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HISTOLIGICAL CHANGES OCCURING IN THE TERMINAL GANGLIA OF THE VENTRAL NERVE CORD OF *PIERIS BRASSICAE* (LINN.) (PIERIDAE: LEPIDOPTERA).

FIRDAUSIA AZAM ALI

Department of Zoology, University of the Punjab Quaid-e-Azam Campus Lahore-54590, Pakistan

Abstract: The terminal composite ganglion of the adult *Pieris brassicae* is made up by the fusion of the 6th, 7th, 8th larval abdominal ganglia. In all six pairs of peripheral nerves are given off by this complex throughout the life of the insect. In the larva each ganglion has its separate set of nerve tracts which number is retained in a compressed and modified form in the adult.

Key words: Histology, ventral nerve cord, *Pieris brassicae*.

INTRODUCTION

With the presence of segmentally ganglionated nerve cord, much of the coordination of body functions and behaviour has been decentralized in insects. The decapitated bodies and severed abdomins are capable of maintaining various life support activities like walking, copulation and oviposition (Elzina, 1988). Nerves radiating from ganglia and complicated sets of nerve tracts within, composed of bundles of axons, are involved in transmission and response. The impulses travel through different pathways between and within the ganglia. Some of these pathways are relatively simple while others are extremely complicated. Low level stimuli may only produce a simple reflex through the segmental ganglia but strong stimuli produce a number of impulses along many sensory neurones which overflow at synapses into additional neurones and result in integrated motor patterns.

Coalescence of different ganglia, which is a frequent phenomenon resulting in the presence of fewer ganglia, increaes the efficiency of transmission greatly. This concentration of different ganglia into centres of nervous material is common in higher insects. Appart from composite cephalic and thoracic centres the terminal ventral ganglion is also a compound ganglion composed of at least three segmental ganglia. It is an important nervous centre which in addition to its normal segmental musculature, also supplies posterior part of the gut and the reproductive system.

In the present study an attempt has been made to study the metamorphic changes taking place in the various nerve tracts and the associated neurones of the terminal ventral ganglion in *Pieris brassicae*.

MATERIALS AND METHODS

First instar larvae of *Pieris brassicae* were kept constantly at 20 - 20^{O}C and fed on cabbage leaves. The various larval and pupal stages and the adults were reared from these. Various larvae were killed for dissection and histological treatment in the middle of the instar.

The ventral nerve cord was removed by dissection in all cases except in the Ist and 2nd instar larvae whose size was too small to do this satisfactorily. Material was fixed in Bouin's solution and Zenker's or Gilson's fixatives for staining in Mallory's Triple Stain or Heidenhain's Iron Haematoxylin. The material was embedded in paraffin wax and serial sections were cut at 5 - 8 μm.

To study the nerve paths or tracts and to provide addtional information on the cellular constituents, Wigglesworth's (1957, 1959) method of osmium tetroxide fixation followed by ethyl gallate treatment was used. Carlton and Drury's (1956) and Baker's (1966) account of osmium fixation was useful. Material fixed in osmium tetroxide and stained by ethyl gallate was mounted in D.P.X.

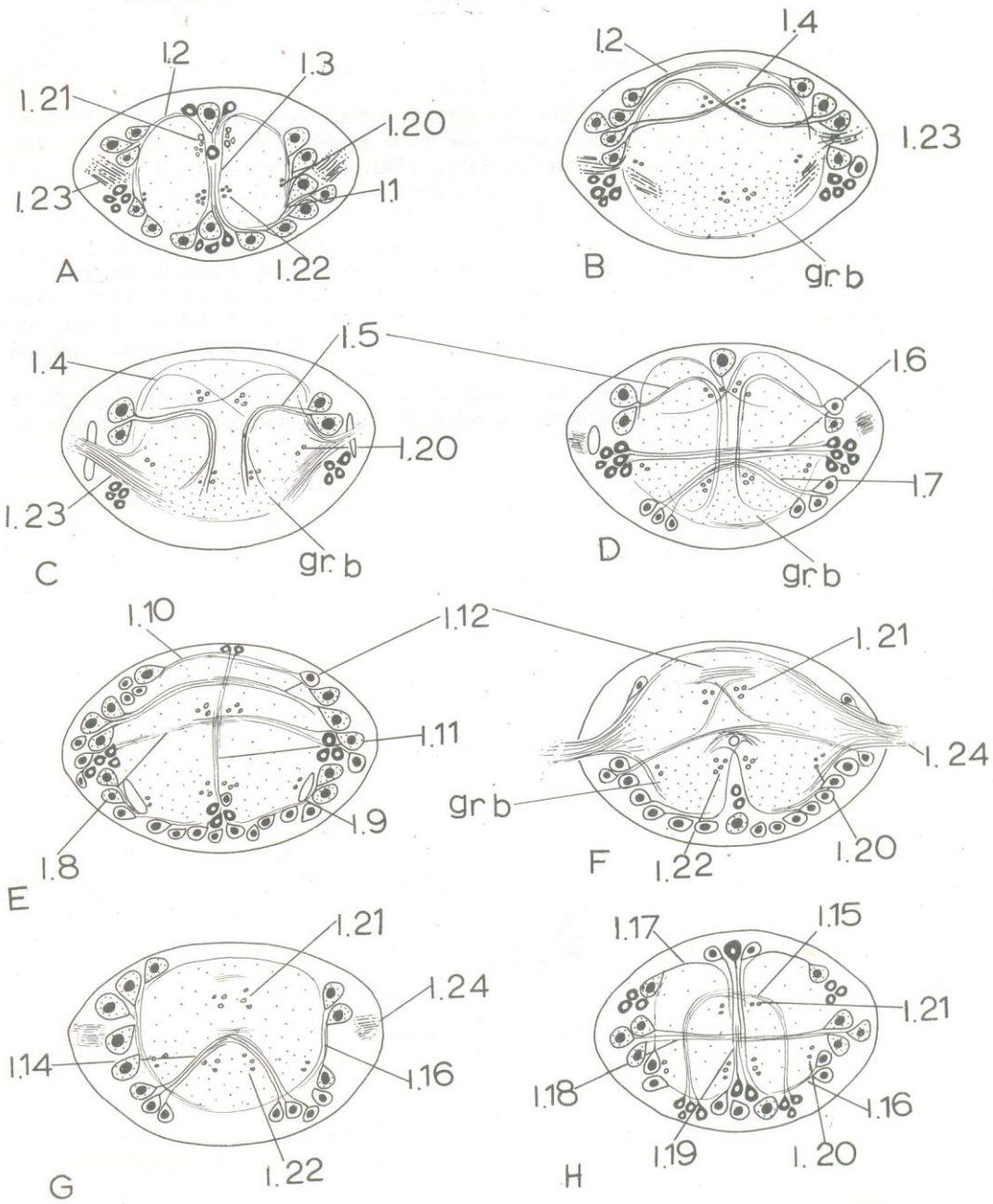
RESULTS AND DISCUSSION

Compound abdominal ganglia (6th, 7th and 8th)
a. Peripheral nerves

Two pairs of peripheral nerves leave each ganglion to supply the muscles of the body wall. This number remains constant throughout all developmental stages of the insect. Even as early as 24 - 72 hours after pupal life begins, the nerves from the sixth abdominal ganglion can be seen leaving the almost empty shell of this ganglion. At this stage it is very difficult to judge where these nerves originate, since the cells in the reduced ganglion are vacuolated and all of the same appearence. In the late stages and in the adult these nerves comprise fibres from neurones in the seventh and eight (last compound) abdominal ganglia and some probably also from the 5th abdominal ganglia. But as the nerves appear to arise from the interganglionic connectives it is difficult to locate the exact position of the neurones giving rise to them. The next two pairs of nerves are given off latrally and the last pairs are given off in a latero-posterior and posterior position. The last two might be termed the caudal nerves, they supply the reproductive system of the adult and the gut as well as some of the body wall muscles.

Fig. 1. Serial digramatic drawings of the transverse sections of the seventh abdominal ganglion of 5th instar larva showing neurones with their fibre tracts and other features. Cells with dark nuclei and dotted cytoplasm represent large motor neurones; cells with dark nuclei and white cytoplasm represent medium sized neurones; cells with dark cytoplasm represent association neurones; small clusters of circles represent axons cut transversely and heavily shaded areas represent glomerular bodies.

Abbreviations used in figures: abd., Association neurone; abd.6, abd,8, Sixth to eight abdominal Ganglia; g.m.c., Ganglion mother-cell; gl.I, Type I Glial cell; gl.III, Type III glial cell; gl.IV, Type IV glial cell; I.1, I.2 Larval abdominal fibre tracts; m.n., Motor neurone; nl. Neurilema; np., Neuropile; nv. fb., Nerve fibre; pkn., Pyknotic cell; tr., Trachea.


1.2
1.3
1.21
1.20
1.23
1.1
1.22
A
1.2
1.4
1.23
gr.b
B
1.4
1.5
1.20
1.23
gr.b
C
1.6
1.7
gr.b
D
1.10
1.12
1.11
1.9
1.8
E
1.21
1.24
gr.b
1.22
1.20
F
1.21
1.24
1.14
1.16
1.22
G
1.17
1.15
1.21
1.18
1.16
1.19
1.20
H

b. Neuropile and axonal tracts

As usual the neuropile occupies the central part of the ganglia and is surrounded by the cellular cortex which has already been described earlier (Ali, 1973). The neuropile is of the "Structured Stratified type" (Maynard, 1962). In the larval and early pupal stages when these posterior ganglia are distinnct, all the major fibre tracts, as described for the third abdominal ganglion (Ali, 1991), are very distinct. The set of fibre tracts for the sixth abdominal ganglion is separate as is also for the seventh and eight abdominal ganglia. Figs. 1 and 2 show the various fibre tracts for the last two ganglia in the 5th instar larva. Altogether, therefore, there are three sets of fibre tracts each with 24 tracts, essentially identical with those of the third abdominal ganglion. for convenience sake they are named the same as for the third abdominal ganglion that is, 1.1 to 1.24 (Ali, 1991). But when the sixth abdominal ganglion loses its separate identity, and becomes fused with the seventh and eight abdominal ganglia to form the last compound ganglion of the adult, then the sixth abdominal ganglion loses

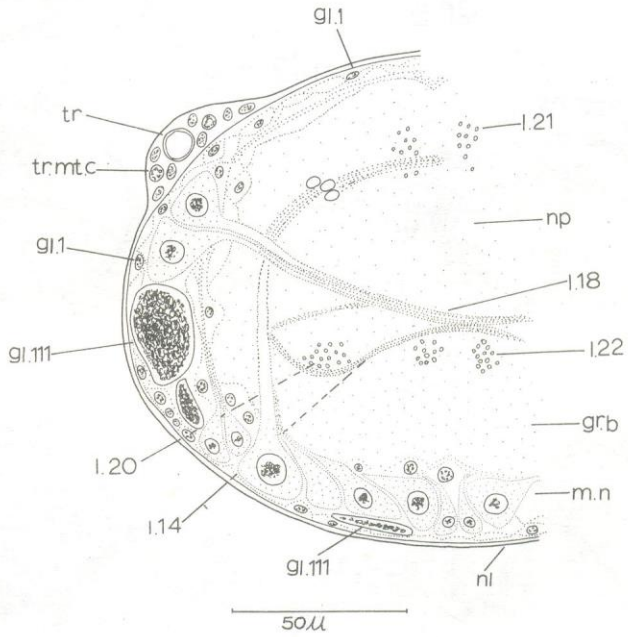


Fig. 2. Diagrammatic drawings of serial transverse sections through eighth abdominal ganglion of 5th instar larva, with same explantions as in Fig. 1.

its separate identity, and becomes fused with the seventh and eighth abdominal ganglia to form the last compound ganglion of the adult, then the two posterior sets tracts become greatly compressed and their previous arrangement undergoes modification.

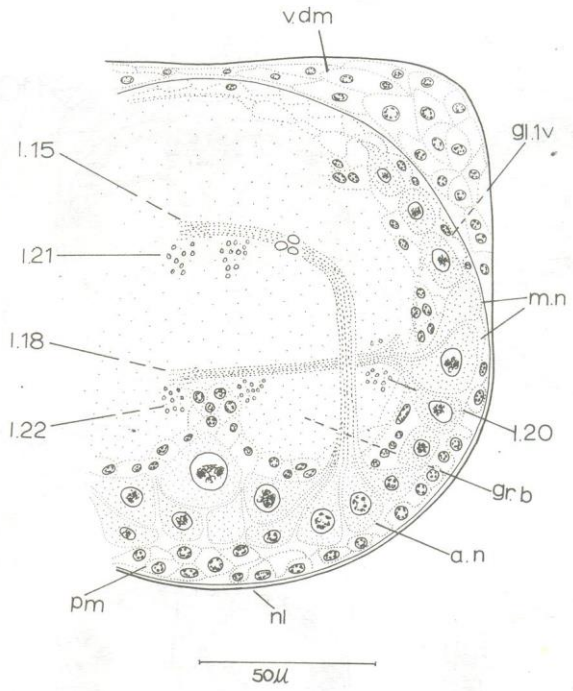


Fig. 3. Diagrammatic drawings of serial transverse sections through sixth abdominal ganglion of adult, with same explantions as in Fig. 1.

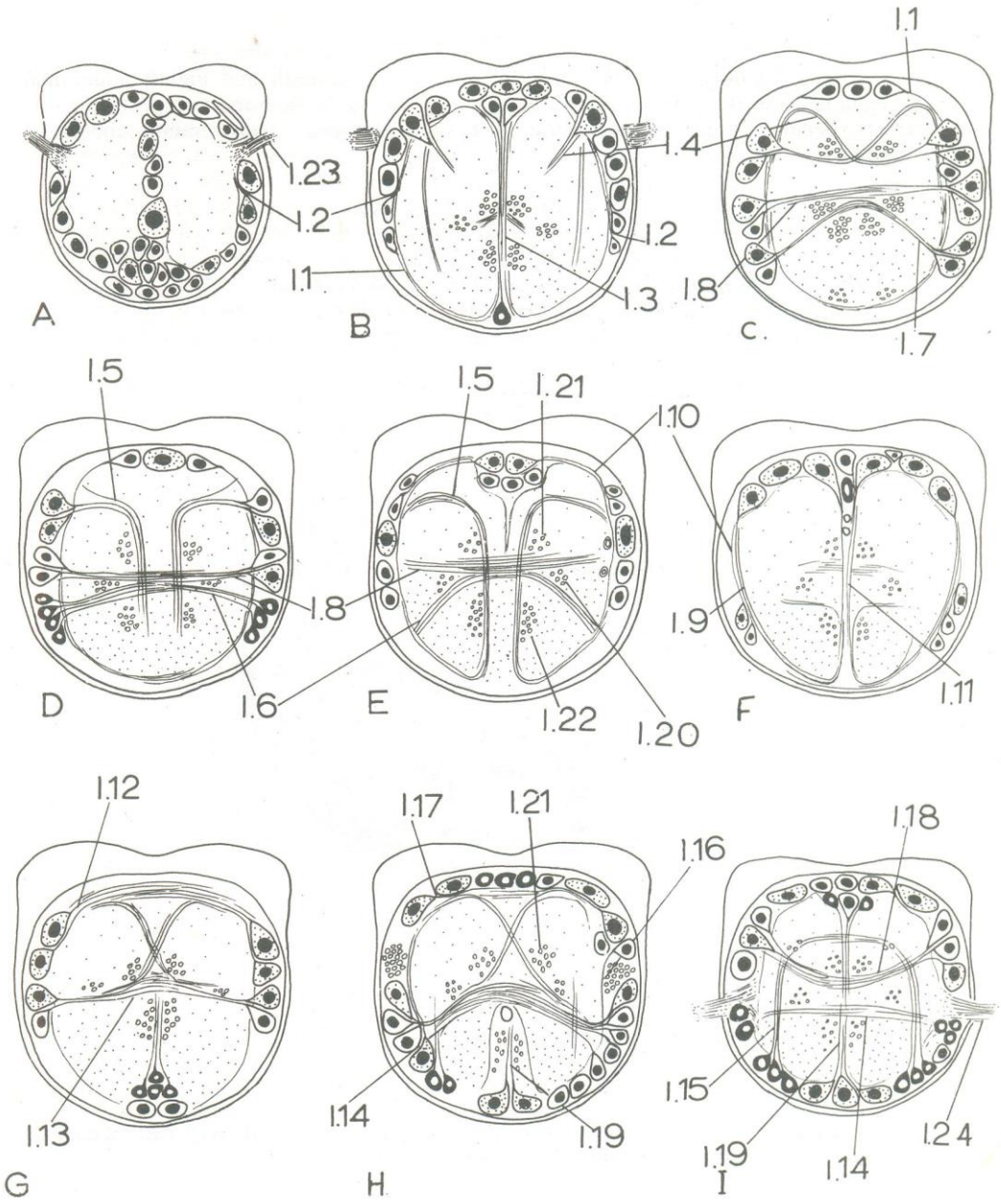


Fig. 4. Diagrammatic drawings of serial transverse sections through eighth abdominal ganglion of adult, with same explantions as in Fig. 1.

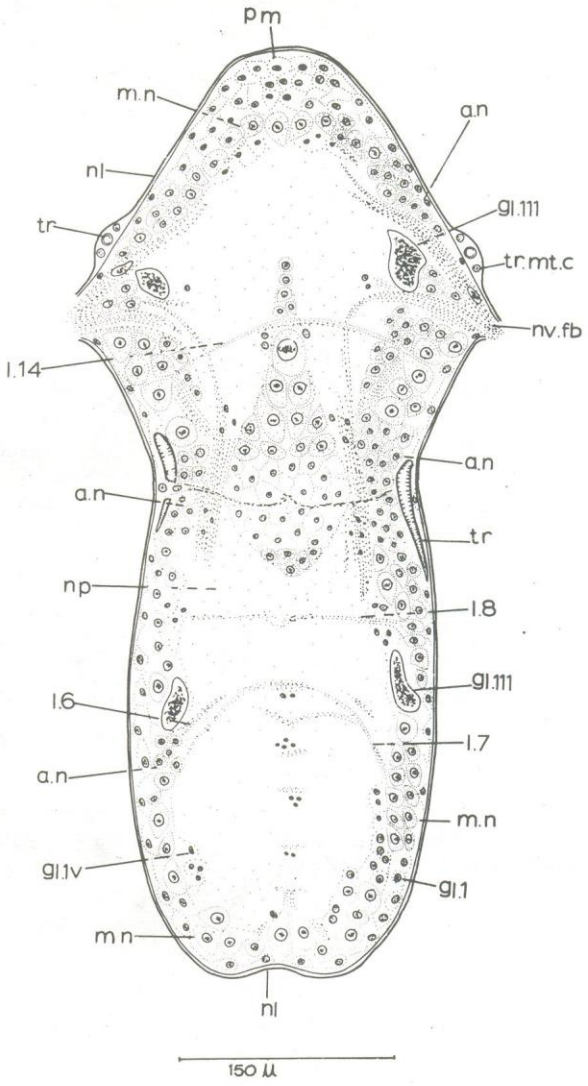


Fig. 5. Frontal section through seventh and eight abdominal ganglia of prepupa showing perineurium neurones and glial cells.

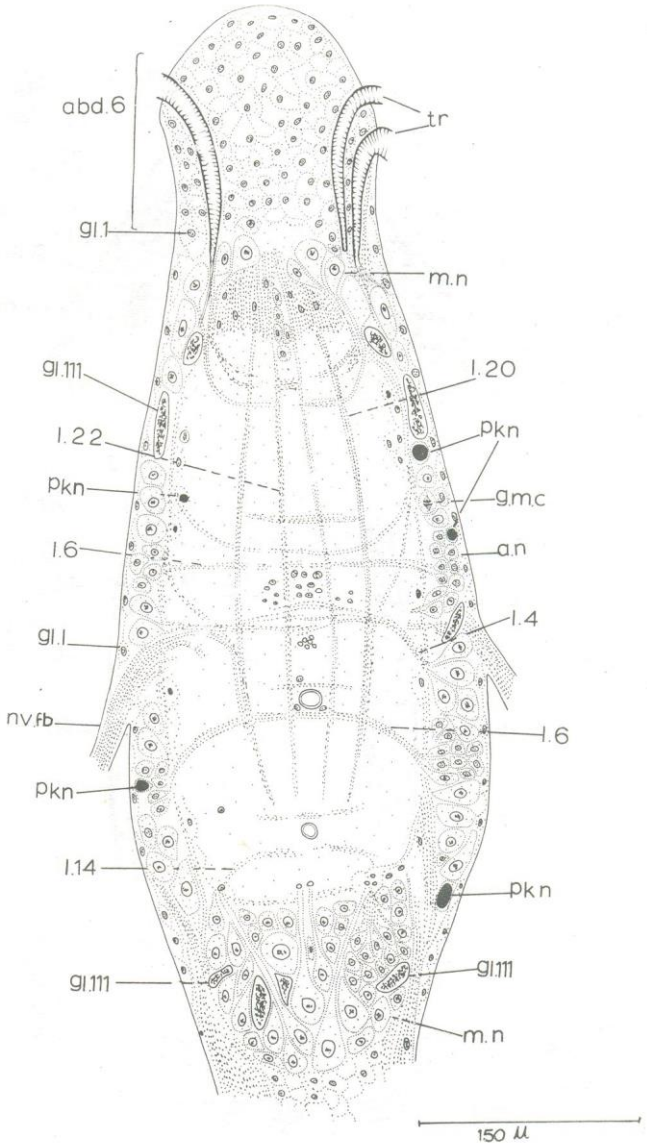


Fig. 6. Frontal section through last compund abdominal of 72-hour pupa illustrating the hypertrophied perineurial cells of the sixth abdominal ganglion, pyknotic cells and some other features.

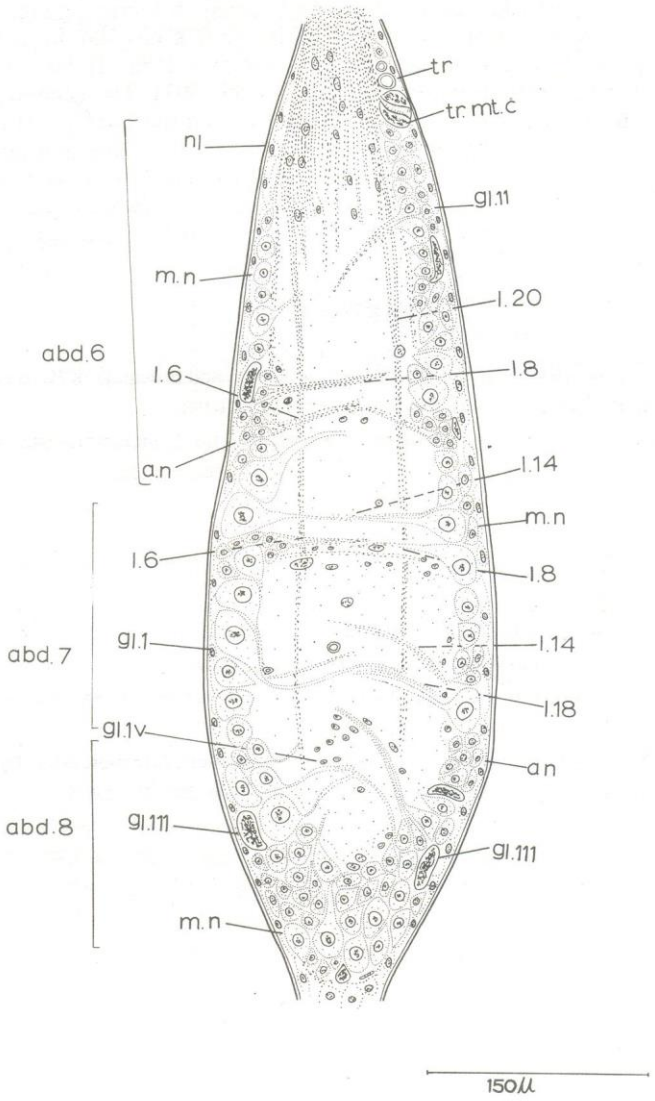


Fig. 7. Frontal section through compund abdominal ganglion of 180-hour pupa showing neurones, fibre tracts and glial cells.

The whole compund ganglion of the adult seems to be divided into two parts externally. The anterior part (derived from the sixth larval abdominal ganglion) is oval or spindle shaped in cross-section but the posterior part s circular in corss-section and, of course, represents two ganglia. The anterior part (Fig. 3) has all the fibre tracts as described for the third abdominal ganglion (Ali 1991). The second set (Fig. 4 A-E) has all except four tracts (Nos. 1, 4, 8, 12 and 13), and the third set (Fig. 4 F - L) lacks tract No. 1, 11, 12. The eight abdominal ganglion in the larva and adult has an additional tract (1.25) given off from a group of ventorlateral motor neurones at the posterior end of the ganglion (Fig. 2G and4K). It runs dorsalwards and crosses the midline on the dorsal side like tract 1.15. Figs. 5-7 show some tracts for the prepupa and some pupal instars.

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