

CELLULAR COMPONENTS OF THE BRAIN OF *MUSCA DOMESTICA* L.
(MUSCIDAE : DIPTERA)

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Abstract: The brain of *Musca domestica* has nervous and non-nervous supporting and nutritive glial tissue. Neurons are for the most part association neurons forming optic, globuli and general type of association or intermicial neurons. Motor neurons are confined to denticerebrum only and are few. Specialized neurons performing secretory function are abundant in the pars intercerebralis region of the brain. Four types of glial cells are found. The characters and the dimensions vary according to the type.

Key words: Neurons, neurosecretory cells, glial cells, housefly.

INTRODUCTION

Among other things, the survival of every animal depends on receiving and responding to information about their environment. In addition to this, the monitoring and coordination of internal events is also essential, as different life processes are governed by them. The nervous system performs these integrative functions. It possesses electrical and chemical mechanism for information reception, transmission, and processing which results in the appropriate behaviour.

In insects the nervous system consists of a chain of central ganglia connected with sensory and effector organs via afferent and efferent nerves. Each ganglion is composed essentially of ramifying neuroglial cells having supporting and nutritive functions and the more distinctive numerous nervous which are specialized for nervous functions and have prologations and branches. Neurons in central nervous systems of insects are characteristically monopolar. Their prologations and branches are processes that are especially adapted for neural transmission and can relatively rapidly generate and conduct electrochemical nervous impulses. (Huber, 1974; Richards and Davies, 1977; Shankland and Frazier, 1985).

Musca domestica, the common housefly was chosen for the present study as it is a mechanical carrier of over hundred species of pathogens causing poliomyelitis, trachoma, infectious hepatitis, Q fever among many other diseases.

MATERIALS AND METHODS

Collection and maintenance of insects

Musca domestica, used for the present research work were collected from the meat shops near Quaid-e-Azam Campus, Punjab University, Lahore. They were brought to the laboratory where they were sorted out and put in clean 5"x5"x10" plastic jars.

Cotton wool soaked in milk-sugar solution was given as food in small glass petridishes. The flies so maintained were used as stock for rearing purposes. In order to get new generations of flies, about 15 mixed adult males and females were taken out and kept in sterilized 3"x6" glass jars. Some rearing was also done in plastic bowls of 8" diameter and 4" depth, containing specially prepared rearing medium which consisted of maize meal, 125 g; molasses, 125 ml; bakers yeast, 18 g; powdered agar, 18 g; propionic acid, 02 ml and water 1075 ml.

The flies usually laid eggs after 24 hours. The eggs hatched after 6-12 hours of deposition. Larval life lasted for about 10 days. Puparial stage lasted for 4-6 days. When the adults emerged, they were kept in separate containers and fed on a diet of milk-sugar solution.

Histological studies

The head and anterior part of the thorax was removed with the help of a sharp scalpel, fixed for 24 hours in Bouins fixative. Dehydration was done with ascending grades of alcohol, cleared in cedar wood oil and embedded in paraffin wax. Serial 8-10 μ m thick sections were cut with a rotary microtome. Sections were stained in hematoxyline, counter stained with eosin, and mounted in canada balsam.

RESULTS AND DISCUSSION

The brain lies just above the oesophagus between the apodemes of the tentorium. It is the dorsal ganglionic centre of the head and is, as usual, made up by the fusion of three embryonic ganglia *i.e.*, Protocerebrum, Deutocerebrum and Tritocerebrum.

Histologically, the two main divisions of the brain are, cortex and medulla or neuropile.

Cortex is the cellular peripheral part possessing three main types of cells *i.e.*, Neurons, Glial or supporting cells and Neurosecretory cells.

Neurons (Figs. 1-7; Table 1)

These cells are the major constituents of the cortex. They lie between the perineurium and neuropile (Richard and Davies, 1977; Ali, 1973, 1993). These are generally categorized as: the motor, sensory and association or internuncial neurons.

This division is based on their morphological and functional characteristics: *e.g.*, size, distribution of chromatin material, presence or absence of nucleoli and whether they perform motor, sensory or association functions constituting transmission channels for the sensory inputs that arrive.

Motor neurons

The only motor neurons found in the brain of the housefly, as in other insects, are present in the region of the deutocerebrum where presumably their axons innervate the mixed antennal nerves. They possess large nuclei with chromatin material concentrated at the centre. Nucleolus is usually single and quite distinct. Considerable cytoplasm is present around the nucleus. Their length ranges from 6-12 μm and the width from 6-10 μm .

Sensory neurons

These are the commonest type found in the brain and are distinctly recognizable from other types of neurons. They are smaller in size as compared to the other types and form the major bulk of the cortex. They can be divided into three categories according to their location, *i.e.*, optic ganglion neurons; globuli cells of corpora pedunculata; general type composing rest of the sensory cell mass.

a) *Optic ganglion neurons*

These are small and very tightly packed, so that their cell boundaries are difficult to discern. They have scanty cytoplasm but their nuclei have a rich supply of scattered chromatin granules. Amount of the chromatin material is variable in different cells. Some are more profusely supplied as compared to the others, but in all the cases chromatin rich nuclei almost fill the whole of the cell bodies. The length of their nuclei varies from 2 - 3.5 μm , while the breadth ranges from 2 - 2.5 μm . Their axons form the different chiasma and axonal tracts of the optic ganglion.

b) *Globuli cells of corpora pedunculata*

These cells are present on the dorsal side of the corpora pedunculata, filling their cups and calyces and sending their axonal tracts in the neuropile thus forming the stems and roots of the corpora pedunculata. These are also small and very tightly packed like the optic ganglion neurons. They have been called beaker cells by Bretschneider. (1913, 1921 and 1924), globuli cells by Johansson (1957); Ali (1973) and many other later workers. Their nuclei are large and packed with chromatin material. Their cell boundaries could not be clearly distinguished like those of the optic ganglion cells. These cells vary from 3-4 μm in length and from 2.5-4 μm in width.

c) *General sensory cells.*

All the neuronal cells of the brain except the above mentioned and association neurons are the 'general sensory cells'. These cells are of variable size. They possess

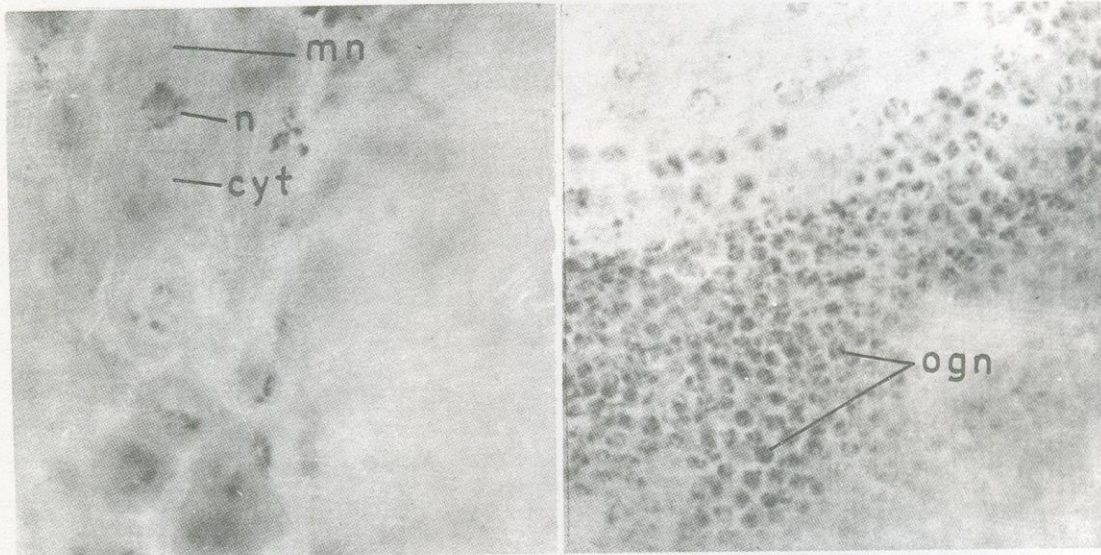


Fig. 1: T.S. of the brain of *Musca domestica*, showing motor neurons (mn), optic ganglion neuron (ogn), cytoplasm (cys) and nucleus (n). Magnification, 100X; Stain, haematoxylin and eosin.

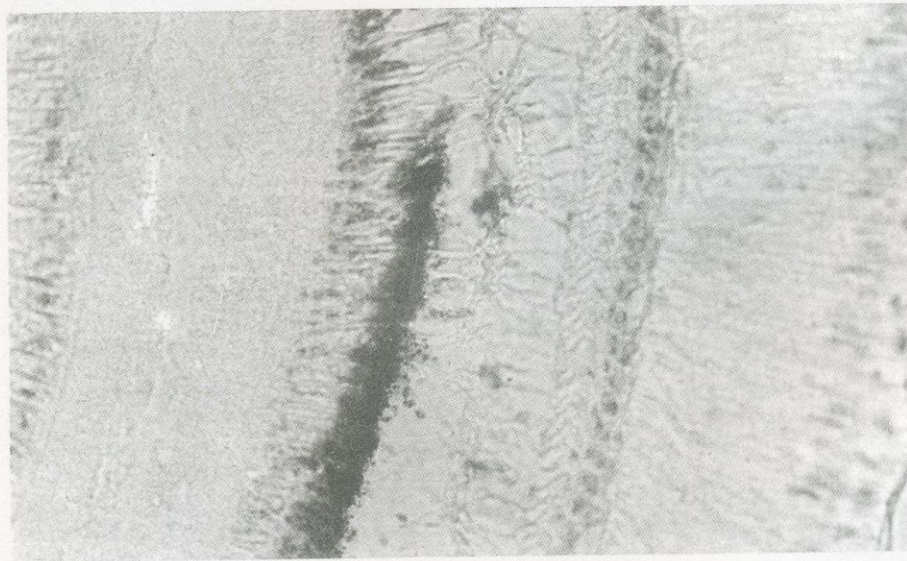


Fig. 2: T.S. of the brain of *Musca domestica*, showing optic lobe. Magnification, 100X; Stain, haematoxylin and eosin.

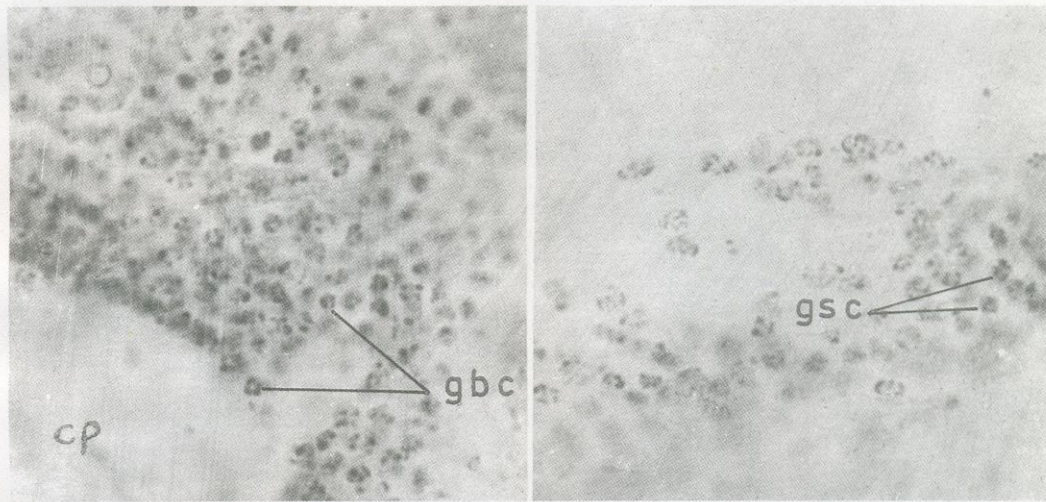


Fig. 3: T.S. of the brain of *Musca domestica*, showing globuli cells (gbc) of corpora pedunculata (cp) and general sensory cells (gsc). Magnification, 100X; Stain, haematoxylin and eosin.

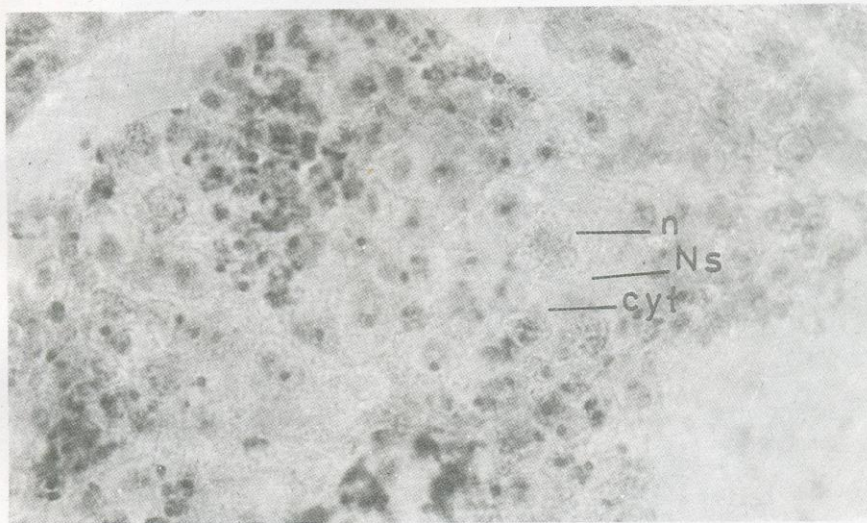


Fig. 4: T.S. of brain of *Musca domestica*, showing neurosecretory cells (ns), cytoplasm (cyt) and nucleus (n). Magnification, 100X; Stain, haematoxylin and eosin.

one or two nucleoli with scattered chromatin material, and have scanty cytoplasm. Their nuclei range from 3-4 μ m in length and 2.5-3 μ m in width.

Neurosecretory cells

These are predominantly present in the parts Intercerebralis region of the protocerebrum where they are present in groups. They are specialized neurons which apart from possessing endocrine function also show electrical sings of nervous activity (Cook and Milligan, 1972; Richards and Davies, 1977). All these cells have rounded or elliptical nuclei with a conspicuous nucleolus and centrally concentrated chromatin material. They have abundant cytoplams with distinct cell boundaries. Their nuclei range from 7.5-15 μ m in length and 5-7.5 μ m in width. The cell size ranges from 12-20 μ m in length and 9-20 μ m in width.

Glial cells.

These form the non-nervous componant of the brain. They have a supporting and nutritional role. Four types of glial cells are present in the cortex and can be recognized as glial type I, type II, type III and type IV. This division was based after the work of Wigglesworth (1956) and Ali (1973).

The glial type I cells

They form the cellular constituents of the perilemma. Their nuclei are small rounded or elliptical. On the dorsal aspect of the brain the perineurium is 1-2 cells thick but on the ventral side and around olfactory lobes it is upto 4 cells thick. The cells are vacuolated with scanty cytoplasm. The thickness of neural lamella, (the outer non-cellular part of the cortex) also varies from 1 μ m to 5 μ m. It is thickest at mid-dorsal region and on the ventrolateral aspect of the brain. The length range of nuclei is 5-7.5 μ m and width range is 2-4 μ m.

The glial type II cells

These cells are dispersed among the neurons between the perineurium and neuropile. Their nuclei are spherical or elliptical with scattered chromatin material, with a length range of 2.5-5 μ m and width range of 2.5-5 μ m. They have distinct cell boundaries but scanty cytoplasm. They are sometimes difficult to distinguish from the neurons.

The glial type III cells

These were easily recognized because of their gaint nuclei. These are elongate with somewhat irregular boundaries. However, their cytoplasm was not discernable. The length of the nuclei ranged from 12.5-17.5 μ m and width from 9-11 μ m.

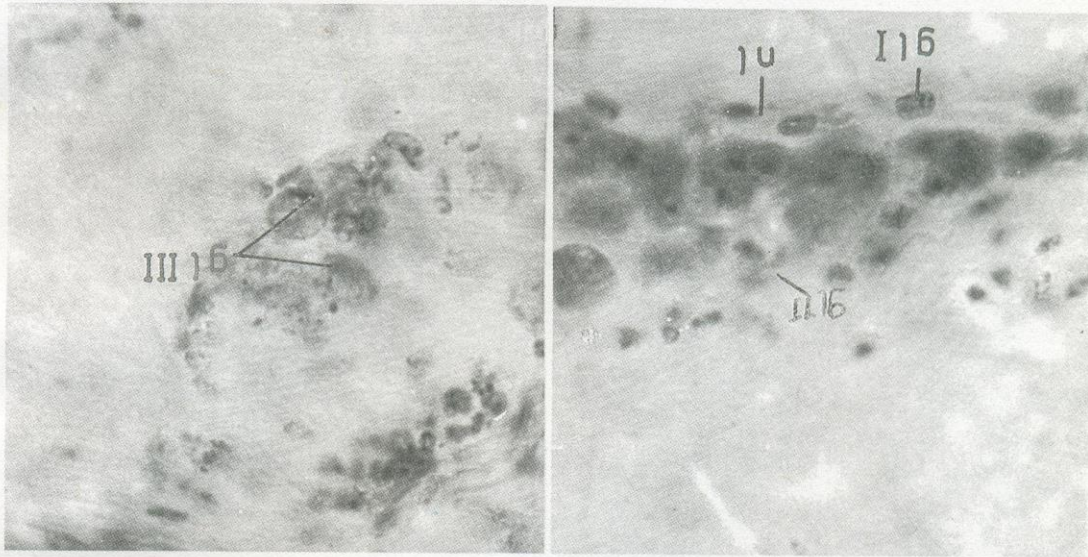


Fig. 5: T.S. of brain of *Musca domestica*, showing neural lamella (nl), glial type I (gl-I), glial II (gl-II) and glial III (gl-III) cells. Magnification, 100X; Stain, haematoxylin and eosin.



Fig. 6: T.S. of the brain of *Musca domestica*, showing glial IV cells in the neuropile of the protocerebrum. Magnification, 100X; Stain, haematoxylin and eosin.



Fig. 7: T.S. of neuropile to the ventral side of protocerebrum showing glial type IV cells and different glomerular bodies. Magnification, 40X; Stain, haematoxylin and eosin.

Table I: Dimensions of nucleic of different cells of brain in control insects of *M. domestica*.

Cell types	Length (μm)			Width (μm)		
	Range	Mean	S.D.	Range	Mean	S.D.
Glial type I	5-7.5	5.5	0.68	2-4	3	0.71
Glial type II	2.5-5	3	0.88	2.5-5	3	0.68
Glial type III	12.5-17.5	15.5	2.73	9-11	10	0.88
Glial type IV	4-5	5	0.55	2-2.5	2	0.27
Motor neurons	6-12	10.5	3.6	6-10	8	1.6
Optic ganglion neurone	2-3.5	2.5	0.55	2-2.5	2	0.31
Globuli cells	3-4	3	0.36	2.5-4	3	0.55
General sensory cells	3-4	3	0.95	2.5-3.5	3	0.32
Neurosecretory cells	7.5-15	10	3.11	5-7.5	6	1.25

The glial type IV cells

These are similar in structure to the glial type I cells. They form a sheath around the neuropile, separating it from the rest of the cortical cells. They also surround all the important glomerular bodies of the brain and are also seen scattered randomly in the neuropile itself. Their cytoplasm is scanty and cell boundaries are indistinct. The nucleus possess scattered chromatin material. The length of the nuclei is 4-5 μ m and width about 2-2.5 μ m.

The neuropile

The neuropile is the central part of brain and is traversed by axons of different diameter, some of which are arranged in definite bundles and form distinct fibre tracts. Neuropile also possess some important glomerular bodies for example optic ganglia, cerpora pedunculata and central body. Some of them have been studied in detail (Bullock and Honidge, 1965; Muncini and Frontali, 1967; Frontali and Mancini, 1970 and Weiss, 1974). The neuropile of the olfactory lobe has several clearly distinct glomerular bodies lying in it (Fig.7).

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