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Embryonic Development of the Corpora Allata of Papilionidae (Lepidoptera)

Masahiro TANAKA

Synopsis

Embryonic development of the corpora allata of *Parnassius glacialis*, *Luehdorfia japonica*, *Byasa (Atrophaneura) alcinous alcinous* and *Papilio machaon hippocrates* is described. The origin and the formation of corpora allata are the same among these four species belonging to different genera respectively. When the cephalo-gnathal appendages begin to arrange themselves around the stomodaeal opening, and the prothoracic glands are separated from the ectoderm before the revolution stage, the rudiments of corpora allata appear as a pair of ingrowths on the wall of the apodemes of flexor mandibulae. They are carried dorsally in close contact with the wall of apodemes, and then they are cut off from it, coming finally to lie at the posterior part of the extremities of the transverse bridge of the tentorium, under the ventral side of the brain.

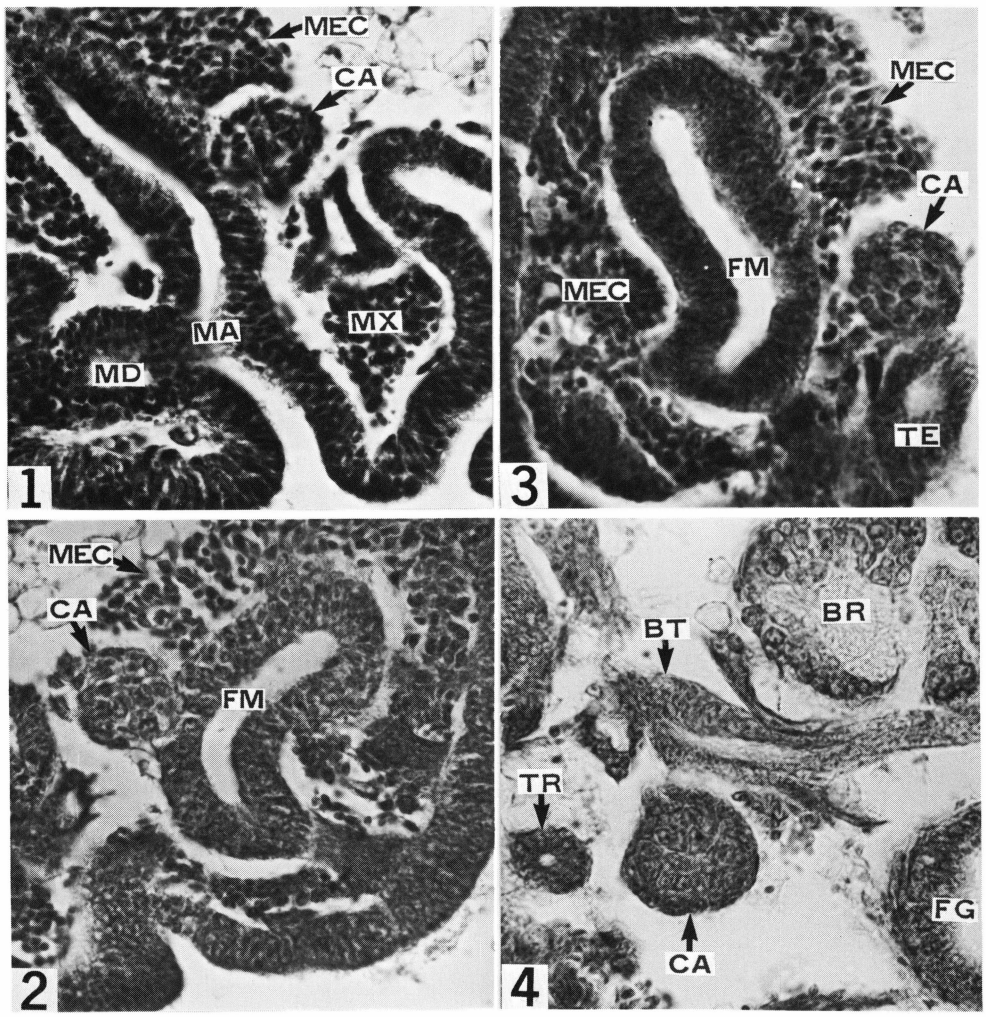
Introduction

Several observations on the embryonic development of corpora allata in the Lepidoptera have been done by Ito (1918), Eastham (1930), Okada (1960), Kobayashi (1983) and Kobayashi and Ando (1983). The origin of corpora allata and the manner of their formation in the early stage of development are essentially the same in the lepidopteran embryos until now studied, but there are some differences of opinions concerning the later stage among the species or genera in the order.

In the present paper, the author describes the embryonic development of corpora allata of *Parnassius glacialis*, *Luehdorfia japonica*, *Byasa (Atrophaneura) alcinous alcinous* and *Papilio machaon hippocrates*.

Materials and Methods

To obtain eggs for the study, pregnant females of *Parnassius glacialis* Butler,



Figs. 1 - 4. Formation of the corpora allata in *Byasa (Atrophaneura) alcinous alcinous*.
1. Longitudinal section through the gnathal region of the embryo, at about 3 days after oviposition. 2. Cross section through the head region, at the somewhat later stage as shown in Fig. 1. 3. Cross section through the head region, shortly before the revolution stage (at about 3.5 days after oviposition). 4. Cross section through the head region, at the embryonic moulting stage (at about 4.5 days after oviposition).

CA, corpora allata; BR, brain; BT, bridge of tentorium; FG, fore-gut; FM, flexor mandibulae; MA, madibular apodeme; MD, mandible; MEC, mesodermal cell; MX, maxilla; TE, tentorium; TR, trachea. .

Luehdorfia japonica Leech, *Byasa (Atrophaneura) alcinous alcinous* Klug and *Papilio machaon hippocrates* C. et R. Felder were captured at various parts in Gifu Prefecture in 1980 to 1983. Freshly laid eggs of *Par. glacialis* were obtained in May, those of *L. japonica* in April, those of *B. (A.) alcinous alcinous* in June and those of *Pap. machaon hippocrates* in September and kept at room temperature in the laboratory.

The eggs at various ages were fixed in Carnoy's fluid for 30−40 min or alcoholic Bouin's fluid for 60 min. After fixation, the eggs removed of their chorion were dehydrated and embedded in paraffin. Sections were cut in 8 μm thick and stained with Delafield's haematoxylin and eosin.

Observations

At about 11 days after oviposition in *Par. glacialis*, about 7. 5 days in *L. japonica*, about 3 days in *B. (A.) alcinous alcinous* and about 3 days in *Pap. machaon hippocrates*, the embryos decrease in length, owing to the remarkable shortening of the head region including the gnathal segments, but they increase in width. Then the cephalic and the gnathal regions fuse each other, and three ganglia in the gnathal segments unite to form a large single suboesophageal ganglion. The cephalo-gnathal appendages come together to form the mouthparts around the stomodaeal opening. The prothoracic glands are separated from the wall of the labial segment to be deposited at the anterior margin of prothoracic segment. At this stage the mandibular apodeme at the latero-posterior part of the base of each mandibular appendage, sends out two outgrowths at its end, of which an anterior branch or outgrowth will develop to the flexor mandibulae and a posterior one to the salivary gland.

Formation of the corpora allata takes place in the wall of the apodeme of the flexor mandibulae. As a sign of beginning of their formation, proliferation of the cells occurs near the middle part of the inner wall of each apodeme, but the proliferated cells have essentially the same structure as cells of the apodeme wall in this stage.

With the lapse of time the proliferated cells become a cellular outgrowth or cell-mass which is located in close contact with the inner wall of the crescent-shaped apodeme in a cross section of embryo. This cell-mass is a rudiment of the corpora allata. It is a solid elliptic body with no lumen (Fig. 1).

The origin and the process of development of the rudiments of corpora allata are of the same among four species studied belonging to a different genus respectively.

As development proceeds, the rudiments of corpora allata gradually grow in close contact with the wall of mandibular apodemes (Fig. 2) and are carried dorsally by the growth of the latter. When the fusion of gnathal ganglia to form the suboesophageal ganglion takes place, the corpora allata are carried more dorsally. Then they are cut off as a pair of solid elliptic cell-masses from the wall of the apodemes and are deposited between the inner wall of apodemes and the posterior arms of the tentorium (Fig. 3). At this time the corpora allata of *B. (A.) alcinous alcinous*, about 35 by 40 μm in size, are composed of about 20 cells, that of *L. japonica* of about 8 cells and that of *Par. glacialis* of 4−5 cells, in the sections.

As the brain moves at the revolution stage to the dorsal side of the suboesophageal

ganglion, the corpora allata come to be situated under the ventral side of the brain between the mandibular apodemes and the posterior arms of the tentorium. Now the developing corpora allata are round or oval in shape, about 40 by 45 μm in size in *B. (A.) alcinous alcinous* and about 35 by 35 μm in *Pap. machaon hippocrates.*

At the embryonic moulting stage the corpora allata assume a shape of the round bodies and then they take their definitive position at the posterior part of the extremities of the transverse bridge of the tentorium (Fig. 4). In this stage the corpora allata of *B.(A.)alcinous alcinous* are about 40 μm in diameter, consisting of about 35 nuclei in a section and those of *Pap. machaon hippocrates* about 30 μm, consisting of about 25 nuclei and those of *Par. glacialis* about 10 μm, consisting of about 10 nuclei.

In the full grown embryos of the studied species the corpora allata are somewhat smaller than those at the embryonic moulting stage, but they retain the same position and form. This state of the corpora allata does not change until hatching.

Discussion

In the early stage of embryogenesis the manner of development of corpora allata in *Par. glacialis*, *L. japonica*, *B.(A.) alcinous alcinous* and *Pap. machaon hippocrates* is in its fundamental points the same as the observed by Ito (1918, in *Bombyx* and *Antheraea*), Eastham (1930, in *Pieris*), Okada (1960, in *Chilo*), Kobayashi (1983, in *Neomicropteryx* and *Nepticula*) and Kobayashi and Ando (1983, in *Neomicropteryx*). That is, the rudiments of the corpora allata arise as a pair of ingrowths, or cell-masses, from the wall of the mandibular apodemes, but there are some differences in their later stages of formation among the species. Okada (1960) has described in *Chilo* that the corpora allata fused with the corpus cardiacum into a single body in the late embryonic stage, and Ito (1918) has stated for *Antheraea* that they completely divided into two globular masses in close contact with each other. In the present four species, however, neither the fusion of corpora allata with the corpus cardiacum nor their division into two masses were observed.

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Author's address: Dr. M. Tanaka
Kanô High School, Nanyô-chô, Kanô, Gifu 500, Japan