44. The Control of Growth and Development in *Bombyx mori*. XXXIX

Axonal Pathways between the Cerebral Neurosecretory Cells and the Retrocerebral Complex in Bombyx mori

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A precise investigation has been done by Nijhout (1975) on minute axonal pathways of various neurosecretory cell groups in the larval and pupal brains of *Manduca sexta*, use being made of a cobalt diffusion and precipitation technique. With the same technique the present study was undertaken on the neurosecretory anatomy of *Bombyx mori*, with special regard to axonal pathways from the cerebral neurosecretory cells to the retrocerebral complex. It has been presumed that the corpus allatum (CA) might be innervated by hormones derived from the protocerebral cell groups (IA, II and III) from which axons were sent to the CC-CA complex, and that the corpus cardiacum (CC) might be innervated by hormones coming from the tritocerebral cell group (IV).

Materials and methods. Eggs from 2 different strains (1st white egg (w_1) and 2nd white egg (w_2)) were incubated at 25°C under the light condition, and their 5th instar larvae provided material for experiments. The cobalt staining technique applied following the procedure devised by Okajima (1974).

Observations. In Fig. 1 was given the current nomenclature for several aspects necessary for this paper. Details of the neurosecretory around the retrocerebral complex vary from individual to individual, since adjacent nerves do or do not fuse partly along their length.

There were two nerves which connected each CC with the brain. The posterior nerve can be regarded as the nervous corporis cardiaci I, II and III (ncc-I+II+III), since it connected various groups of protocerebral neurosecretory cells with the retrocerebral complex (CC and CA). The anterior nerve (ncc-IV) originated from a small group of tritocerebral neurosecretory cells. A large number of

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neurons runs between the CC and CA. These seemed to be fused into a single bundle, or to be separated into 2 or 3 broad tracts which are connected with the CC and CA. Probably they are generally referred to as the nerve corporis allati (nca).

Fig. 1. Diagram of the endocrine system of *B. mori*, indicating levels and directions (arrow) of cobalt induction of the photographs shown in Figs. 2-9. Br: brain. CC: corpus cardiacum. CA: corpus allatum. SG: subesophageal ganglion. ncc: nervi corporis cardiaci.

Filling via the ncc-I+II+III. Filling the ncc-I+II+III towards the brain from the nca showed 3 groups of cell bodies (Fig. 2). A group of 9-10 contralateral cells (I) was found occupying the anteriomedial portion of the brain. This group was always heterogenous consisting of 4 large cells (A) and 5-6 smaller ones (B). Cell bodies of this group were arranged in an almost linear array. A group of 15 ipsilateral cells (II) occurred in the dorsomedial portion of the brain. A group of 2 cells (III) was observed in the dorsolateral cortex of the brain contralateral to the adhered ncc-I+II+III. Fig. 10 is a diagrammatic representation of the arrangement of cell bodies from which axons were sent outward the right-hand ncc-I+II+III.

Upon entering the brain the ncc-I+II+III splits. One branch runs along the ventral side of the brain and bends sharply upwards by crossing into the contralateral hemisphere. This branch contained fibers from cell groups I and II. The precise course of the fibers from group III was not ascertained, being indicated in Fig. 10 by a dashed line. The second branch of the ncc-I+II+III runs almost directly to the cell group II from the point of entry of this nerve into the brain.

Fig. 3 shows cell bodies of group I, II and a dendritic distribution observed when the adhered ncc-I+II+III+IV was filled towards the brain. Fig. 4 is a dendritic field in the tritocerebral por-

Figs. 2-9

tion that was filled via a branch which splits off the ncc-IV near the brain (see Fig. 10 left-hand). In this condition neurosecretory cells were not seen, but in filling via the ncc IV 3 cell bodies were apparent (see Fig. 10 right-hand and Fig. 5). Fig. 7 is an axonal distribution in the CA detected when the ncc-IV was filled in the direction of the CC-CA complex.

Cells that innervate the CA. Filling the ncc-I+II+III towards the brain from a cut proximal to the CC revealed 2 groups of cell

bodies (Fig. 8): IB and a half number of II. However, when the ncc-I+II+III was filled from the CA towards the brain, there appeared 3 groups of cell bodies, III, IA and a half number of II (Fig. 9).

Fig. 10. Diagrammatic illustration of results of the cobalt stain.

Axons or cells that innervate the CC. Fig. 6 is an anterior view of fibers in the CC observed when the ncc-IV was filled towards the CC-CA complex. Two distinct dendritic fields of fibers in the CC were apparent. The hormone from 3 neurosecretory cells of group IV appears to control the CC through the ncc-IV.

Discussion. Evidence was presented to suggest that two or three neurosecretory cell bodies of group III or IV receive the immediate influence of environmental factors such as light or temperature (Morohoshi *et al.* 1977). It seems that the former controls cell activities of group IA, and finally the CA activity, and that the latter controls cell activities of the CC.

The brain seems to act for two types of stimuli: hormonal and axonal. It appears that the CA (Morohoshi *et al.* 1975) and CC (Gersch 1976) are two representative organs which are controlled by hormones, while the suboesophageal ganglion (SG) is a representative organ controlled by the axons from the brain. The CA controls protein metabolism (Morohoshi *et al.* 1971), and the CC and SG control carbohydrate and fat metabolism (Gersch 1976; Hasegawa *et al.* 1967).

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