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The larval and imaginal oenocytes of *Callosobruchus maculatus* (FABRICIUS)

(Coleoptera: Bruchidae)

With 5 textfigures

Introduction

Very little work has been done on the origin, arrangement and the metamorphic behaviour of oenocytes in Coleoptera. WHEELER (1892) made general observations on the origin and location of oenocytes in different orders of insects. KOCH (1940) studied the structure of oenocytes in *Tribolium castaneum* (HERBST) while ROTH (1942) described their structure and arrangement in *Tenebrio molitor* LINNAEUS and *T. obscurus* FABRICIUS. KREUSCHER (1922), ALBRO (1930) and, MURRAY & TIEGS (1935) have reported the metamorphic behaviour of oenocytes in the beetles *Galerucella nymphaeae* LINNAEUS, *Dytiscus marginalis* and *Calandra oryzae* LINNAEUS respectively. WIGGLESWORTH (1948) observed the behaviour of oenocytes in the pupal stage of *Tenebrio molitor* LINNAEUS in connection with the secretion of cuticulin layer of the epicuticle.

The work so far done on the oenocytes of Coleoptera reveals that there is much variation in their structure, arrangement and metamorphic behaviour. Additional information from different families of the group is therefore very essential for finding the generalized condition of oenocytes in Coleoptera and its comparison with condition met with in other Endopterygotes and for that matter with other insect groups. The present study deals with the origin, arrangement and the metamorphic behaviour of the oenocytes of *Callosobruchus maculatus* (FABRICIUS).

Material and Technique

Callosobruchus maculatus (FABRICIUS), a multibrooded pest of stored pulses, was bred in the laboratory on the grains of *Phaseolus radiatus* (MUNG) at a constant temperature of 30 °C and R. H. 70%. Its larvae, prepupae and pupae were taken by cutting open the grains at the appropriate time (ARORA & PAJNI, 1957).

The oenocytes were studied in the serial longitudinal sections of the entire larva, prepupa, pupa and the freshly emerged imago which were fixed in hot CARL's fixative for 15 to 25 minutes, the period increasing with the size of the material. The sections were doubly stained with iron haematoxylin and alcoholic eosin.

Observations

The oenocytes are the large cells of varying shapes irregularly scattered in the fat body but usually situated along the stigmata and the tracheae.

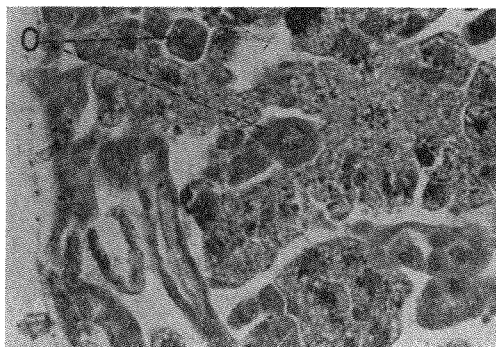


Fig. 1. Oenocytes of first instar larva ($\times 256$).
O, oenocytes

The oenocytes in the first instar larva of *C. maculatus* (Fig. 1) are large spherical, oval or irregular cells with distinct spherical nuclei and homogeneous finely granular cytoplasm. They are situated inner to the hypodermal layer clustered particularly close to and in between the stigmata from where they seem to migrate into the interior as they are found scattered in the adjoining fat body. The oenocytes grow in the subsequent larval stadia (Fig. 2) when some

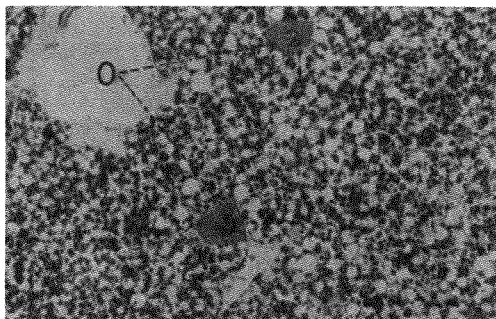


Fig. 2. Oenocytes of fourth instar larva ($\times 160$).
O, oenocytes

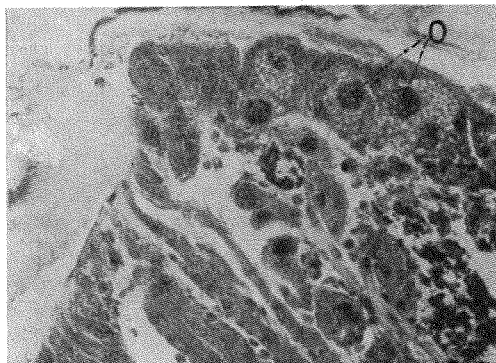


Fig. 3. Formation of new oenocytes from hypodermal layer in the fourth instar larva ($\times 200$). O, oenocytes

new oenocytes also appear to differentiate from the hypodermal cells in the head region (Fig. 3). The oenocytes do not appear to undergo any division during the larval period.

The oenocytes of the prepupa are similar to those of the fully formed larva but during this stage in addition to the large larval oenocytes other small oenocytes called the imaginal oenocytes, make their appearance as special segmentally arranged spherical groups of hypodermal cells in the vicinity of thoracic and abdominal stigmata (Fig. 4). Each segmental group of oenocytes consists of 5—8 small oenocytes.

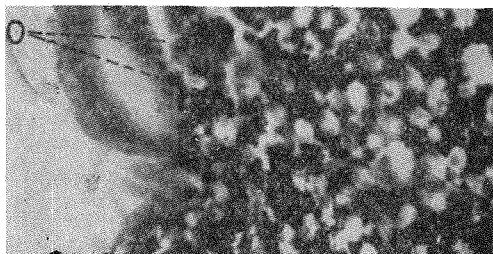


Fig. 5. Reduced oenocytes in the pupa ($\times 205$). O, oenocytes

Fig. 4. Segmental group of imaginal oenocytes in the prepupa ($\times 205$). SG, Segmental group of imaginal oenocytes; SP, spiracle

The larval oenocytes undergo a considerable reduction in their size in the early pupa (Fig. 5), gradually lose their cytoplasm and are almost completely disintegrated in the late pupa. The imaginal oenocytes arise as regular streams from the segmental groups of hypodermal cells in the freshly emerged imago. The imaginal oenocytes are relatively smaller than the larval oenocytes.

Discussion

The oenocytes in Coleoptera are arranged in three ways in close association with the spiracles. They may be found scattered indiscriminately near and inbetween the spiracles as in the larva and adult of *Callosobruchus*, in the larva of *Galerucella* (ALBRO, 1930) and in the larva and adult of *Calandra* (MURRAY & TIEGS, 1935); or arranged in more or less spherical segmental clusters close to the spiracles as in the adult of *Dytiscus* (KREUSCHER, 1922) and in the larva, pupa and adult of *Tenebrio* (ROTH, 1942; WIGGLESWORTH, 1948) or disposed in longitudinal lateral bands of varying extent with rows of oenocytes as side branches towards the spiracles as in the larva of *Dytiscus* (KREUSCHER, 1922) and the larva of *Ctenicera* (EIDT, 1958). It is not easy to say which of the three

conditions is the primitive one. According to WHEELER (1892), however, the oenocytes in most of the insects originate in the embryo from the segmentally arranged groups of cells near the spiracles and this original condition is maintained in the adults of Exopterygote orders Odonata, Plecoptera, Isoptera and Ephemeroptera. This primitive condition has probably led to the lengthening of the segmental groups into small bands of varying dimensions as in Thysanoptera (WHEELER, 1892), in Lepidopteran *Ephestia* (STEUDEL, 1912) and in some Coleoptera described above and has ultimately resulted in the haphazard dispersal of the oenocytes throughout the fat body as in aphids (WHEELER, 1892), certain Hymenoptera (PEREZ, 1902, 1911) and Diptera (PEREZ, 1910). Whereas the origin of imaginal oenocytes from segmental groups of hypodermal cells met with in *Callosobruchus* has been described in the beetles *Calandra* and *Dytiscus*, their differentiation from the hypodermal layer in the head region has been observed for the first time in *Callosobruchus*.

The cytoplasm of the oenocytes in *Callosobruchus* is finely granular and devoid of any special inclusions. Various kinds of cytoplasmic inclusions have, however, been described in Coleoptera as well as in other insects. These include peripheral vacuoles in *Calandra* (MURRAY & TIEGS, 1935), *Galerucella* (ALBRO, 1930) and *Rhodnius* (WIGGLESWORTH, 1934); radiating canals in *Dytiscus* (KREUSCHER, 1922) and in the Lepidopteran *Ephestia* (STEUDEL, 1912); clumps of brownish granules in *Tenebrio* (ROTH, 1940), certain sod like structures in *Tribolium* (KOCH, 1940) and, refractile spheres and amber coloured granules in *Periplaneta* (KRAMER & WIGGLESWORTH, 1950). The presence of various inclusions in the cytoplasm of oenocytes is probably concerned with their secretory activity relating to the deposition of the cuticulin layer of the epicuticle and cuticular waxes (WIGGLESWORTH, 1934, 1947, 1948; KRAMER & WIGGLESWORTH, 1950).

The oenocytes in most of the beetles show two generations which is apparently the generalized condition of the group but there are cases where one of the generations, the imaginal, is suppressed resulting in a single generation of larval oenocytes only. In *Callosobruchus* the larval oenocytes are lost during the pupal stage and are replaced by imaginal oenocytes arising from segmental groups of hypodermal cells. The condition met with in *Calandra* (MURRAY & TIEGS, 1935) is almost similar to that in *Callosobruchus* except that in the former some of the larval oenocytes fail to disintegrate and continue to be present with the imaginal oenocytes in the adult. In *Dytiscus*, according to KREUSCHER (1922), the larval oenocytes do not dwindle away completely but are only reduced to about 1/3 their original size during the pupal stage and both the larval and imaginal generations of oenocytes coexist in the adult. *Galerucella*, as has been observed by ALBRO (1930), has one generation of larval oenocytes only which exhibit an interesting phenomenon of cyclic activity during each stadium, the oenocytes growing to develop vacuoles and bursting at each moult. A similar behaviour of oenocytes has been described in the pupal stage of *Tenebrio* by WIGGLESWORTH (1948), in *Ephestia* by STEUDEL (1912) and in *Rhodnius* by WIGGLESWORTH (1934). The generalized condition of two generations of oenocytes in

Coleoptera has its parallel in some other Endopterygotes like the Hymenopteran *Nasonia* (TIEGS, 1922), the Lepidopterans *Bombyx* (VERSON & BISSON, 1900) and *Ephesia* (STEUDEL, 1912) and Dipteran *Calliphora* (PEREZ, 1910). The Hemipteroid insects, on the other hand, show a condition of possessing more than two generations, a new generation of oenocytes appearing at each moult and the old generation disappearing as in *Notonecta* (POISSON, 1924) and *Rhodnius* (WIGGLESWORTH, 1934).

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Summary

There are two generations of oenocytes in *Callosobruchus maculatus* (FABRICIUS), the large larval oenocytes and comparatively small imaginal oenocytes, both scattered haphazardly in the fat body but clustered particularly close to and in between the stigmata. The larval oenocytes are lost during the pupal stage and are replaced by imaginal oenocytes arising from segmental groups of hypodermal cells which make their appearance in the vicinity of spiracles in the prepupa. The structure, origin and metamorphic behaviour of the oenocytes are discussed.

Zusammenfassung

Es gibt zwei Generationen von Önozyten bei *Callosobruchus maculatus* (FABRICIUS), die großen Larvenönozyten und die verhältnismäßig kleinen Imagoönozyten. Beide sind willkürlich über den Fettkörper verteilt, drängen sich aber besonders dicht um die Stigmata und zwischen ihnen. Die Larvenönozyten verlieren sich im Puppenstadium und werden durch die Imagoönozyten ersetzt. Letztere entstehen aus Segmentgruppen von Hypodermiszellen, die in der Nähe von Tracheen bei der Praepuppe auftreten. Struktur, Ursprung und gestaltveränderndes Verhalten der Önozyten werden erörtert.

Резюме

Имеются два поколения энцитов в *Callosobruchus maculatus* (FABRICIUS), большие личиночные и сравнительно маленькие имагинальные. Оба совсем произвольно распределены по жирной ткани, особенно густо они находятся вблизи стигматов и между ними. Личиночные энциты теряются в кукольной фазе и заменяются имагинальными. Последние образуются из групп сегментов клеток гиподерма, которые возникают в передкукольной фазе вблизи трахеев. Структура, происхождение и формоизменительность энцитов обсуждается.

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