CHAPTER V
CHAPTER — V

MORPHOLOGY AND HISTOLOGY OF THE ACCESSORY REPRODUCTIVE GLAND IN THE MALE CRICKET OF G. SIGILLATUS WALKER

It has been studied in the last chapter that the post embryonic development of the male accessory reproductive gland of Gryllodes sigillatus is mesodermal in origin and the follicles of the gland are formed from the epithelial cells of the ampulla in the late last nymphal stage. Records in the entomological literature revealed that the histology of the male accessory gland has been studied in coleopterans, Hydrophilus piecus (Blatter, 1897; Topi, 1942; Palladini et al., 1969), Popillia japonica (Anderson, 1950); hymenopteran, honey bee (Bishop, 1920); hemipterans, Leptocoris trivitatus (Payne, 1934), Oncopeltus fasciatus (Banhag and Wick, 1953), Adelphocoris lineolatus (Masner, 1965), Cyclorella siccipolia (Bose and Sinha, 1967), Lepidopterans, Ephestia kuhniella Zeller (Musgrave, 1937), Hallothis zea (Callahan and Cascio, 1963). Choristoneura fumiferana (Outram, 1970) and orthopterans (review : Ito, 1924), Melanoplus differentialis (Else, 1933), Leucophae a mederae (Van Wyk, 1952), Locusta migratoria
migratorioides (Gregory, 1965; Cantacuzene, 1967a); Schistocerca gregaria Forskal (Cantacuzene, 1967a; Odhiambo, 1969), Blatella germanica (Dufrangais, 1968), Necrosia sparaxes Westwood (Gangrade, 1970), Gomphercus rufus (Hartmann, 1971), in dictyopterans (Louis and Kumar, 1971) and in Gryllides, Plebeiogryllus guttiventris (Ranganathan, 1971). From a review of the literature it is evident that information is available more on orthopterus insects rather than in others. Pickford et al., (1969) have shown that the male accessory reproductive gland complex of the migratory grasshopper, Malenoplus sanguinipes consists of 1 pair of long hyaline glands, 4 pairs of white glands, 10 pairs of short hyaline glands and 1 pair of seminal vesicles. Beams et al., (1962) have studied the ultrastructure of the conglobate or phallic gland of Periplaneta americana. Adiyodi and Adiyodi (1974) have studied the ultrastructural level of the utriculi majores of the accessory reproductive gland of the same species. The ultrastructure of the male reproductive gland in the colorado beetle has been investigated by DeLoof and Lagasse (1972). However, opinions differ among investigators on the nature of secretory products and the type of the glands observed in these insects (Snodgrass, 1937). The accessory gland of Blattella
germanica has been divided into two groups based on their length (Snodgrass, 1937) and in the same species Khalifa (1960) has divided the glands into three groups taking into account of their secretory content. But, Dufrangais (1968) has divided the gland into eight groups in the cockroach Blattella germanica based on morphological, anatomical and histological criteria. In Schistocerca gregaria opinion is differing among investigators as to the number of types of glands present. Cantacuzene (1967a) on her observations she described the accessory gland into fifteen different types of tubules based on morphology and physiology of the gland. But, Odhiambo (1969) has grouped them in the same species under nine types. In Locusta migratoria migratorioides the accessory gland are grouped into four types on the basis of their secretory content (Gregory, 1965). But cantacuzene (1967a) has divided the gland into fifteen types.

The review of literature, at hand, it is evident that our present knowledge of the male accessory reproductive gland is very limited and has not studied so far either on their morphological and histological organization or physiological or their secretory nature. It has, therefore, been programmed to study in detail the histological organisation and its secretory
activity of the male accessory reproductive gland in the house cricket, *Gryllodes sigillatus*.

**Material and methods**

Male crickets of *Gryllodes sigillatus* were obtained from the laboratory stock colony for the current investigation. The adult insects on their imaginal moult were dated and reared in a separate rearing jars. Thus, these specimens were sacrificed at appropriate stages for the studies of the accessory reproductive gland. The required adult male crickets accessory reproductive gland in different stages were exposed by vivisecting the specimens in insect Ringer solution (Ephrussi and Beadle, 1936). The ringer was subsequently removed and the gland was fixed in Bouin's fluid. Paraffin embedded material was sectioned at 6 μ thickness and stained in Ehrlich or Heidenhain's haematoxylin counter stained with alcoholic eosin or Masson's trichrome.

The criteria for assessing the different stages of the gland activity are based on the structure of the glandular epithelium and the amount of secretory products. Accordingly the arbitrary stages of activity have been established viz.,
1. First day male accessory reproductive gland
2. Second day male accessory reproductive gland
3. Third day male accessory reproductive gland
4. Fourth day male accessory reproductive gland
5. Sixth day male accessory reproductive gland
6. Eighth day male accessory reproductive gland
7. Ninth day male accessory reproductive gland before mating and
8. Ninth day male accessory reproductive gland after mating.

OBSERVATIONS

General topography and morphology of the accessory reproductive gland

In the male house cricket, G. sigillatus the accessory reproductive gland (ARG) is situated just above the last abdominal ganglion. It lies at posterior median end of the abdominal cavity below the rectum. The gland is just like mushroom shaped structure. It consists of numerable number of fine follicular tubules which are apposed together (Fig. 46) all around above the last abdominal ganglion. The ARG tubules can be distinguished into two categories based on their size
viz., 1. Utriculi minoris: A group of tubules which are situated at an anterio dorsal region of the gland and these are smaller than rest of the other tubules. 2. Utriculi majores: The longer tubules termed as utriculi majores. All the other longer tubules which are open into the swollen anterio-lateral end as well as towards posterior end of the ejaculatory duct. Further, the utriculi majores have been distinguished on the basis of the appearance of the tubules present when the ARG is immersed in insect Ringer solution viz. (1). A transparent tubules; these are on ventral position and transparent and (2) Granular tubules, which are situated at the posterio-lateral and anterio-lateral side in a bunch with thick epithelial lining. (Fig. 46).

Histology

The accessory reproductive gland follicular tubules in the male Gryllodes sigillatus have basically similar structure. Each tubule of the gland is simple epithelial structure the cell boundaries are not distinctly demarkated and formed of a single layered epithelial lining which enclosed a central lumen. The epithelium of the tubule is surrounded by a thin muscular layer (Fig. 47 and 53). Further, the diameter of
the lumen within the tubule is not uniform it tapers gradually towards the proximal end concomitant with this at the base of the tube the glandular epithelium is thinner (Fig. 48). The epithelium consists of a large spherical or oval nuclei (Fig. 47, 61 & 67). The secretion of the cells is in the form of fine granules which may be homogenous or heterogenous depending upon the types of cells. (Fig. 50).

First day accessory reproductive gland

The accessory reproductive gland of the cricket, G. sigillatus after their imaginal moult into adult were observed on the first day. The tubules of the gland are smaller at the mid-anterior dorsal side. There is no secretion in any follicles of the gland but by about 6 hours after their imaginal moult, the secretory granules are observed to be secreted into the lumen of the follicles. (Fig. 47).

Utriculi minoris

In a transverse section, it has been observed that the MARG tubules are more or less in a circular outline. The tubules of utriculi minoris measures 35.10 μ in length and 15.21 μ in thickness. The tubules consists of a single layer of
glandular epithelium resting on a delicate basement membrane and below lies a thin muscular wall. The cytoplasm of the cell is scanty, basophilic and appears granular. The nuclei of the epithelial cells are found to be close to the base of the cells and arranged in a neat row. These appear either oval or round. The nucleolus is not discernible and the condensed chromatin granules are closely packed. All the free end of the tubules, the glandular epithelium measures 11.68 µ, while at its base where it opens into the gland it measures 9.15 µ, in thickness (Fig. 49).

Utriculi majores

The tubules of utriculi majores, in transverse section have been observed that they are not in circular outline. They measure 47.50 µ in length and 15.7 µ in thickness and the thickness of the follicles is not uniform. The follicular wall is composed of a single layer of glandular epithelium enveloped by a thin basement membrane and muscular wall. The cytoplasm of the cells is sparse, granulated and basophilic. The nuclei in the epithelial cells are either oval or round and mostly placed at the centre of the cells. The chromatin granules fill the entire nucleus and nucleolus is
not clearly discernable. At the proximal end of the tubules is measured 10.68 μ thickness and its distal end of the tubule is 11.90 μ thick. The lumen within the tubules show a gradual increase in its size from the distal to the proximal end. (Fig. 52, 53 and 54).

Granular tubules

The tubules which occurring as a bunches latero-posteriorly near the seminal vesicle and ventral to the proximal end of the ejaculatory duct exhibits a different histological picture when compared to those of utriculi minoris and majores. The tubules of the glandular epithelium is thick and is covered by a circular wall. The cytoplasm is densely granulated and positive to iron haematoxylin. (Fig. 55). The nuclei are not aligned in the centre but present a dense stratified appearance there is not much of a size variations encountered between the distal and proximal end of the tubules 11.91 μ thick at the distal end 11.51 μ at the proximal end but the lumen within the tubule narrow down at its distal end. The secretory activity of the gland is noticed by about six hours after the imaginal ecdysis into adult. The secretory granules are eosinophilic and make their appearance at the apical end of
the glandular epithelium. The secretory products are subsequently extruded into the lumen. Small secretory granules are encountered towards the inner surface of the epithelial lining of the lumen. Whereas, the larger ones are found in the centre of the lumen of the follicles. (Fig. 56).

Second day accessory reproductive gland

There is a gradual increase in the size of the gland and tubules of the accessory reproductive gland also increased in their length. So also there is a gradual increase of the secretory products in the follicles.

The basic morphology and histology of the MARG is not changed much from that of the first day gland excepting for the increase in length of the follicles and secretory activity of the gland. The glandular epithelium shows a little increase in its thickness compared to that of one day old gland follicles. In addition to this the size difference is not evident. The distal end of the epithelium measures 11.94 μ in thickness while at the proximal end is 11.90 μ. Also, the nuclei of the epithelial cells at the distal end measures 8.5 μ and those at the proximal end measures 6.12 μ. Further, in these nuclei and the nucleoli appear as darkly stained bodies admit the
dispersed chromatin granules. The cytoplasm is granulated, basophilic and vacuolated. However, in a few follicles of utriculi majores, both at the ventro-lateral and anterio-lateral region, secretory product is not encountered in the lumen (Fig. 52, 53 & 54).

Secretory material is found more in the distal ends of the tubules of the utriculi majores. The cytoplasm in the active secretory region is vacuolated. The nuclei in these epithelial cells are big (9.51 μ) compared to those occurring at the proximal end of the follicles (6.12 μ). The nucleoli appear as darkly stained material and chromatin in the cells are dispersed. (Fig. 54 & 55).

Third day accessory reproductive gland

The structure of the accessory reproductive gland after imaginal ecdysis on this third day has been in a gradual increase in the size of the gland as well as follicles. There is an increase in the secretory product also. There is not much of deviation on the third day of the gland excepting for their increase in size and in length of the follicular tubules of utriculi majores and minoris. Secretory material is found more in the distal ends of the tubules. The cytoplasm in the
secretory region is vacuolated and nuclei in these epithelial cells also are bigger in size as compared to those of second day accessory reproductive gland follicles. Increase in the amount of eosinophilic secretion is noticed in the follicles of utriculi majores in which the lumen is mostly filled. The glandular epithelium shows a little increase in its thickness compared to that of second day tubules. In addition to this the size difference is evident. The proximal and distal end of the epithelium measures 12.01 μ and 12.24 μ respectively. The nuclei of the epithelial cells at the proximal end measures 6.92 μ and these at the distal end measures 9.15 μ. In these epithelium the nuclei and the nucleoli appear as darkly stained bodies amidst the dispersed chromatin granules. The cytoplasm is granulated, vacuolated and basophilic. However, in a few tubules of utriculi majores, both at the anterolateral and ventro-lateral position, the secretory products is not encountered in the lumen (Fig. 56). The thick granular tubules show an increase in the amount of the coarsely granulated secretory substance is found in the lumen and basophilic in nature. In these granulated follicles, the cytoplasm is coarsely granulated and the nuclei are round and are closely arranged (Fig. 54, 55 & 56).
Fourth day accessory reproductive gland

On the fourth day of the adult life, the reproductive gland structure is an increase in the size of the gland, tubules and secretory products. As the secretory substances provides the structural material for the formation of spermatophore are formed from the fourth day onwards. This confirmity is evidenced with the courtship behaviour of the male cricket Gryllodes sigillatus (Chapter III).

The basic histological structure as well as nature of the accessory reproductive gland in the fourth day, do not change much in different categories of the tubules, in the normal condition of male insect before mating. But cytological indications of secretory activities were noticed and have a few changes. The secretory activities have become pronounced in the granular epithelium. The intervening cytoplasm is finely granulated, basophilic and show small vacuities (Fig. 58). The nuclei in the tubular follicles of utriculi majores occur evenly spaced and the nucleoli present a strong basophilic reaction. The secretory content has filled the follicular lumen and is finally granulated and eosinophilic (Fig. 59 & 60). The utriculi majores of the accessory gland has not much changed.
The glandular follicles cell cytoplasm has the granulated basophilic cytoplasm. The secretion is coarsely granulated and eosinophilic (Fig. 61 & 62).

Fifth, Sixth, Seventh and Eighth day gland

From fourth day onwards, the male cricket, *Gryllodes sigillatus* attains a sexual maturity and started the singing of mating song which is evidenced in Chapter III. The spermatophores are seen, and formed from 4th day onwards. The secretory substances provide the structural materials for the formation of spermatophore. On these days of adult life, the tubules are all filled with the secretory products (Fig. 63).

Ninth day, accessory reproductive gland before mating

In all the three kinds of tubules the lumen is filled with the secretory substances. In most of the follicles of utriculi majores and minoris the glandular epithelium appears thin, the nuclei in majority of the cells appear 'empty' this represents a characteristic feature of the epithelium. There is not much of a deviation in the histological picture of the epithelium of the utriculi minoris except for the great increase in the secretory product. The secretory content is
homogenous and eosinophilic (Fig. 60). When the follicles of utriculi majores are bloated with the granulated eosinophilic secretion on the eighth day, the glandular epithelium has become thin representing a beaded appearance (Fig. 64 & 65).

Ninth day accessory reproductive gland after mating

Immediately after mating the elaboration and extrusion of materials into the lumen of the MARG is most common and continues until the gland is bloated with secretion. After mating, there is a reduction in the secretory product in the different types of tubules, but the degree of reduction varies in each type. The spaces and vacuoles are noticed in the secretory mass (Fig. 66).

The follicles of glandular epithelium of the both utriculi majores and minoris has increased in its thickness (vide Table 9). The basic cytoplasmic content of the cells has significantly increased. This conspicuous picture is noticed at the apical end of the follicles (Fig. 66). The cytoplasm is finely granulated, basophilic and contains vesicles. Such vesiculated cytoplasm has been noticed, is common in the utriculi majores tubules and granular tubules. Concomitantly with the increase in the thickness of the epithelium and
Table 9: Glandular epithelial thickness of different follicles of the MBRG in the cricket *Gryllus sigillatus* walker.

<table>
<thead>
<tr>
<th>Stages of MARG after imaginal moult into adult</th>
<th>Utriculi minoris</th>
<th>Utriculi majores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-granulated tubules</td>
<td>Granulated tubules</td>
</tr>
<tr>
<td>Proximal end</td>
<td>Distal end</td>
<td>Proximal end</td>
</tr>
<tr>
<td>First day</td>
<td>9.15 ± 0.91</td>
<td>10.28 ± 0.94</td>
</tr>
<tr>
<td>Second day</td>
<td>10.16 ± 0.84</td>
<td>10.22 ± 0.91</td>
</tr>
<tr>
<td>Third day</td>
<td>11.15 ± 0.96</td>
<td>11.16 ± 0.96</td>
</tr>
<tr>
<td>Fourth day</td>
<td>12.24 ± 1.20</td>
<td>12.82 ± 1.10</td>
</tr>
<tr>
<td>Sixth day</td>
<td>13.10 ± 1.25</td>
<td>13.86 ± 1.22</td>
</tr>
<tr>
<td>Eighth day</td>
<td>13.25 ± 1.20</td>
<td>13.90 ± 1.25</td>
</tr>
<tr>
<td>Ninth day</td>
<td>14.15 ± 0.75</td>
<td>14.96 ± 1.24</td>
</tr>
<tr>
<td>Ninth day after mating</td>
<td>14.90 ± 1.05</td>
<td>15.91 ± 1.20</td>
</tr>
</tbody>
</table>

Measurements in \( \mu \text{m} \pm \text{S.E.} \)
cytoplasmic content, the size of the nuclei has also been observed especially at the distal end of the follicles. The chromatin granules are not clumped as it was in the cells, as noticed just after moult, but they are distributed more towards the nuclear membrane. The secretory granules vary in their appearance, mostly they are confined to the periphery of the cells, at the apical end (Fig. 67). Such extruded secretory granules later coalesce with one another in the lumen forming a larger secretory mass, which once again bloats the follicles of the accessory reproductive gland (Fig. 68).

Discussion

The current study of accessory reproductive gland follicles in male *Gryllodes sigillatus* can be classified under three groups, viz. 1) utriculi minoris, 2) utriculi majores, the ventral transparent follicles and 3) the granular follicles, on the appearance when immersed in the Singer solution, the nature of the epithelium and the nature of the secretory content. In all the follicles the epithelium is composed of a single layer thickness of glandular cells and enveloped by a delicate basement membrane with a layer of muscle. Ito (1924) has reported in his studies on various
orthopterans that the similarities in the histological organization of the epithelium is to be enveloped by a basement membrane with a thin muscular wall. Else (1933) has shown the histological features in *Melanoplus differentialis* that the follicular epithelium is a singular layer of glandular cells and enveloped by a delicate membrane of muscle layer. Odhiambo (1969) has also reported the presence of basal membrane and muscular wall lining the outer surface of the follicles in *Schistocerca gregaria*. Outram (1970) has recorded in *Choristoneura fumiferana* that the glandular epithelium of the accessory reproductive gland covered by the muscular wall. Similarly De Loof and Lagasse (1972) in *Leptinotarsa decemlineata*, Ramalingam and Graig (1978) in *Aedes triseriatus* have reported the presence of muscular wall and basement membranes enveloping the epithelium of the accessory gland. The histological features of the follicular epithelium resembles that of *Plebeogryllus guttiventris* by Ranganathan (1972). Adiyodi and Adiyodi (1974) have studied at the ultrastructural level of utriculi majores of the MARG in *Periplaneta americana* and revealed the presence of basement membrane and muscular layer. Cantacuzene (1967a) has shown in *Locusta migratoria* that the accessory gland tubules at the distal portion of the lumen
is large, the thin muscular coat and the cells are vacuolated in appearance.

The histological organisation that the presence of muscular wall and basement membrane is enveloping the epithelium of the accessory reproductive gland follicles in *Gryllodes sigillatus* supported the above investigations. In the present study, it has been observed in the male *G. sigillatus* that the follicles of MARG could be grouped into three categories based on (1) the length of the follicles (2) the nature of the glandular epithelium, (3) appearance when immersed in Ringer and the appearance of the secretory contents.

The utriculi minoris and utriculi majores show morphological variations in their length. The granular follicles are characterised by stratified thick epithelium, granulated basophilic cytoplasm and basophilic secretory content. The ventral transparent follicles appear clear in Ringer. The morphological variations of MARG shows in different groups of insects (Review: De Loof and Lagasse, 1972; Adiyodi, 1974; Ranganathan, 1972) Khalifa (1950) has been divided the accessory gland of cockroach, *Blatella germanica* into three
catagoris. Whereas, Dufrangais (1968) has divided the accessory gland of the same species into eight different types on the morphological aspects of the secretory product. Van Wyk (1952) has distinguished the accessory gland into three groups on the basis of morphological study in Leucophaea maderae. Gregory (1965) has divided the accessory gland into four groups on the basis of appearance of their secretory mass in the Locusta migratoria migratorioides. However, Cantacuzene (1967a) has divided the gland of the same species into fifteen types. Odhiambo (1969) has grouped the accessory gland of Schistocerca gregaria into nine different types on the basis of morphological and secretory content. However, Cantacuzene (1967a) has divided the accessory reproductive gland of the same species into fifteen different types on the basis of morphological aspects of the secretion. From a review of the literature it is clearly indicating that there are variations on the basis of the classification but the morphological variations in the length of the follicles or the structure of the glandular epithelium or in the appearance of the secretory product reflect the variations in the cytoarchitecture of the accessory gland. The present study on Gryllodes sigillatus has also been revealed that grouping of accessory reproductive
gland tubules can be made on the basis of their length, the appearance of the secretory mass, and the structure of the epithelium, a criteria which has been adopted for other different species of insects mentioned earlier studies.

Macro-apocrine type of secretory activity

It has been reported earlier that the follicles of the accessory reproductive gland in \textit{G. sigillatus} exhibit varying histological picture at the proximal and distal ends of the tubules. Generally, in all the types of the follicles, the diameter of the lumen is reduced at the distal end, the epithelium is thick with large nuclei and granular cytoplasm. At the proximal ends of the tubules the diameter of the lumen is increased, the epithelium is thin with small nuclei and the cytoplasm is less. Further, it has been noticed from the late first day onwards that when the secretory activity starts the nuclei at the distal end of the tubules appear empty due to dispersed nature of the chromatin and the nucleolus is prominent. These characteristic cytological features are of indicative of secretory activity. It has been shown by Odhiambo (1969) in \textit{Schistocerca gregaria} that the distal half of the follicles of the accessory gland are secretory since he could
observe PAS positive material particularly to the distal end of the tubules. Gregory (1965) noticed in *Locusta migratoria migratorioides* that the accessory gland tubules at the proximal region have thick muscular coat and the cells appear narrower than the distal part. Contacuzene (1967a) has shown in *Locusta migratoria* that the accessory gland tubules at the distal portion of the lumen is large, the thin muscular coat and the cells are vacuolated in appearance. Also, Anderson (1950) in *Popillia japonica* has observed that the cells at the basal portion of the accessory gland tubules do not seem to be secretory. Ranganathan (1972) has noticed in *P. guttiventris* that the secretory granules are seen only at the distal end of the follicles. It has been observed in *Gryllodes sigillatus* that the secretory products that are noticed only at the distal portion of the gland follicles and they are released or extruded about six hours after imaginal ecdysis into adult. Further, secretory product is replanished in the tubules six to eight hours after mating for the next formation of spermatophore. On the basis of above investigations and the evidential observations made in *G. sigillatus*, it is concluded that the distal portion alone appears to be secretory and can be designated as macro-apocrine type of secretory activity.
In the current study in *Gryllodes sigillatus* it has been observed that the secretory products of the three types of follicles vary in their appearance. It has been observed that the secretion in the utriculi minoris is finely granulated and eosinophilic and in the utriculi majores including the ventral transparent tubules it is granulated and eosinophilic. But in the granular tubules it is coarsely granulated and basophilic in nature. These variations in the presence of the secretory product in the different tubules seem to suggest the acidic nature and the proteineous (basic nature) of the secretion. Morphological variations of the secretory product of the MARG has been recorded in many insects. It has shown by Louis and Kumar (1971) in Dictyopterans that in the long tubules of MARG two layers of an outer fine compact colourless secretion and an inner layer of eosinophilic granular secretion. In the intermediate tubules, the outer layer of the secretion is fine, compact and lightly eosinophilic while inner layer is compact and strongly eosinophilic. Whereas, in the short tubules the outer layer is of lightly eosinophilic, fine compact secretion and an inner layer is slightly coarse, compact and strongly eosinophilic. Ranganathan (1972) has observed in *P. guttiventris*, that the morphological variations in the three
type of tubules vary in their appearance. He has observed that the secretion in the utriculi minoris is finally granulated and eosinophilic, in the utriculi majores including the ventral transparent tubules granulated and eosinophilic while in the granular follicles it is coarsely granulated and basophilic. Ramalingam and Craig (1977) have observed the morphological variations in the secretory granules at the ultrastructural level in the MARG of Aedes triseriatus. These variations in appearance of the secretory products in the different follicles seem to suggest the acidic and the basic nature of the secretory substances.
Fig. 46: Whole mount of MARG of adult *G. sigillatus* when immersed in insect Ringer, showing VD, vas deferens; TT, transparent tubules; NT, non-transparent tubules (granular), X 35.

Fig. 47: A portion of follicular T.S. showing E, epithelium; M, muscular layer; N, Nuclei; SP, secretory product; X 1000.

Fig. 48: T.S. of follicles of utriculi majores, the granulated and non-granulated MARG in *G. sigillatus* showing D, diameter of the lumen; ET, epithelial thickness; PT, proximal tubular end; DT, distal end; X 100.
EXPLANATION TO FIGURES

Fig. 49 : T.S. of first day MARG follicles of *G. sigillatus*
showing E, epithelium; N, Nuclei, L, Lumen; X 1000

Fig. 50 : T.S. of first day MARG tubules of *G. sigillatus*
showing secretory contents. HO, homogenous; HE, heterogenous; X 100.

Fig. 51 : T.S. of first day MARG follicles of *G. sigillatus*
showing all tubules more or less circular outline, UMI, utriculi minoris; UMT, utriculi majores transparent; UMG, utriculi majores granulated; X 100.
EXPLANATION TO FIGURES

Fig. 52 : T.S. of first day MARG utriculi majores showing L, lumen; X 100.

Fig. 53 : T.S. of second day accessory reproductive gland transparent follicles showing thickness of proximal end CW, circular wall BM, basement membrane; N. nuclei, X 1000.

Fig. 54 : T.S. of second day transparent follicles of male accessory reproductive gland showing N. nucleus; C, cytoplasm, X 1000.
EXPLANATION TO FIGURES

Fig. 55: T.S. of second day granular follicles of MARG in G. sigillatus showing N, Nuclei; C. cytoplasms X 1000.

Fig. 56: T.S. of third day MARG of utriculi majores showing CGS, coarsely granulated secretory substance; X 1000.

Fig. 57: T.S. of third day MARG of utriculi minoris showing C. cytoplasm; N, nuclei, X 1000.
EXPLANATION TO FIGURES

Fig. 58: T.S. of fourth day MARG of utriculi majores showing IC, Interviewing cytoplasm; SV, small vacuities; X 1000.

Fig. 59: T.S. of fourth day MARG of utriculi majores showing the secretory product (sp), and Lumen (L.) X 400.

Fig. 60: T.S. of fourth day MARG of utriculi minoris showing secretory content in the lumen. FG, Finely granulated and eosinophilic; E. epithelium basophilic; X 100.
EXPLANATION TO FIGURES

Fig. 61: T.S of fourth day MARG of utriculi major follicles showing C, cytoplasm; N, nuclei; X 1000.

Fig. 62: T.S. of fourth day MARG of utriculi major follicles showing C, cytoplasm S, secretion; X 400.

Fig. 63: T.S. of eighth day MARG of utriculi major follicles showing SP, secretory products; X 400.
EXPLANATION TO FIGURES

Fig. 64: Whole mount of ninth day MARG utriculi majores showing B, beaded appearance; X 35.

Fig. 65: L.S. of ninth day MARG utriculi major follicles showing B, beaded appearance; X 1000.

Fig. 66: T.S. of ninth day MARG utriculi majores tubules after mating showing SV, space and vacuoles; X 400.
EXPLANATION TO FIGURES

Fig. 67 : T.S. of ninth day MARG of utriculi major follicles showing N, nuclei; CG, chromatin granules; X 1000.

Fig. 68 : T.S. of ninth day MARG of utriculi major follicle at the apical end showing SG secretory granules; C, cytoplasm; N, Nuclei; X 1000.