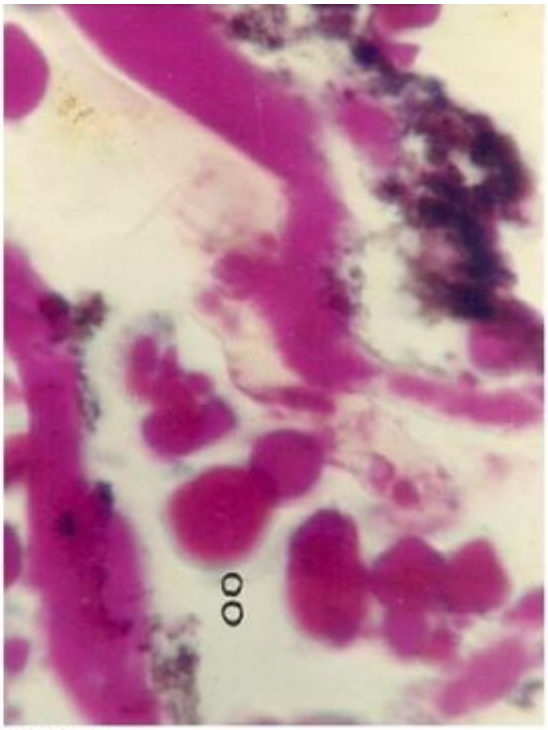


Figure. 3. Non-flagellated free sperms found in the

FOO - Fertilized oocytes; S – Sperm
Figure.4.Proximal region of Vagina showing Fertilization

CH-Chitin; CU-Cuticle
Figure 5. The Oviduct of Uca Triangular bengali



OO - Oocytes
Figure 6. The loading of oocytes in the lumens of the oviduct.

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