INTERNAL MORPHOLOGY AND HISTOLOGY OF THE FISH MITE
LARDOGLYPHUS KONOI (SASA AND ASANUMA) (ACARINA : ACARIDAE)

3. NERVOUS SYSTEM *

BY

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ABSTRACT

The nervous system of adult *Lardoglyphus konoi* is described from paraffin, serial sections cut at six microns thickness and viewed under immersion lens. The nervous system consists of the supra and suboesophageal ganglia, circum oesophageal connectives, the ventral ganglia, and a few nerves. The nervous system is not so much centralised and fused as reported in other mites. In the ventral chain at least five separate ganglionic aggregations are distinguishable. The nervous system is compared with that of other Chelicerates.

INTRODUCTION

In two previous publications (VIJAYAMBIKA and JOHN, in press) the morphology and histology of the alimentary canal and the reproductive system of *L. konoi* were described. The present paper reports observations on the detailed morphology and histology of the nervous system.

The descriptions are made from serial paraffin sections and for details of fixation and staining methods readers are referred to the previous publications in the series.

OBSERVATIONS

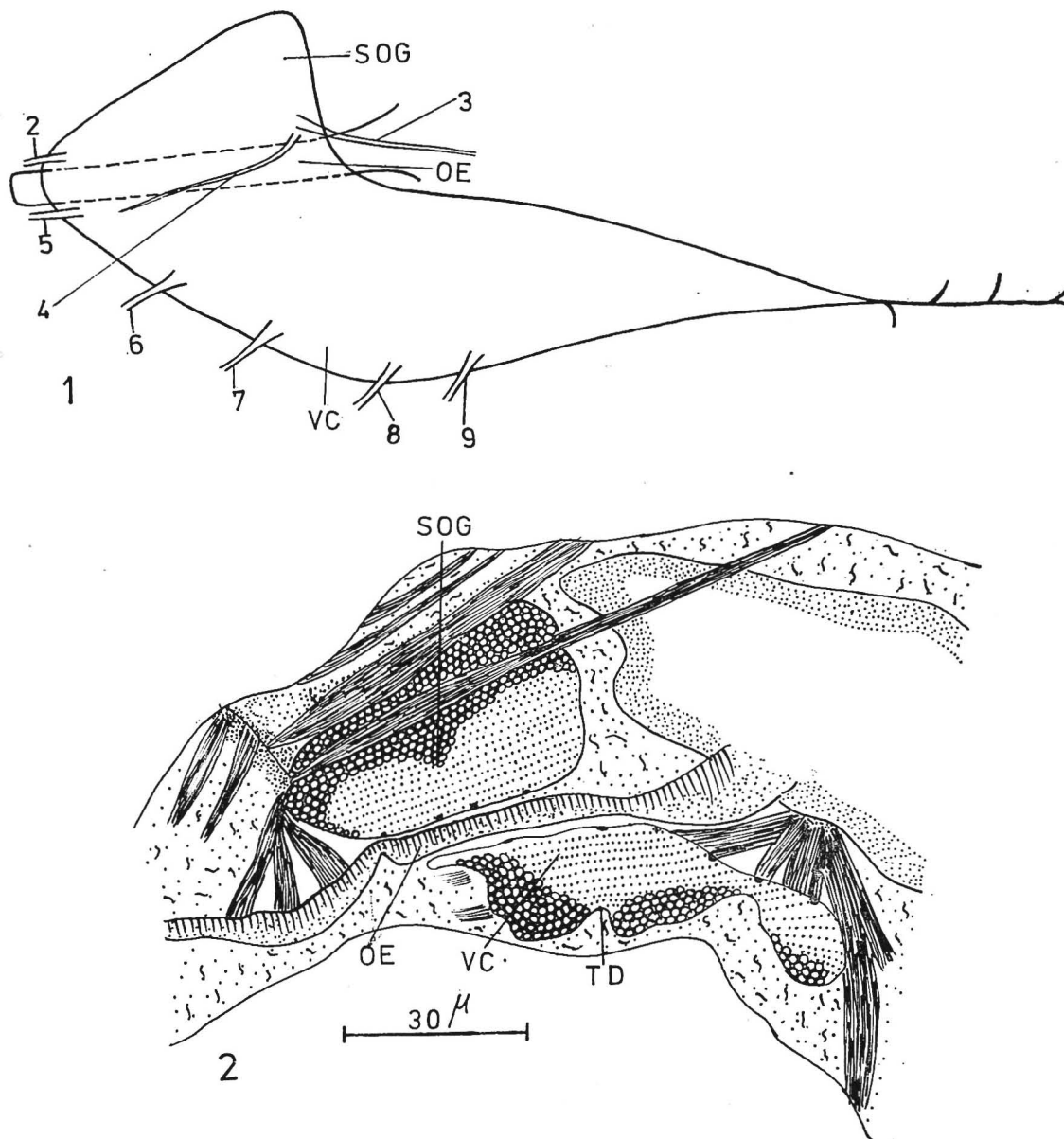The nervous system consists of the brain, circumoesophageal connectives, a ventral cord of ganglia and a few nerves.

The brain or the supracesophageal ganglion is anteromedian in position and superior to the oesophageal canal (see figs. 1, 2). It is wedge shaped with the narrow end directed forwards and the broad end directed backwards. The dorsal, posterior angles are curved, giving the posterior end of the brain a bulbous appearance. The brain is also tall towards the posterior end providing this end with two vertical sides.

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The supraoesophageal ganglion though median in position, can be divided into two longitudinal halves by the presence of a median dorsal furrow (DF fig. 3). The two vertical sides are also slightly dented inwards more towards their bases, to lodge two strong bands of dorsoventral muscles running along the sides of the brain. (see fig. 3).

The supraoesophageal ganglion is surrounded on all sides by a supporting or connective tissue sheath, the neurilemma. The neurilemma is very thin with widely distributed, elongated and pyriform nuclei.

FIGS. 1-2 : 1) Diagramatic representation of the nervous system in the lateral view ; SOG, Supraoesophageal ganglion. VC, Ventral cord. Œ, Œsophagus. 2-9 Nevers arising from the central nervous system ; 2) Obliquely vertical longitudinal section through the anterior region of the adult ; SOG, Supraoesophageal ganglion. OE, OEsophagus. VC, Ventral cord. TD, Transverse depression.

The cell rind of the supraoesophageal ganglion is localised to the dorsal and dorsolateral sides (see fig. 3). It is several layers deep with the cells tightly packed. The cells sink deeper at some points in the ventral margin of the rind (see fig. 2). The cells are small wtih poor cytoplasm, and prominent centrally located nuclei.

The mid dorsal furrow on the brain divides the more superficial layers of cells in the rind also, into two lateral halves. Towards the base, at the posterior end in each lateral half of the cell rind, a small group of cells is faintly differentiated into a separate cluster. These clusters may be termed the tritocerebrum. Apart from the faint differentiation into the tritocerebral groups, and the lateral division by the dorsal furrow, no further differentiation into separate groups or clusters is visible in the cell rind.

The nerve fibres of the cells in the rind are concentrated to the central region of the brain, forming a fibrous core or medulla. Within this fibrous core, a median neuropile is distinguishable in the hinder half more or less towards the middle of its height (CB fig. 3). This is the central body. Dorsal to the central body and lying across the fibrous core is another neuropile, which is the protocerebral bridge (PB fig. 3). Situated ventrally on the outer edges of the core and behind the foregoing structures are present two more neuropiles seen in association with the tritocerebral groups of cells. They are connected together by a transverse commissure.

Starting from the ventral sides of the brain and running vertically downwards on each side of the oesophagus is a bundle of parallel fibres (see fig. 3). This bundle is devoid of cell rind on the outer surface. Each of this bundle is the circumoesophageal connective (COE. fig. 3). The lower ends of the circumoesophageal connectives join the ventral cord of ganglia at its anterodorsal surface.

The ventral cord is median in position and extends up to slightly beyond the ventral muscle mass (see fig. 1). It is unpaired throughout its length, without any transverse commissures. On the ventral cord, there is the suboesophageal ganglion at the anteriormost end and sections reveal a linear row of four ganglionic swellings in addition to the suboesophageal ganglion (see fig. 4). The ganglionic swellings are directed downwards (see fig. 2) and are separated from each other by transverse depressions (TD fig. 2) and short lengths of the cord.
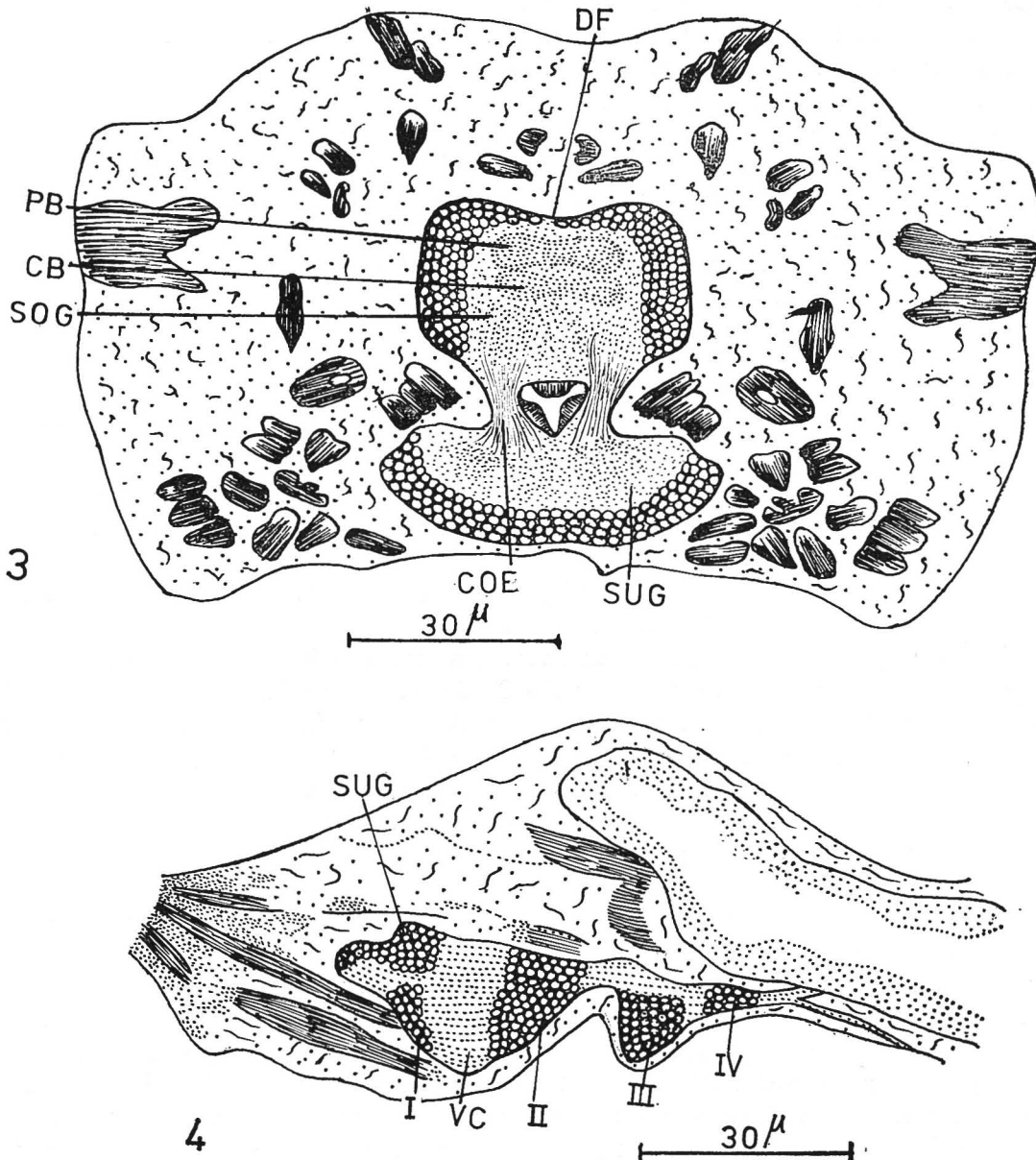
The suboesophageal ganglion and the ganglionic swellings are capped on the ventral (fig. 2) and ventrolateral (fig. 4) sides by a cell rind of several cells deep. The cells are small, tightly packed, poor in cytoplasm and rich in chromatin. The short lengths of the nerve cord between the ganglia are bare on all sides (see figs. 2, 4) making them true connectives.

In the suboesophageal ganglion and the other ganglia of the ventral cord, there is no median separation of the cell rind as in the supraoesophageal ganglion, and the transverse fusion is complete (see fig. 3). The cell rind in these ganglia is followed by a fibrous core, which is homogenous and without differentiation into transverse commissure.

Beyond the ganglia the ventral cord tapers into a rat-tail nerve, which runs along the median ventral body wall, (see figs. 1, 4) a short distance backwards giving branches to the genitalia, stomach and rectum during its course.

In addition to these nerves, sections both longitudinal and transverse have also revealed the presence of the following nerves arising from the different ganglia.

1) A pair of nerves (2 fig. 1) from the distal tip of the supraoesophageal ganglion, to the rostrum.
2) A pair of nerves from the tritocerebral region (3 fig. 1) of the supraoesophageal ganglion to the caeca and median nerve (4 fig. 1) from the same region to the pharyngeal wall.
3) A pair of nerves from the suboesophageal ganglion (5 fig. 1) to the chelicera.
4) A pair each from the four ganglia of the ventral cord, (6, 7, 8, 9 fig. 1) to each pair of legs.

FIGS. 3-4 : 3) Transverse section of the brain through the region of the central body ; SOG, Supraoesophageal ganglion.   SUG, Suboesophageal ganglion.   DF, Dorsal furrow on the supraoesophageal ganglion.   PB, Protocerebral bridge.   CB, Central body.   COE, Circumoesophageal connective ; 4) Obliquely longitudinal section through the lateral edge of the ventral cord ; SUG, Subœsophageal ganglion.   VC, Ventral cord. I to IV, Ganglia of the ventral cord.

DISCUSSION

Protocerebrum, deutocerebrum and tritocerebrum, of which the protocerebrum is the anteriormost are the three main distinguishable regions of an arthropod brain.   (HORRIDGE 1965). Among these, according to him the Chelicerata have no antennae and so correspondingly no

deutocerebrum. Also according to him, the tritocerebrum is the ventral or inferior part of the brain which gives rise to the nerves to the labrum, the stomatogastric system to the alimentary canal, etc. In the species under discussion, a pair of nerves from the faintly demarcated group of cells on the lateroventral sides of the supraoesophageal ganglion enervate the caeca. Also from the region of these groups of cells, there is a median nerve going to the pharynx. As such, the small groups of cells on the lateroventral sides of the supraoesophageal ganglion can justifiably be considered as the tritocerebral lobes of the present species ; the entire rest of the brain will constitute the protocerebrum.

It was seen in the present species, that the central body and the protocerebral bridge which are parts of the protocerebrum are shifted to the dorsal side of the hind half of the brain. This is suggestive that the concentration and forward shifting of the central nervous system during phylogeny have taken place to such an extent, that in the present day species, there is an anterodorsal deflection of the brain.

According to HANSTROM (1919) as quoted by HORRIDGE (1965) in *Trombidium*, Acarina, the structures present in the protocerebrum are only a central body and glomeruli of the accessory eyes. In *Bdella*, also an Acarine, the central body also is not present. In the present species no glomeruli of the accessory eyes are present, but a median protocerebral bridge is visible in addition to the central body.

HORRIDGE has stated that the cheliceral ganglia migrate forwards round the mouth in ontogeny and fuse with the brain so that in Chelicerata, the tritocerebrum is the ganglion of the chelicera. In *Lardoglyphus* we find that the chelicerae are enervated by the suboesophageal ganglion.

According to the same author, among the Chelicerates, from Xiphosura through scorpions and spiders, there is a progressive forward concentration of ganglia and in many of them the cord forms a single mass round the mouth. He also states that in the Acarina, the concentration of the nervous system has proceeded further than any other arthropod group so that the protocerebrum and the ventral ganglia together from a single mass. In the accounts of the nervous system in Acarines (MICHAEL, 1901 ; NALEPA 1884 ; KUO and NESBITT, 1970 and WOODRING and COOK, 1962) the fused and unregmented nature of the central nervous system is stressed. In the ventral cord of *Lardoglyphus*, at least four ganglionic aggregations are discernible separately for reasons already stated, which would suggest that in the species under discussion the description of the central nervous system as a single mass will not be quite justified.

In the degree of concentration, the nervous system of *Lardoglyphus* approaches among the chelicerates, that of spiders (Araneidae), in which there is a single ventral mass below the brain consisting of five ganglionic masses (HORRIDGE 1965) and the Pedipalpi in which all ganglia are fused in a cephalothoracic mass except for two or three at the posterior end of a median abdominal nerve as in thelyphonids (HORRIDGE 1965). But in spider, the lateral halves of the segmental ganglia are separated by transverse commissures, a feature which is absent in *Lardoglyphus*.

Absence of large scale differentiation of the fibrous core of the brain, with practically no visible tracts and globuli masses of cells may quite conceivably fit in with the grazing mode of life of *Lardoglyphus*, where new forms of activity and integrating function of the nervous system can be expected to be the least. All the same, the high degree of concentration the neural apparatus has reached is a pointer to the high level of organisation, the species has achieved.

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