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THE FIBER TRACTS OF THE FUSED THORACIC GANGLIA OF THE ADULT *EPHESTIA KUEHNIELLA* ZELLER (LEPIDOPTERA: PYRALIDÆ)

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The histology of the nervous system of the various orders of insects has been studied by many biologists, but nearly all of these have been concerned with the brain. As Snodgrass (1935) has stated the fiber tracts of the thoracic ganglia of an adult winged insect have not been worked out. Zawarzin (1924) has studied the ventral ganglia of *Æschna* larvæ; his figures and descriptions are excellent. Other workers, Binet (1894), Graichen (1936), etc., while studying the ganglia other than the brain have failed to elaborate upon the fiber tracts.

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Adult *Ephestia* were fixed in Bouin-Duboscq-Brasil, embedded in tissuemat and serial sections cut at 10 micra. The sections were stained by the protargol method of Bodian (1937).

The fused thoracic ganglia of adult Lepidoptera in general are composed of the second and third thoracic and the first

three abdominal ganglia of the larva. This ganglionic mass is roughly rectangular in shape (figs. 1 & 2), and is constricted near the middle (anterior-posterior aspect). The anterior portion, more conveniently termed the anterior lobe, is composed of the two larval thoracic ganglia (Th. II & III), whereas the posterior lobe is composed of the first three larval abdominal ganglia (Abd. I, II, III). These lobes are identified by a prominent tracheal tube (figs. 1 & 2 Tr.) which passes dorsad between them from the ventral surface of the ganglia in a median (dextro-sinistral) position. They are further differentiated by a noticeable constriction in the neuropile. (In these figures the neuropile is white and the ganglionic cell layer stippled. For the sake of clarity fiber tracts are shown as single fibers.)

In sagittal view (fig. 2) there are five bundles or tracts of fibers which enter the anterior lobe of the ganglia from the pro-mesothoracic commissures (c). The uppermost bundle (fig. 2 p) consists of motor association fibers originating in the prothoracic ganglion and extending to the posterior lobe of these fused ganglia. Fibers are given off from this bundle and ramify among the fibers of the neuropile of both lobes. Below this bundle there is a large fibre tract (fig. 2, q) which passes through the entire length of the ganglionic mass; side branches are given off which extend into the neuropile of each lobe. These are motor fibers originating in the brain and extending through the ganglionic mass.

The middle bundle of fibers (b) is quite large and ends in the neuropile of the anterior lobe. These are sensory fibers which come directly from the wings. It is quite surprising to find such a large bundle of nerve fibres which can be traced directly into the wings themselves, but this is more readily comprehended when one considers the large number of olfactory pores found on the wings of Lepidoptera by McIndoo (1917). In *Ephestia* this bundle leaves the pro-mesothoracic commissure (c) at a point just posterior to the prothoracic ganglion.

The fourth bundle of fibers (fig. 2 r) is comparable to the second in that it extends throughout the entire mass of fused ganglia passing toward the abdominal ganglia. It originates in the region of the brain and is composed of sensory fibers; side branches are given off to the neuropile of both lobes.

The lowest bundle of fibers (a) is the ventral counterpart of the uppermost group. These fibres originate in the prothoracic ganglion and end in the posterior lobe of the fused ganglia. Like the other bundles this one has side branches which ramify among the fibers of the neuropile in both lobes.

The association fibers (j') which come from the abdominal region ramify among the fibers of the neuropile of the posterior lobe, but do not extend to the anterior lobe. There are association fibers, located on either side of the dividing line described above.

By examining the association fiber tracts (dorso-ventral, and dextro-sinistral) it is easy to differentiate the larval components which have contributed to the formation of the fused adult ganglia. There are well defined fiber tracts which extend from dorsal to ventral (n), and dextral to sinistral (e, j, k) areas (in both directions) in each section. Each group of fibers, on the whole, is confined to that portion of the ganglion which originally constituted a larval ganglion. In sagittal sections the dextro-sinistral fibers (o, o') appear as well defined bundles and in frontal sections the dorso-ventral fibers have a like appearance. There are two main regions of dextro-sinistral association fibers as seen in sagittal view. The dorsal region (o) contains the motor association fibers, and the ventral region (o') the sensory association fibers. Furthermore, each group of fibers gives off connectives to the adjacent groups; this assures communications between all sections.

The commissures to the mesothoracic legs (L 2 c) pass out of the ganglionic mass from the posterior lateral ventral portion of the anterior lobe; the motor cells (d) are located on the lateral anterior portion of the anterior lobe, e.g. that portion derived from the larval mesothoracic ganglion. Each of these cells gives off a large axon which in turn gives off a number of small branches to the neuropile before passing ventrally to the leg. There are a number of sensory fibers from the leg (f) which ramify among the various fibers of the neuropile of the anterior lobe.

Surprisingly enough the commissures to the metathoracic legs (L 3 c) leave the ganglionic mass at the posterior lateral point of the posterior lobe. The motor cells (h), however, which supply the neurones for these legs are located

on the posterior lateral surface of the anterior lobe, e.g. that portion derived from the larval metathoracic ganglion. These cells, like those supplying the mesothoracic legs, give off large axons which in turn give off side branches to the neuropile before passing to the leg commissure. The sensory fibers (l) which pass from the metathoracic legs to the ganglia end in the neuropile of the posterior lobe; one group ends in the anterior ventral portion and the other in the dorsal median area, but neither extends into the anterior lobe.

The motor fibers (g) which innervate the thoracic muscles (and thus supply the impulses for flight) originate in cells located in the posterior ventral lateral portion of the anterior lobe. These fibers pass dorsad in the neuropile and give off side branches to the surrounding areas, especially the dorsal motor area, and pass among the ganglion cells to the surface in a dorsal lateral position (W M C) from which point they pass directly among the thoracic muscles.

The axons of the motor cells of the posterior lobe (i, i', i'') all pass through the commissure (m) to the abdominal region. Each gives off fibers to the surrounding neuropile as it passes through it.

There are many small association fibers which pass from one section of the neuropile to another, but they have not been shown in the figures or discussed. This description is primarily concerned with the major tracts.

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DESCRIPTION OF PLATE 9

- Fig. 1. A diagrammatic reconstruction of a frontal view of the fused thoracic ganglia of *Ephestia kuehniella* Zeller. The neuro-pile is white and the ganglionic cell layer stippled. For the explanation of the lettering see the text.
- Fig. 2. A diagrammatic reconstruction of a sagittal view of the fused thoracic ganglia of *Ephestia kuehniella* Zeller. The neuro-pile is white and the ganglionic cell layer stippled. For the explanation of the lettering see the text.

Pyle — Thoracic Ganglia of Ephestia.