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**Some Observations on the Endocrine Systems in the
Embryos of *Anacridium aegyptium*, L. (Orthoptera-Ac-
rididae) II The Neurosecretory cells and corpora Car-
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by

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Some Observations on the Endocrine Systems in the Embryos of *Anacridium aegyptium*, L. (Orthoptera-Acrididae) II The Neurosecretory cells and corpora Cardiac and Corpora allata

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ABSTRACT

The neurosecretory cells, the corpora cardiaca and the corpora allata of the embryos of *Anacridium aegyptium*, L. can be observed at the 19th stage, the stage after the embryo has rotated at the posterior pole of the egg.

The neurosecretory cells in the head can be seen in the brain (in the protocerebrum and tritocerebrum) and the frontal and phageal ganglia, but only the neurosecretory cells of the brain were studied. They are few in number and are scattered at the periphery of protocerebrum, especially in the median, lateral and antero-ventral regions, but do not form groups. The most conspicuous neurosecretory cells are those in the mid-line of the antero-ventral region of the protocerebrum. One type of neurosecretory cells can be identified by their granules, but it is not possible to distinguish cyclic activity during embryonic development.

The corpora cardiaca (anterior paired and unpaired lobes and posterior lobes) are enclosed in the aorta. Their structure is syncytial. It is not possible to distinguish the glandular part of the corpora cardiaca in which there is no variation during embryonic life.

The corpora allata, which are a pair of ellipsoidal structures, are situated at both sides of the oesophagus at the 19th embryonic

stage. They also have a syncytial structure and do not show variations during embryonic development.

INTRODUCTION

There is no doubt about the role of endocrine centers in the adult and the nymphal stages of insects, but during the course of embryonic development in invertebrates, the function of glands and neurosecretory cells is still not very clear.

To the present time, there have been only a few publications dealing with the neurosecretory cells and the other endocrine centers in Orthoptera (Insects) during embryogenesis. Jones [10,11] working with embryos of *Locusta pardalina* and *Locusta migratoria* and KüçükEKŞİ [13, 14, 15] with embryos of *Schistocerca gregaria* (Forsk.) and *Anacridium aegyptium*, L. stated that the ventral head glands have a function in embryonic development. These glands are concerned with the retraction of the epidermis from the cuticle, but the role of the other endocrine centres is not clear. Saralee Neumann Van Horn [20] indicated that the neuroendocrine system (ventral head glands, corpora cardiaca and corpora allata) in the embryos of *Aulocara elliotti* may function during post-diapause development. On the other hand Mueller [17] concluded from a study of embryos of *Melanoplus differentialis* cultivated in vitro, that the neuroendocrine system of the head and prothorax is not necessary for control of the embryonic molts and embryonic development does not depend on the nervous or endocrine centers in the head.

The aim of the present work was to study the development of neurosecretory cells, corpora cardiaca, and corpora allata in the embryos of *Anacridium aegyptium* and, if possible, to relate this development to their histologic properties and their functions.

Material and methods used in this work are the same as those described in the previous paper [15] reporting the results of a study of the ventral head glands of the embryos of *Anacridium aegyptium*, L.

OBSERVATIONS

The neurosecretory cells: These cells are first observed in the brain of the embryos of *Anacridium aegyptium* in the 19th stage (just after rotation of the embryo in the posterior end of the egg). They are few in number and scattered only at the periphery of protocerebrum and tritocerebrum, as in the embryos of *Locusta migratoria*, *L. pardalina* [10, 11], *Schistocerca gregaria* [14], *Dysdercus cingulatus* [19] and in the embryos of the cockroach (*Periplaneta americana* L.) [12].

The nuclei and the cytoplasm of the neurosecretory cells are larger than normal neurons and their cytoplasm contain some inclusions which stain a dark bluish purple with Gomori chrome-haematoxylin phloxine (CHP). It is not possible to observe the different type of neurosecretory cells according to their inclusions.

Throughout the embryonic stages (stages 19, 20, 21, 22, 23, 24), and in the very early hatchlings some neurosecretory cells can be identified at the periphery of protocerebrum (median, lateral and ventral regions) and at the tritocerebrum and also at the frontal and suboesophageal ganglia. The neurosecretory cells especially in the protocerebrum and the tritocerebrum are not seen as groups of several cells. The neurosecretory cells in the suboesophageal ganglion are clearer than in protocerebrum and they can be observed in mid -dorsal, dorso-lateral and mid-ventral groups.

During the embryonic stages referred to above one or two neurosecretory cells can be observed at the same place, at the bottom of optic lobe (the first protocerebral lobe) on both sides of the protocerebrum, and a few pyriform cells (about four in two groups of two cells each) can also be observed at the mid-line of antero-ventral region of protocerebrum (Fig. 1,2).

Two diameters of nuclei of the neurosecretory cells in the protocerebrum are measured in all embryonic stages. Their ranges, means, and standard errors are given in table I.

Differentiation and increasing inclusions of the neurosecretory cells throughout embryonic development can not be observed.

The corpora cardiaca: The corpora cardiaca in the embryos of *Anacridium aegyptium* are very similar to those in the embryos

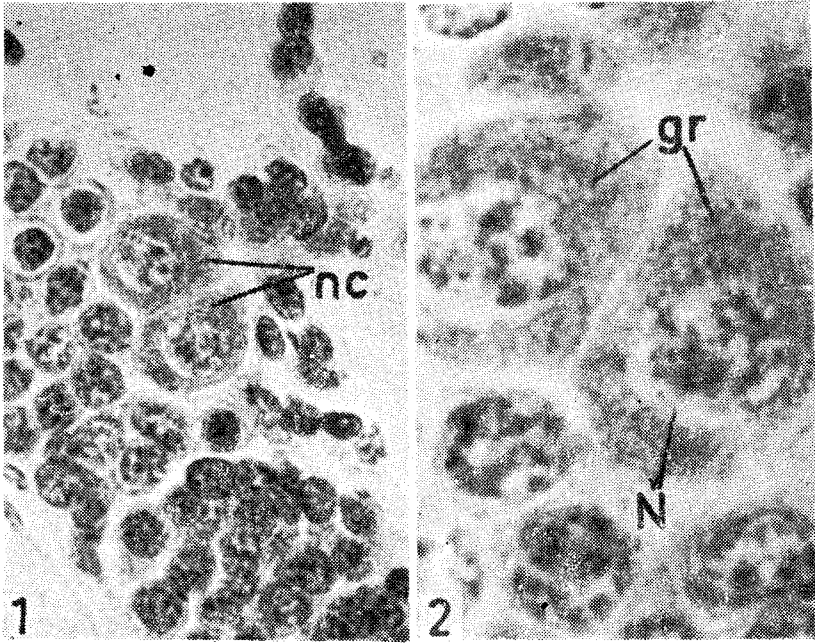


Fig. 1. Brain, pear shaped neurosecretory cells in the antero-ventral region of protocerebrum. At the 21 st embryonic stage. 10X40

Fig. 2. Brain pear shaped neurosecretory cells in the antero-ventral region of protocerebrum. At the 21st embryonic stage. 10X100

of *Schistocerca gregaria* [14 and their position is the same in the adults of *Anacridium* [5] and *Schistocerca gregaria* [9].

The gland is comprised of two portions, the anterior and the posterior lobes. The corpora cardiaca (oesophageal ganglia or pharyngeal ganglia) can be identified as a pair of elongated structures projected into the aorta at both sides and are first seen at the 19th embryonic stage (Fig.3). It is the anterior paired lobes of the corpora cardiaca which fuse ventrally to form the unpaired lobes which make up the ventral wall of the aorta. The anterior part of the corpora cardiaca is U shaped and its unpaired lobe is situated immediately above the hypocerebral ganglion. The posterior lobes of the corpora cardiaca which are situated dorsal to the anterior parts appear as parallel paired lobes made of two or three rows of cells and are intimately associated with the walls of the aorta. Their outer surfaces are folded. But it is difficult to distinguish the posterior corpora cardiaca, because of their very thin

structure. They can be only observed in the later embryonic stages (after 21st embryonic stage).

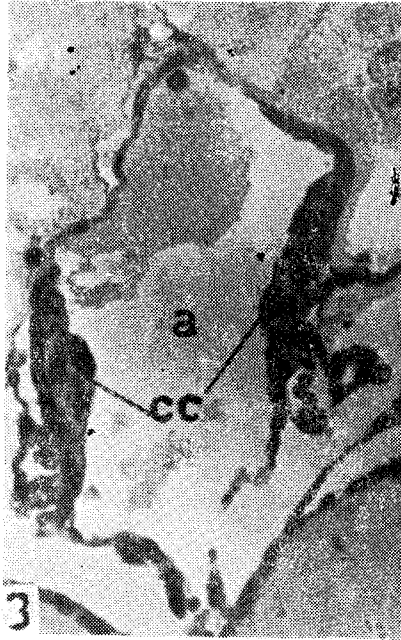


Fig. 3. Paired corpora cardiaca at the 21st embryonic stage. 10X10

The cytoplasm of the corpora cardiaca is syncytial. There are small elliptical nuclei which are tightly packed with sparse cytoplasm between them (Fig.4,5). Some tracheoles and some vacuoles can also be seen in the later stages. The sizes of the nuclei are measured during all the embryonic stages after and including embryonic stage 19. The ranges of the diameters of the nuclei and their means and standard errors are given in table 2. There is no differentiation in the structure of the cytoplasm during the embryonic stages. Some small Gomori-positive granules can be seen in the cytoplasm during embryonic development, but there are no differences according to stage.

The corpora allata; The corpora allata are paired ellipsoidal bodies. They take their exact positions on both sides of oesophagus,

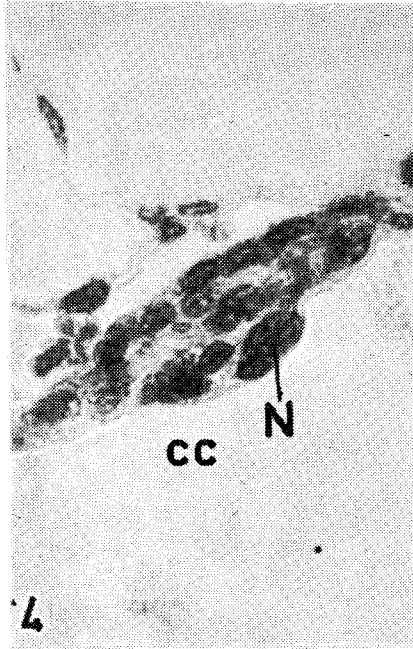


Fig. 4. Corpus cardiacum (paired) at the 21st embryonic stage. 10X40

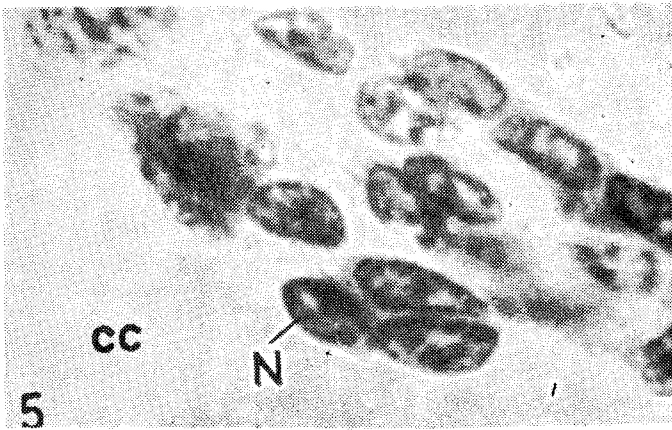


Fig. 5. Corpus Cardiacum (paired) at the 21 embryonic stage. 10X100

TABLE I:

Dimensions of two diameters (shortest and longest) of the nuclei of the neurosecretory cells in the protocerebrum of the embryos and in the very early hatchlings of *Anacridium aegyptium*, L.

Stages	Range of short. dia of nuclei (micron)	Range of long. dia. of nuclei (micron)	Mean and s. e of short. dia. of nuclei (micron)	Mean and s. e. of long. dia. of nuclei (micron)
19	8.33-15.00	11.66-20.00	10.16±0.55	15.18±1.66
20	6.66-13.33	8.33-16.66	10.00±0.50	13.33±0.71
21	8.33-13.33	11.66-16.66	10.00±0.61	14.36±0.53
22	8.33-16.66	11.66-23.33	12.30±0.55	15.90±1.01
23	8.33-16.66	10.00-23.33	11.16±0.75	15.38±1.21
24	8.33-20.00	13.33-20.00	12.73±0.93	15.66±0.43
in 24 hours after hatching	8.33-18.33	8.33-23.33	11.93±0.23	15.43±0.36

TABLE 2:

Dimensions of two diameters (shortest and longest) of the nuclei of the corpora cardiaca in the embryos and in the very early hatchlings of *Anacridium aegyptium*, L.

Stages	Range of shortest dia. of nuclei (microns)	Range of longest dia. of nuclei (micron)	Mean and s.e of shortest dia. of nuclei (microns)	Mean and s.e of longest dia. of nuclei (microns)
19	3.33-8.33	5-11.66	5.00±0.171	7.88±0.15
20	3.33-6.66	5-11.66	5.05±0.13	7.88±0.18
21	3.33-8.33	5-10.00	5.28±0.16	7.66±0.164
22	3.33-8.33	5-10.00	5.30±0.25	7.21±0.15
23	3.33-8.33	5-10.00	5.05±0.10	7.25±0.15
24	3.33-6.66	5-10.00	5.51±0.25	7.71±0.46
in 24 hours after hatching	3.33-6.66	5-10.00	4.95±0.21	7.43±0.21

TABLE: 3
 Dimensions of two diameters (shortest and longest) of the corpora allata and their nuclei in the embryos and in the very early hatchlings of *Anaeridium aegyptium*, L.

Stages	Range of sh. dia. of c. allatum (micron)	mean and s.e. of sh. dia of c. allatum (micron)	Ran. of L. dia of c. allatum (micron)	mean and s.e. of L. dia. of c. allatum (micron)	Range of sh. dia. of nuclei (micron)	mean and s.e. of sh. dia. of nuclei (micron)	Range of L. dia. of nuclei (micron)	Mean and s.e. of L. dia nuclei (micron)
19	28.3 - 43.3	34.86 ± 1.06	33.3 - 50.0	40.91 ± 1.433	3.3 - 8.3	5.20 ± 0.06	5.0 - 10.0	7.50 ± 0.153
20	35.0 - 45.0	39.16 ± 1.31	43.3 - 55.0	48.66 ± 1.01	3.3 - 8.3	5.23 ± 0.11	5.0 - 11.6	7.78 ± 0.20
21	33.3 - 41.6	36.11 ± 1.05	41.6 - 53.3	46.48 ± 1.51	3.3 - 8.3	5.58 ± 0.18	5.0 - 10.0	7.55 ± 0.17
22	28.3 - 35.0	32.08 ± 1.71	30.0 - 53.0	45.00 ± 5.175	5.0 - 6.6	5.66 ± 0.20	6.6 - 10.0	7.45 ± 0.19
23	30.0 - 40.0	35.00 ± 1.03	38.3 - 51.6	46.50 ± 1.38	3.3 - 8.3	5.00 ± 0.21	5.0 - 10.0	7.66 ± 0.30
24	30.0 - 36.6	34.60 ± 1.56	36.6 - 58.3	46.60 ± 2.85	3.3 - 6.6	4.28 ± 0.25	3.3 - 10.0	6.15 ± 1.14
in 24 hours after hatching	25.0 - 38.3	30.80 ± 1.40	33.3 - 53.3	43.11 ± 1.10	3.3 - 6.6	4.75 ± 0.21	5.0 - 10.0	6.73 ± 0.25

posterior and ventral to the corpora cardiaca at the 19th embryonic stage (Fig.6).

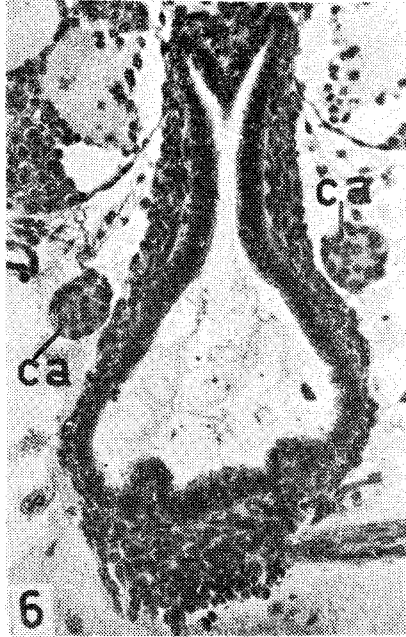


Fig. 6. Corpora allata at 23 rd embryonic stage. 10X10

The cytoplasm is syncytial and sometimes the cell walls can be observed. The nuclei are densely packed in sparse cytoplasm with small inclusions and tracheoles (Fig. 7). The gland is surrounded by a thin connective tissue whose cells are ellipsoidal. It is possible to see the nervi corporis allati I connecting the glands to the corpora cardiaca.

Two diameters (shortest and longest) of the glands and nuclei were measured in the later embryonic stages (19, 20, 21, 22, 23, 24) and in the very early hatchlings of different specimens. Their means and standard errors are given in table III.

No visible change in the differentiation of the cytoplasm and nuclei can be observed during embryonic development. The cytoplasm has small granules but does not contain any visible

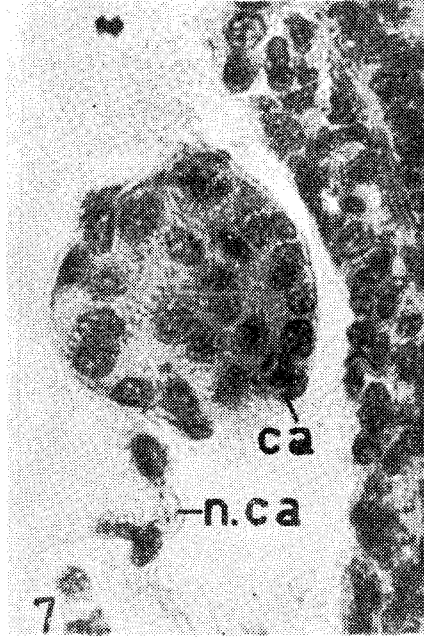


Fig.7. Corpus allatum and its connection with c. cardiacum. 10x40

vacuoles. The character of the granules seems not to be related to embryonic development. There is some increase and fluctuation in mean diameters of the nuclei, but there is no increase and differentiation in the cytoplasm. (At the active stage the volume of the gland enlarges, the appearance of the cytoplasm changes becoming vacuolated and containing many secretory granules [16] [4,5], [3] etc.

Thus it is not possible to give any idea of their function according to the embryonic stage.

DISCUSSION

The structure and position of the endocrine system of the embryos of *Anacridium aegyptium* is similar to that of other Locusts such as the adults and the Central American locust *Schistocerca paranensis* Burm [21], the embryos of *Schistocerca gregaria* [14] and *Locusta migratoria*, *L. pardalina* [10, 11].

The neurosecretory cells in the head region of embryos of *Anacridium aegyptium* are found in the protocerebrum, tritocerebrum and frontal and suboesophageal ganglia. Only the neurosecretory cells of the protocerebrum were studied, but there are also small number of neurosecretory cells scattered at the periphery of the protocerebrum (especially in the median, lateral and ventro-medial regions) as in the embryos of *Scistocerca gregaria* [14], *Periplanata americana* L. [12], the embryos of *Locusta pardalina* [10], and *Dysdercus* [19]. Very conspicuous pear shaped (about four) neurosecretory cells are observed in the mid-line of the antero-ventral face of the protocerebrum in the later (19-24) embryonic stages as in the embryos of *Schistocerca gregaria* [14]. It is thought that the location and appearance of these cells are similar to those cells which are found in the adult of *Anacridium*, *Acheta domesticus*, *Melanogryllus desertus* [7], *Melanoplus sanguinipes* [2], *Locusta migratoria*, *Schistocerca gregaria* [8].

It is not possible to distinguish the different types of neurosecretory cells in the embryos of *Anacridium aegyptium*, but in adult of *Anacridium* [5], *Acheta domesticus* [6], *Schistocerca gregaria* [9], *Iphita* [18] and *Galeruca tanaceti* (L.) [22] they can be distinguished by the use of Gomori chrome haematoxylin-phloxine.

It is not possible by the situation of the cytoplasm and the inclusions and sizes of the nuclei of the neurosecretory cells to judge if there is a cyclic activation or to decide whether they are more active at some stages than at others. Clarke and Langley [1] also did not observe any histological evidence for a neurosecretory cycle in the medial neurosecretory cells of the locust brain (*Locusta migratoria*) during the larval instars.

The corpora cardiaca can be first observed in their exact places at the 19th stage. The anterior paired lobes are the elongated bodies inside the aorta. The anterior unpaired lobes form the ventral wall of the aorta. The posterior portion consist of very thin parallel paired lobes dorsal to the anterior lobes. The situation in the embryo is similar to that in the adult of *Anacridium aegyptium* [5].

The cytoplasm is syncytial. During embryonic development some small inclusions can be seen in the cytoplasm. It is not pos-

sible to distinguish the glandular portion according to the inclusions as in adult insects [9] [5]. There are no variations during the embryonic development.

The corpora allata: From the 19th stage onwards the corpora allata of the embryo of *Anacridium* can be seen as ellipsoidal paired bodies situated at both sides of oesophagus (in their customary position). The structure are seen to be syncytial when examined under a light microscope. Sometimes, the cell wall can be seen. The nuclei of gland are densely packed and the cytoplasm between them is sparse. Some small tracheoles can be seen inside the gland. The structure in the embryo of *A. aegyptium* is as in the embryo of *Schistocerca gregaria* [14], *Locusta migratoria* and *L. Pardalina* [10]. There is no differentiation of the cytoplasm in embryonic life, as there is in the adults of *Anacridium* [5], the Central American locust, *Schistocerca paranensis* Burm (*S. cancellata* Forsk.) [21] and *Melanoplus differentialis* [16] etc. There is some fluctuation in the mean dimensions of the nuclei of the c. allata in the embryonic stages but it does not give any clear idea about their different activities.

EXPLANATION OF FIGURES

Photomicrographs of sections of brain (for neurosecretory cells) and corpora cardiaca and corpora allata of *Anacridium aegyptium*, L.

Fixing: Bouin; staining: Gomori-phloxin

a- aorta, ca-corpora allata, cc-paired corpora cardiaca,
gr- granule, N-nucleus, nc-neurosecretory cells, n.ca-nervous corporis allati.

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ÖZET

Anacridium aegyptium, L. - Mısır çekirgesinde embriyonik gelişme devresi boyunca beyin nörosekresyon hücreleri, corpora cardiaca ve corpora allata iç salgı bezlerinin gelişmeleri histolojik olarak incelendi. Aynı zamanda bu çalışma ile embriyo gelişme devresi boyunca, nörosekresyon hücreleri ve bezlerin histolojik görünümleri ile aktiviteleri arasında bir ilgi kurulmağa çalışıldı.

Nörosekresyon hücreleri (N. S. H) corpora cardiaca ve corpora allata ilk defa 19. cu embriyo gelişme safhasında (embriyo yumurta'nın posterör kutbu etrafında dönüşünü tamamladıktan hemen sonra) gözlemlendi.

Nörosekresyon hücreleri, baş bölgesinde: beyinde, frontal ganglion ve subözofagal ganglionlarda görülür. Bunlardan sadece beyinde olanlar embriyo gelişme devresi boyunca incelendi. Beyinde bilhassa protocerebrum ve tritocerebrum bölgesinde N. S. H. lerine rastlanır, Protocerebrum bölgesinin çevresinde serpilmiş vaziyettedir. Büyük hücre grupları halinde görülmezler, yalnız median, lateral ve antero-ventral bölgelerde birkaç hücreden müteşekkül topluluklar teşkil ederler. Bilhassa antero-ventral bölgede bulunan daha iri armut biçimli olan N. S. H. leri bütün embriyo devreleri boyunca 4-5 hücreden müteşekkül topluluklar halinde görülür. "Gomori-Haematoxylin phloxine" ile boyama sonucu granüllerine göre bir tip nörosekresyon hücresi ayırt edilebildi. Gelişme safhalarına göre hücrelerin yapı ve büyüklüklerinde fonksiyon değişikliğine atfedilecek herhangi bir fark gözlemlenmedi.

Corpora cardiaca; Anterior çift c. cardiaca aort içersine doğru uzantı teşkil eder, ventralde birleşik çift olmayan c. cardiacum'u meydana getirirler. Sinsityal yapıdadır. Posterior c. cardiaca ise anterior c. cardiaca'ya nazaran dorsal ve posterior'e düşen, aort çeperlerini her iki yandan sınırlayan birkaç hücre sırasından ibaret ince uzun 1 çift lopluktan ibarettir.. Embriyo gelişmesi boyunca c. cardiaca'nın yapısında hücrenel bir farklılaşma görülmez.

Corpora allata; 19. cu embriyo safçhasında özofagus'un her iki yanında yer alan bir çift elipsoidal bez durumundadır. Sinsityal yapıdadır. Embriyonun gelişme süresi boyunca yapısında herhangi bir fark görülmez.

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