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THE MORPHOLOGICAL STUDY OF THE RECTUM OF THE ORIENTAL FRUIT FLY, *DACUS DORSALIS* HENDEL WITH SCANNING ELECTRON MICROSCOPY[1]

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Wen-Yung Lee, Tao-Hsing Chang and Tzung-Kuo Tseng (1986) The morphology of a sex-pheromone producing gland found in the rectum of *Dacus dorsalis* males was studies by the scanning electron microscope. *Bull. Inst. Zool. Academia Sinica* **25**(1): 39-46. The rectum appears as a sac fairly like a cucumber. The entire sac is coated by the well-developed circular muscle and a few tracheoles inserted into the muscle bundle. The striation of the muscle is very distinctive. Projecting from the anterior end of the rectal sac are four conical rectal papillae. The rectum is almost the same with different ages in the female flies but not in the male flies. While the male fly is in sexual maturation the reservoir and the secretory sac at the posterior dorsal portion of the rectal sac is enlarged, the entire rectal sac, then, becomes a ball like.

Fletcher (1969) demonstrated the development and histology of the sex pheromone glands of the male Queensland fruit fly, *Dacus tryoni*. His experiments showed that the production of this gland acts as a sex pheromone. This pheromone is produced and stored by a gland complex consisting of a secretory sac and a ventral reservoir which is formed from the right posterior wall of the rectal sac. This is the first case in which a sex pheromone is stored in a special reservoir prior to release. Schultz *et al.* (1971) described the suspected sex pheromone glands of three economically important species of *Dacus*, the oriental fruit fly, *D. dorsalis* and the olive fruit fly, *D. oleae*, which correspond closely in their anatomical and histological make up to that described for *D. tryoni* by Fletcher (1969). The gland consists of a reservoir occupying the right lateral posterior one-third of the rectal sac and a small bulblike secretory sac opening into the reservoir at its base. In the melon fly, *D. cucurbitae*, the rectal gland is situated ventro-laterally off the rectal sac, and forms a distinct chamber (Schultz *et al.* 1971). Kobayashi *et al.* (1978) reported the source of production or storage of the pheromone in oriental fruit fly males is the rectal gland. Nation (11) systematically examined males and females of tephritid fruit flies from the genera *Anastrepha*, *Ceratitis*, *Dacus* and *Rhagoletis* for the presence of possible sex pheromone glands, and determined whether particular glands might be characteristic of certain genera. However this gland was not found in species of other genera besides the genera mentioned above. There is a paucity of knowledge of the relationships between gland structure and pheromone production. This is the first report in the systematically study of pheromone producing gland in the

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oriental fruit fly, *Dacus dorsalis*. The scanning electron microscope was used to study the morphology of the rectum to assess the role in the pheromone production and storage.

MATERIALS AND METHODS

The oriental fruit flies, *Dacus dorsalis* Hendel were raised in the fruit fly laboratory, Institute of Zoology, Academia Sinica, Taipei with the techniques described by Chiu (1977). Adult flies were fed with sugar, water, and peptone in 30-cm^3 screen cages held at 25±2°C and 65±5% R. H. The flies were dissected at 1, 3, 5, 7, 10 day after eclosion. The specimens of recta were cut out and fixed in 2.5% glutaraldehyde solution with 0.1 M cacodylate buffer at 4°C for 2 hours, then washed in 2 changes of distilled water, dehydrated through a series of acetone to 100% acetone. After critical-point dehydration treated in liquid CO_2, the recta were mounted on metal stubs, coated with gold in the ion-coater, and observed with the Hitachi S-450 scanning electron microscope.

RESULTS AND DISCUSSION

The external morphology of the rectum in the oriental fruit fly appears as a sac and cucumber-like from the observations of the scanning electron microscope (Fig. 1). The rectal sac is surrounded by a well-developed circular muscle (M), connected anteriorly to the colon (C) and posteriorly to the anal tube (A). Four round shaped conical rectal pads (RP) on the anterior portion of the rectal sac. The number of the rectal pads is various in different insects. The usual number in Dipterans is four or six, but in *Culex pipiens* and *Atherix ibis*, four rectal pads in the males and six in the females (Snodgrass, 1935).

Tonkov (1925) stated that two types of structure in the rectal pad are found in different insects. The first type is simple, only consisting of a single layer of cells, while the second type has two layers of cells and the organs are various either compact or hollow. The structure of the rectal pad in the oriental fruit flies is between the first and the second type. It contains a single layer of cells and forms as a hollow conical invagination with a papilliform. It is, therefore, termed as the rectal papilla (Fig. 2, Rp) instead of the rectal pad in this paper. A ramifying trachea with several branches (Tr) penetrates into each rectal papilla, and their tracheoles (tr) insert to the muscle bundles (Fig. 2 and 13, tr and M).

The morphology of the rectum is similar each other in different ages of the female flies. The figure 3 to 5 are the electron-photographs of the rectum on the first, third and the fifth days after eclosion. The opening of the colon (C) and four rectal papillae project (Rp) on the anterior portion of the rectal sac. The posterior end of the rectum appears round in shape and connects to anal tube (A). However, in the male flies, the posterior portion of the rectum is distinguishably different in its ages. On the first day after eclosion (Fig. 6), there is a small bulb-like structure (S) at the dorsal posterior wall of the rectum near the anal tube (A). This small bulb was designated by Fletcher (1969) as a secretory sac. The posterior portion of the rectal sac in the third-day-old male (Fig. 7) comprises of two parts: the secretory sac (S) and the reservoir (R). The reservoir is in the front position to the secretory sac (S). The function of the reservoir is a storage of the secretion (Fletcher, 1968).

These two components enlarge while the flies are growing, the figure 8 and 9 are the

Fig. 1. The whole view of the rectal sac in the oriental fruit fly. A: Anal tube, C: Colon, M: Circular muscle, RP: Rectal pads, tr: Tracheole.

Fig. 2. The magnification photograph of the anterior portion of the rectum, M: Circular muscle, Rp: Rectal papillae, Tr: Trachea, tr: Tracheoles.


1
C
RP
tr
M
A
2
Tr
Tr
Tr
Rp
tr
M

rectal sac from the fifth and the seventh-day-old males. The secretory sac and the reservoir show bigger than those in the third day old male. On the tenth-day-old flies (Fig. 10), the secretory sac (S) becomes small and the reservoir (R) enlarges. Fletcher (1969) reported that there is a close correlation between the amount of secretion in the reservoir and the onset of sexual activity. The peak of mating activity of the oriental fruit fly is on the tenth day after eclosion (Lee, *et al.* 1982). When the flies mating or the courtship activity will occur, the whole rectal sac is enlarged fairly like a ball as shown in the figure 12 and the rectal papillae (Rp) show as a tiny spot on the top of the rectal sac. The reservoir (R) is full of secretion up to the anterior portion of the rectal sac. The secretion sac (S) become small and the anal tube (A) are still remained. In this time, the striation of the circular muscles almost disappeared by the stretch of the rectal sac as shown in the figure 15. On the contrast, the rectal sac of the female did not change (Fig. 11) during the sexual activity. The striation of the circular muscle was clearly shown in the figures 13 (M) and 14.

Male-produced sex pheromone in Tephritidae have been reported for the Mediterranean fruit fly, *Ceratitis capitata* by Feron (1959), the Queensland fruit fly, *Dacus trioni* by Fletcher (1968), the island fruit fly, *Rioxa pornia* by Pritchard (1967), the Caribbean fruit fly, *Anastrepha suspensa* by Nation (1972), the olive fruit fly, *D. oleae* by Economopoulos *et al.* (1971), the oriental fruit fly, *D. dorsalis* and the melon fly, *D. cucurbitae* by Kobayashi *et al.* (1978) and the apple maggot fly, *Rhagoletis pomonella* by Prokopy (1975). Hodosh *et al.* (1979) found the sex pheromone producing gland of *Drosophila grimshawi* is in the male abdomen, consisting of two intra-anal lobes, and the pheromone is released with the liquid secretion flowing along the intra-anal lobes and was brushed onto the substrate by finger-like projections on the lobes surface. Nation (1981) reported that the pheromone producing gland of the Caribbean fruit fly and the Mediterranean fruit fly are located in the pleural gland and the enlarged salivary glands. Both the pheromone gland of the Queensland fruit fly and the suspected sex-pheromone gland of three species tephritids, *Dacus oleae*, *D. dorsalis* and *D. cucurbitae* are located on the secretory sac of the rectum in the male flies, and their recta include two bulbous structures on the posterior region, a small secretory sac and a large reservoir (Fletcher, 1969; Schultz *et al.* 1971). All these structures in the Queensland fruit fly and the three species of tephritids are much similar to the present studies of the oriental fruit fly. They have a small bulbous secretory sac and an enlarged reservoir. These structure are never present in the female fly.

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Fig. 3-5. The rectal sac of the first-day, the third-day, and the fifth-day female fly after eclosion. The structure of the rectal sac show no change. A: Anal tube, C: Colon, Rp: Rectal papillae.

Fig. 6. The rectal sac of the first-day-old male fly, a small bulblike secretory sac (S) and a reservoir (R) occur in the posterior portion near the anal tube (A).

Fig. 7. The rectal sac of the third-day male fly after eclosion, the reservoir (R) appears enlarged near the secretory sac (S). A: Anal tube.

Fig. 8. The rectal sac of the fifth and the seventh-day male fly after eclosion. The reservoir (R) and the secretory sac (S) appear enlarged. A: Anal tube.

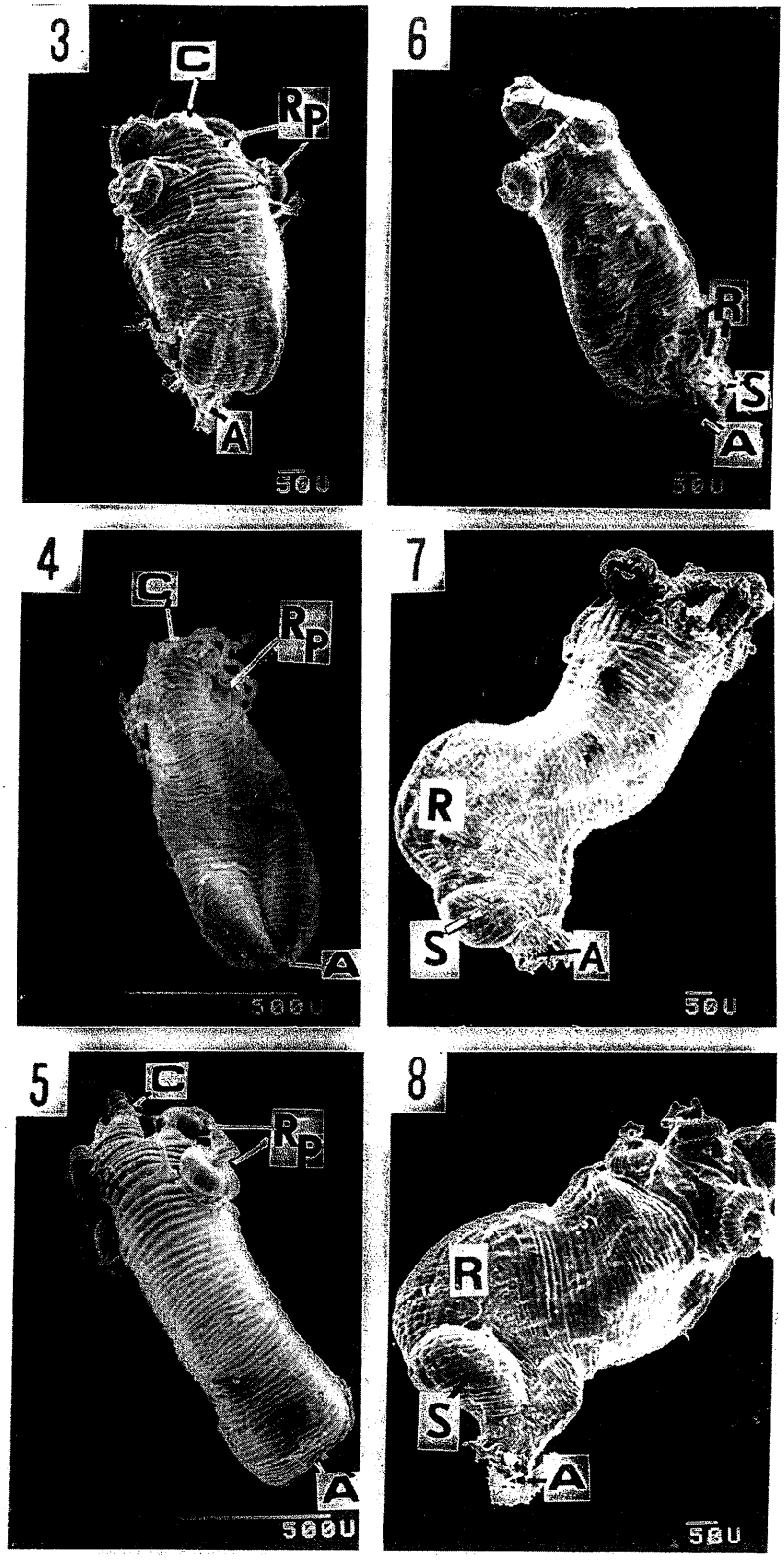
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Fig. 9. The rectal sac of the fifth and the seventh-day male fly after eclosion. The reservoir (R) and the secretory sac (S) appear enlarged. A: Anal tube.

Fig. 10. The rectal sac of the tenth-day male fly after eclosion, the reservoir (R) much enlarged, the secretory sac (S) becomes small beside to the anal tube (A).

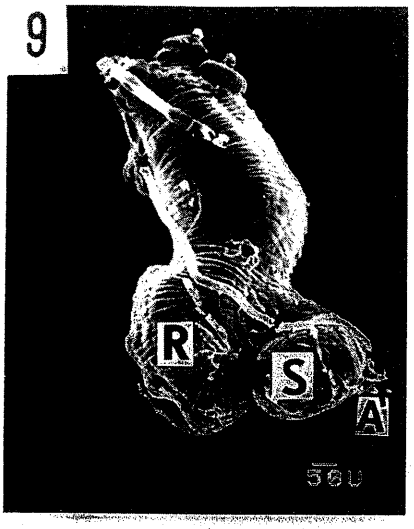
Fig. 11. The rectal sac of female fly during sexual activity. The external structure does not change as in the figure 3 to 5.

Fig. 12. The rectal sac of male fly during sexual activity, the whole shape of the rectal sac become like a ball, the rectal papillae (Rp) become a small cone. A: Anal tube, R: reservoir, S: secretory sac.

Fig. 13. The magnification of the circular muscle (M) of the female fly. The muscle has well-developed striations and the tracheoles (tr) which insert into the muscle bundles.

Fig. 14. The magnification micrograph of the figure 13. The striation of the circular muscle (M) are very distinctive.

Fig. 15. The magnification micrograph of the circular muscle of male fly (Fig. 12) during sexual activity. The striation of the circular muscle are almost disappeared.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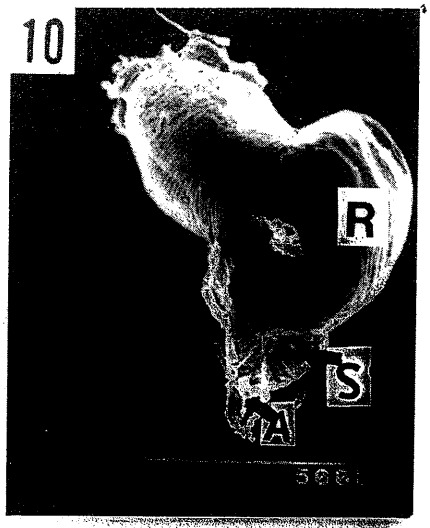
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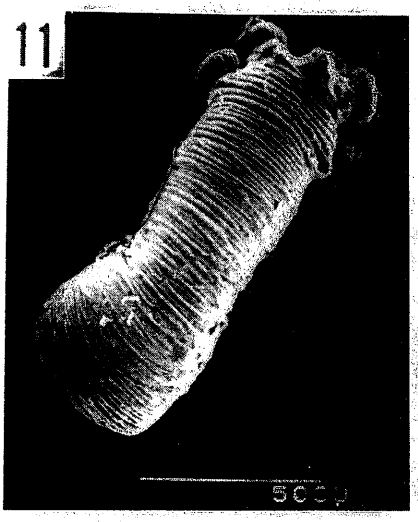
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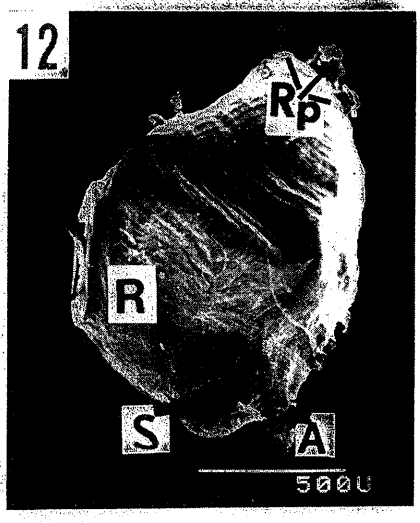
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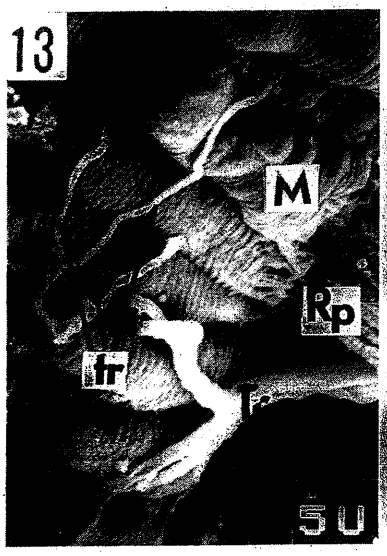
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利用掃描式電子顯微鏡作東方果實蠅直腸之形態學研究

李 文 蓉　張 桃 興　曾 宗 國

利用掃描式電子顯微鏡作東方果實蠅直腸之形態學研究，直腸爲囊狀，像胡瓜，這整個囊被發達的環狀肌所包圍，並有少數氣管插入肌肉中，肌肉的節線非常明顯，在直腸前端有四個突出的圓錐形直腸突起 (rectal papillae)。直腸的後背、肛門管前端有膨大部份稱分泌囊 (secretory sac)。在成長的雄蠅，其直腸的分泌囊前端膨大，稱儲藏部 (reservoir)，儲藏部隨年齡而增大，直到交尾時，雄蠅直腸囊膨大如球狀，內充滿費洛蒙，但雌蠅則沒有此種現象，形狀與幼齡時相同。