Chapter 9

OBSERVATIONS ON THE MEDIAN NEUROSECRETORY CELLS OF THE PARS INTERCEREBRALIS OF THE BRAIN OF POICELOCERA PICTA DURING OVARIAN DEVELOPMENT

Neurosecretory cells in the brain of insects have been described in a large number of pterygote insects. Most authors are agreed that there are normally two groups of these that can be identified in each hemisphere of the brain, a median group lying close to the pars intercerebralis and a lateral group. The axons of the two median groups form two nerves which in their intercerebral course cross over each other in the pars intercerebralis and on leaving the rear of the brain, form the nervi corporis cardiaci interni (NCC I), while the axons of the lateral cells take a direct course to the rear of the brain and externally form the nervi corporis externi (NCC II). Recently a third pair of nerves has been described by Wily (1959) in the cockroach. The neurosecretory material from the brain migrates through the nervi corporis cardiaci to the corpora cardiaca where it accumulates (Thomsen, 1954a, Scharrer, 1952).

The neurosecrtory cells can be distinguished from ordinary nerve cells by their large cell and nuclear size, conspicuous nucleoli and staining reactions (Fraser, 1959). The various phases of secretory activity of these cells can

be associated with changes in their cell volume, nuclear form and cytoplasmic granules which may be coarse, crowded or vacuolar in appearance.

Depending on the staining reactions, generally two types of cells often called as A and B cells (Nayar, 1955a;Johansson, 1958), can be differentiated among the median neurosecretory cells. With the chrom-hematoxylin-phloxin staining, A cells stain blue black and B cells red, (Thomsen, 1954 a,b; Nayar, 1955) while with paraldehyde fuchsin the selective staining of A and B cells will depend on the fixative used (Dupont-Raabe, 1956) and the insect species (Nayar, 1955; Fraser, 1959).

The first investigation on the function of the neurosecretory cells in the brain of insects was undertaken by Wigglesworth (1939, 1940) in Rhodnius prolixus. He showed that a factor regulating moulting is produced by the pars intercerebralis of the protocerebrum. A very thorough study of the function of the neurosecretory cells during the development of the moth Platysamia cecropia was made by Williams (1946, 1947, 1948 a,b). He showed that the diapause in the pupa of Platysamia is regulated by the brain and that the active factor is produced by the median and the lateral groups of neurosecretory cells.

In adult insects, the median neurosecretory cells

have been shown to contain endocrine centres for the control of reproduction (Thomsen, 1952; Nayar,1958). This control has been described to be overall in Calliphora by Thomsen (1952) but Johansson (1958) and Nayar (1958) suggest that they bring about their effect through controlling or stimulating corpora allata. Recently the pars intercerebralis corpora cardiaca system of Schistocerca gregaria has been shown to play a major role in the control of oocyte development(Highnam, 1961 a, 1962).

In the earlier chapters changes in the fat body have been shown to take place as regards lipase activity and ribonucleic acid content during ovarian development. Since homeostasis and differentiation are largely dependent on chemical factors of endocrine nature, a few observations were made on the median neurosecretory cells of the pars intercerebralis in the brain of Poicelocera picta, in order to get some indirect evidence of the effect of neurosecretion on the fat and protein metabolism.

MATERIALS AND METHODS

The grasshoppers (Poicelocera picta) were collected from the field and kept in laboratory cages at room temperature on fresh leaves of Calotropis plants. Both male and female individuals were kept together since it is known that in insects the presence of mature males influences ovarian

development (Highnam and Lusis, 1962). The insects were decapitated and the heads were dipped in fixatives after longitudinal slits were made in the head capsule to facilitate the penetration of the fixative. Fixatives used were Bouins fluid, Bouins with 0.5% Trichloracetic acid instead of acetic acid and Helly's fluid. Serial sections of 8 μ thickness were cut from paraffin blocks. The neurosecretory cells were stained either with Gomori's chrom-alum-hematoxylin-phloxin (Gomori, 1941) or paraldehyde fuchsin as modified by Cameron and Steel (1959) and Ewen (1962). The sexual maturity of the insects was assessed by measuring the length of the terminal oocyte as described in chapter 7.

RESULTS

The neurosecretory cells were located in the dorsal part of the pars intercerebralis region of the protocerebrum in two closely apposed groups. They were found to be covered over by one layer of small cells beneath the brain membrane(fig 1).

The neurosecretory cells were studied in three different groups of Poicelocera picta which were grouped on the basis of the length of the terminal oocyte in their ovary. In the first group the length of the terminal oocyte varied from 1.2 to 2.0 mm; in the second group it varied between 3.3 to 7.0 mm and in the third it had reached a length of 7.7 to 9.0 mm. The first group had either laid

their first batch of eggs or were newly moulted into adults. In the second group fatty yolk deposition had started in the terminal oocytes while in the third the terminal oocytes had reached full maturity and some insects were preparing for oviposition.

From the size and staining reactions, three types of cells designated as A,B and C, could be differentiated in the median neurosecretory cells of the brain of Poicelocera picta (fig.1). A,cells stained blue-black with chromalum-hematoxylin staining and the nuclear diameter of the cells varied from 9 to 10 µ. The nuclei were mostly rounded. With paraldehyde fuchsin the A cells stained deep purple. The B cells were phloxinophilic and stained red with chromalum-hematoxylin-phloxin. The nuclear diameter of these cells varied from 10 to 12 µ and the nuclei were mostly oval in form. The B cells stained faint pink often with greenish tinge with paraldehyde fuchsin.

The C cells were very large and the staining reaction was similar to B cells with paraldehyde fuchsin. Their nuclear diameter varied from 20 to 25 µ. The C cells were similar in description to C and D cells described by Highnam (1961 c) in the median neurosecretory system of Schistocerca gregaria.

The paraldehyde fuchsin appeared to stain the inclusions without colouring the ground cytoplasm, making the observations easier and clear. For the study of the

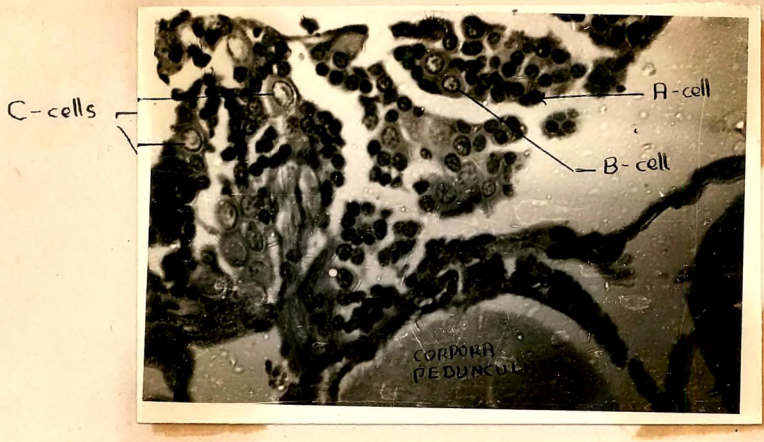

FIG. 1

Vertical section through the pars intercerebralis region of the brain of Poicelocera picta female showing 3 types of neurosecretory cells. (chromalum-hematoxylin-phloxin)

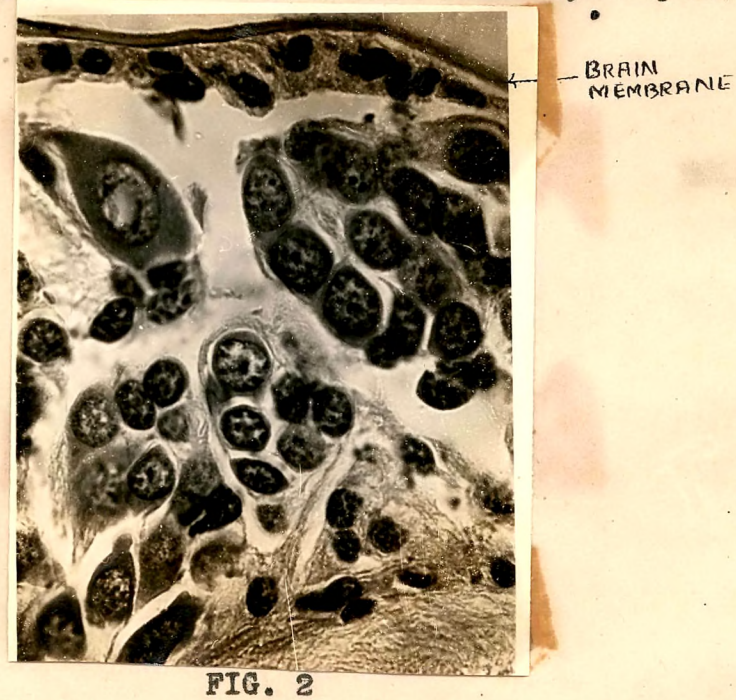

FIG. 2

Vertical section through the pars intercerebralis of thebrain of Poicelocera picta, immature female. Terminal oocyte length=1.2 mm. (Paraldehydefuchsin)

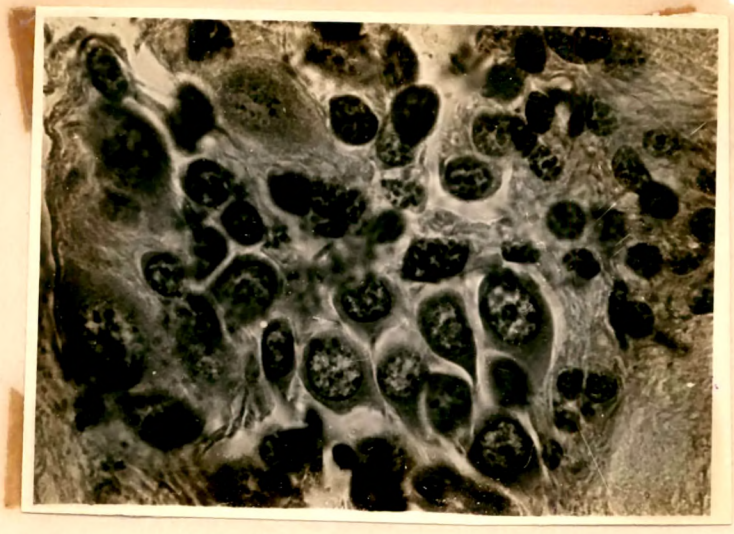

FIG. 3

Vertical section through the pars intercerebralis of the brain of Poicelocera picta.
Terminal oocyte length= 4.0 mm
(Paraldehyde fuchsin)

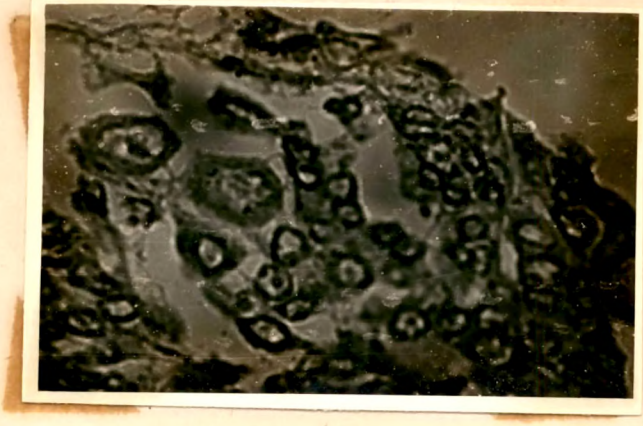

Fig. 4

Vertical section through the pars intercerebralis region of the brain of Poicelocera picta, mature female. Terminal oocyte length = 7.7 mm.
(Paraldehydefuchsin)

neurosecretory activity in the three groups of Poicelocara picta mostly the paraldehyde fuchsin method was followed.

In the first group of insects where the terminal oocyte length varied from 1.2 to 2.0 mm, the fuchsinophilia of the neurosecretory cells was discernible as faint concentric rings of small granules around the nuclei. The reaction was of very low intensity signifying that the cells had either disgorged their contents or were embarking on a secretory phase (fig. 2). The axons of these cells also contained very few paraldehyde fuchsin stainable material. In the second group of animals where the terminal oocyte length varied from 3.3 to 7.0 mm, large amount of paraldehyde fuchsin stainable material was found in the axons of the median neurosecretory cells (fig. 3). The cells themselves contained but few paraldehyde stainable material, giving a reaction of moderate intensity. Neurosecretory cells in the third group where the oocyte had reached full maturity, stained intensely revealing a large amount of neurosecretory material in them. (fig. 4)

DISCUSSION

Several organs of internal secretion are known to control the reproductive processes in insects. The role of corpora allata has been known since long (Wigglesworth, 1954). But that of the neurosecretory cells of the brain and the corpora cardiaca has been only recently recognized (Thomsen,

1952; Highnam, 1961 c). Changes in the histological appearence of the neurosecretory cells of the brain during the ovarian development have been observed in many insects (Thomsen, 1952; Dupont-Raabe, 1952; Arvy, Bounhiol and Gabe, 1953; Formigoni, 1956; Highnam, 1961a, 1962). Thomsen (1952) found that extirpation of the neurosecretory cells of the brain in Calliphora prevented egg maturation and that reimplantation of these cells in animals in which previously they had been removed made the animals sesume egg development. (Nayar, 1958) found that the control of ovarian development in Iphita limbata by corpus allatum is effected through the cerebral neurosecretory cells. Since median neurosecretory cells of the brain, the corpora allata and the corpora cardiaca formed a neurosecretory system it is assumed (Scharrer, 1952) that a high degree of interaction is possible between the hormones they furnish.

Highnam (1961b) found in Schistocerca gregaria, that the cautery of the neurosecretory cells in the pars intercerebralis or cardiacectomy greatly retarded ovarian development. It was further observed that the progress of ovarian development was accompanied by a gradual change in the histological appearance of the neurosecretory system in the immature stage to the mature forms. In the present study the median neurosecretory cells showed variations in stainable properties at different stages of oocyte

development indicating that they contain different amounts of neurosecretory materials. The amount of material contained in a neurosecretory cell at any time depends both upon its rate of synthesis and the rate of discharge. Highnam (1962) has shown that it is the rate of discharge which alone influences the development of ovaries. In Schistocerca gregaria in which electrical stimulation, enforced activity and even wounding, all brought about release of material from the neurosecretory system resulting in increased development of the terminal oocytes (Highnam, 1962).

The intense staining observed in the axons of the neurosecretory cells in the animals in which terminal oocyte length had reached 3.3 to 7.0 mm may be taken to mean that the neurosecretory cells are actively secreting the material and that an active transport of the material from the neurosecretory cells is taking place. Although these observations do not testify to the actual release of the material into the blood, the condition of oocyte development could mean an increased rate of neurosecretion taking place.

In animals with fully mature oocytes, the neurosecretory cells are either not very active or there is no transport and subsequent release of the neurosecretory material from the cells and as a result of which the neurosecretory material accumulates in the cells.

In the immature insects or in insects in which

the first batch of eggs have been laid, the neurosecretory cells contain little stainable material which might mean that the neurosecretory cells are actively secreting or have just passed an active phase of secretion. The latter seems to be true in insects which had laid their first batch of eggs since it is known that during copulation and oviposition neurosecretory material is released in large quantities (Highnam, 1962). These observations point to the conclusion that during oocyte development in Poicelocera picta definite changes are observed in the stainable materials of the median neurosecretory cells of the brain and that these neurosecretory cells may exert a positive influence over oocyte development. The probable role of these cells in fat and protein metabolism is discussed in chapter 10.