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ANATOMICAL AND HISTOLOGICAL STUDIES OF CENTRAL NERVOUS SYSTEM OF SOME SCORPIONS OF IRAN *

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Summary

The central nervous system of *Androctonus crassicauda, Buthotus saulcyi, Odontobuthus doriae, Mesobuthus eupeus,* belonging to the family Buthidae, and *Hemiscorpius lepturus, Scorpio maurus* of the family Scorpionidae were anatomically and histologically studied. It has been found that the number of separate ganglia on the ventral nerve cord, corresponded to the finding of other authors, but the number of ganglia in the prosomian mass contrary to the general view of being 10 were 8 only.

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Introduction

The central nervous system of scorpions is less concentrated than those in the other representatives of the class Arachnida (MILLOT & VACHON 1949). In scorpions, in addition to the prosomian ganglionic mass, there are 7 separate ganglia on the ventral nerve cord, with the last ganglion being a double one, whereas, in other Arachnids, either there is no more than one such a ganglion or they are entirely devoid of it (BIRULA 1917; VACHON 1948 and 1949; MILLOT 1949).

The prosomian ganglionic mass in scorpions consists of two parts: supraesophageal or cerebral, which corresponds to one syncerebron «chelicerian ganglia» (HANSTOROM 1923), and sub-esophageal mass that is belived to compose of 9 fused ganglia (MILLOT & VACHON 1949). Therefore, the total number of the ganglia in scorpions, at the adult stage is considered to be 18 (MILLOT 1949, and SAVORY 1964).

The aim of the present study was to investigate the validity of the widely accepted view of scorpions having a total number of 18 ganglia, in the two families of scorpions occuring in Iran.

Material and methods

1. Materials.

The central nervous system of the following species was studied: *Androctonus crassicauda* (Olivier 1807), *Buthotus saulcyi* (Simon 1880), *Mesobuthus eupeus* (C.L. Koch 1839) and *Odontobuthus doriae* (Thorell 1877) of the family Buthidae; *Hemiscorpius lepturus* (Peters 1861) and *Scorpio maurus* (Linne 1758) of the family Scorpionidae. Specimens were of both sexes and had been collected in Iran.

2. Methods.

Fixation and dissection. To fix nervous system in the specimens, 3 ml of carnoy solution (adsolute alcohol 60 ml, chloroform 30 ml,

glacial acetic acid 10 ml) were injected into the whole body of each scorpion. Subsequently, the injected scorpions were placed in a vial containing 50 ml carnoy solution for a period of 48 hours. To dissect the specimens the fixed scorpions were pinned down on a cork-board. After removing the dorsal chitineous covering and internal organs, the central nervous system (the prosomian ganglionic mass, mesosomian and metasomian separate ganglia and the connecting nerve cord) were faced, which were carefully detached from nearby tissues and removed. These were kept in a 10% formalin solution for a further fixation. The fixed nervous system were trimmed and processed, then embeded in paraffin and sections 6-10 micron in thickness were cut on a rotary microtome.

Staining. The histo-slides were stained by hematoxillin and eosin staining method.

Results

1. Anatomy.

The central nervous system of the studied specimens consist of: a, the prosomian mass, b, separate ganglia, c, connecting nerve cord (fig. 1).

a. The prosomian mass, being curved-shape, consists of fused ganglia through which esophagus tube passes and, hence, two parts can be distinguished: supraesophageal and sub-esophageal.

Fig. 1. General aspect of the central nervous system of the scorpion.

.he supra-esophageal mass (cerebral) is bilobated in its upper portion. The following symmetrical nerves originate from supra-esophagian mass: 1, the nerve that inervates the frontal region; 2, the nerve that inervates the chelicerian muscles; 3, the optic nerve that verticaly leads towards the median eyes; 4, the optic nerve originating from dorso-lateral portion of the mass, which leads towards the lateral eyes.

The sub-esophagian mass is the longitudinal extention of the curve towards the abdomen from which the following symmetrical nerves originate: 1, the nerve that inervates pedipalpi; 2, four nerve fibres which inervate the legs; 3, in addition to the main above mentioned nerves, a network of nerve fibres from the mass give branches to different nearby organs.

b. Separate ganglia. These are 7 ganglia located abdominaly along the median line, of which 3 are located in mesosoma and 4 in metasoma.

The last metasomian ganglion is longer and seems to be double one. A single ventral and two lateral nerve fibres which exit from the mesosomian ganglia inervate the pectines, lung sacs, ventral and dorsal teguments, ventral and dorsal muscles, the intestinal tube and the heart (fig. 9, 10). The nerve fibres originating from the metasomian ganglia inervate the caudal segments and telson.

c. The nerve cord, connecting prosomian mass to the separate ganglia consists of 2 parallel fibres which are engulfed in a covering tisue. The two nerve fibres at the site of exit from the last metasomian ganglion diverse and each branch inervate the dependant venemous gland (fig. 1, 11).

2. Microscopy.

a. General aspects of nervous system structure.

The supra-esophagian mass consists of 2 fused structurally symmetrical ganglia, a large ganglion on top and a smaller one underneath (fig. 5). The optic and frontal nerves originate from the upper ganglion and the chelicerian nerves from the lower one.

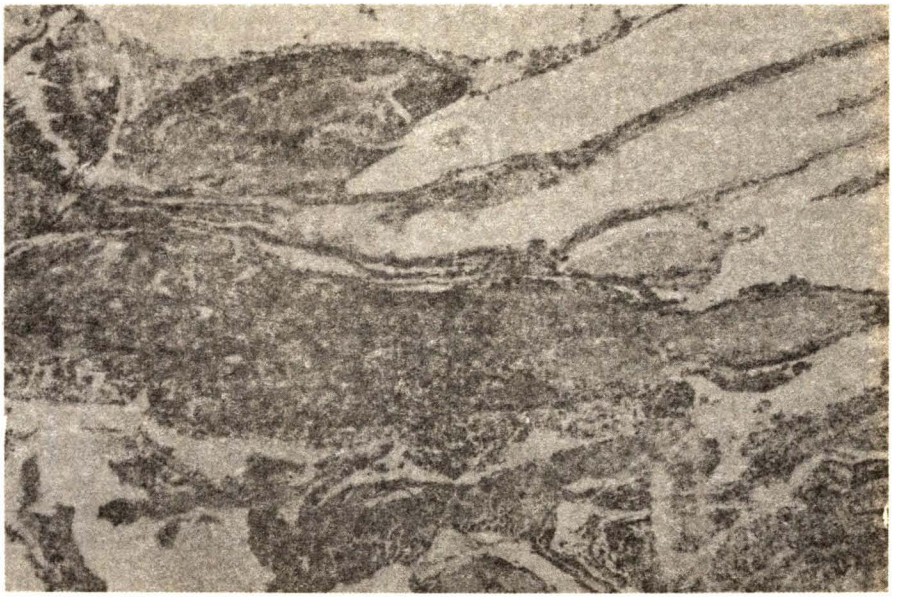

Fig 2. The prosomian ganglionic mass, sectioned longitude-vertically. Notice the passage of the esophagus through.

Fig 3. The prosomian ganglionic mass sectioned longitude-vertically on the left side.

Fig 4. Higher magnification of fig. 3.

The sub-esophagian ganglionic mass, horizontally arranged, consists of 4 distinct ganglia with a symetrical structure (fig. 4, 6). Symmetrical nerve fibres exit from each ganglion and inervate the legs. In addition to these 4 distinct and partialy isolated ganglia, there is, proportionately,

a huge ganglion on each side, in the frontal portion right under the esophageal tube. This seems to consist of two fused ganglia in the longitudinal sectioning (fig. 3, 4), but in the vertical sectioning their clear boundaries are noticeable (fig. 5). From these ganglia the pedipalpial nerves originate. Therefore, counting all, 8 ganglia with symmetrical structure are distinguishable, whereas they apparently seem to be only 6 in number.

There is no noticeable difference between mesosomian and metasomian ganglia, when sectioned vertically and longitudinally, except for the last metasomian ganglion that is larger and appears to be of two fused ganglia on longitudinal sectioning (fig. 11).

Fig 5. The frontal portion of prosomian ganglionic mass sectioned vertically. Notice the esophagus tube engulfed by supra and sub-esophagian ganglionic mass.

Fig 6. Sub-esophagian ganglionic mass sectioned longitudinally. Notice the demarcation of the ganglia caused by the cellular layer.

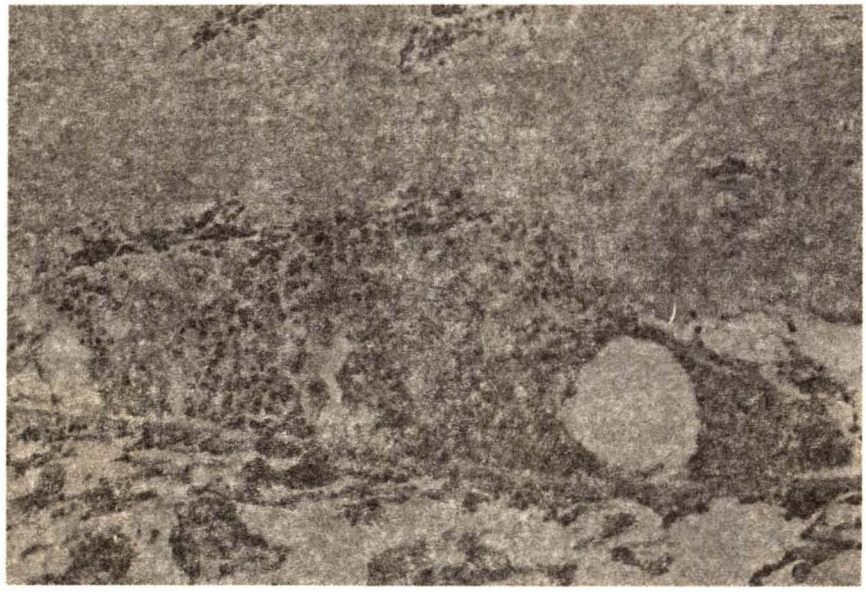

Fig 7. Section from sub-esophagian ganglion. Notice the different type of the nerve cells.

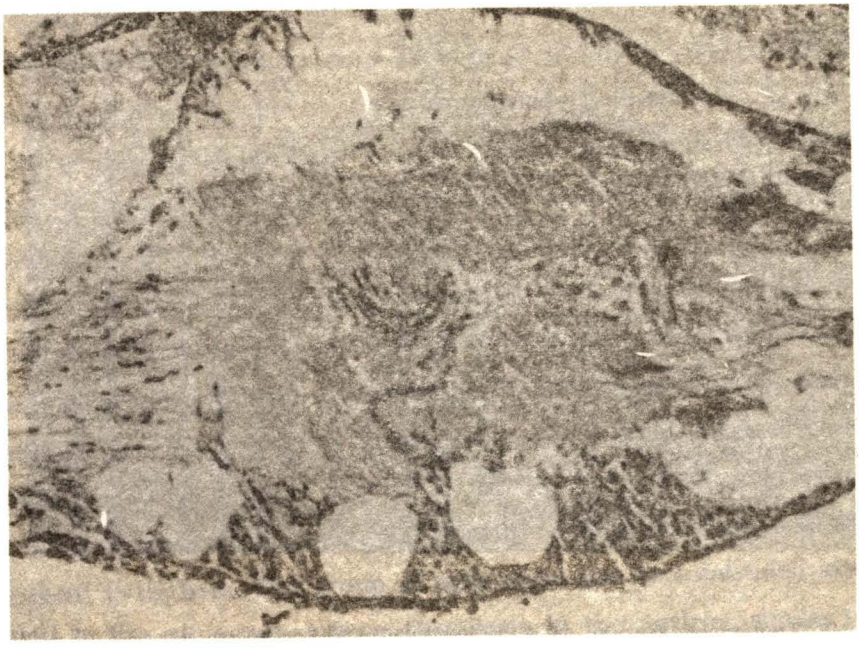

Fig 8. Longitudinal section of a mesosomian ganglion. Notice the cells in the nerve cord.

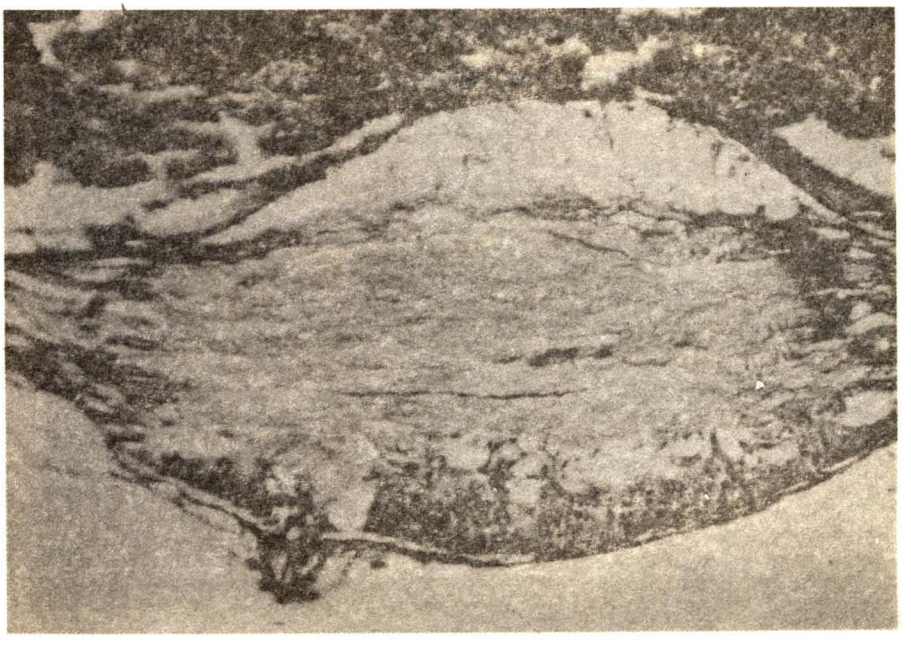

Fig 9. Longitudinal section of a metasomian ganglion. Notice the exit of ventral nerve.

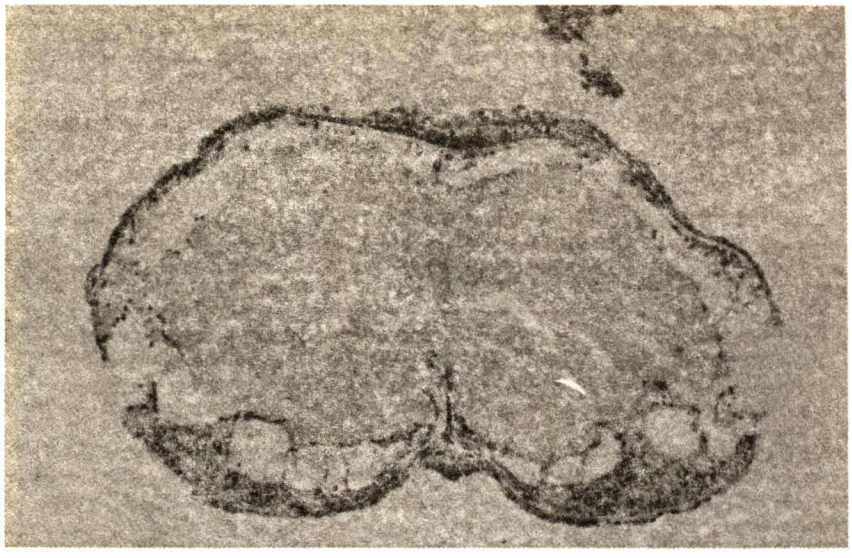

Fig 10. Transversal section of a mesosomian gland. Notice the exit of lateral nerve fibres.

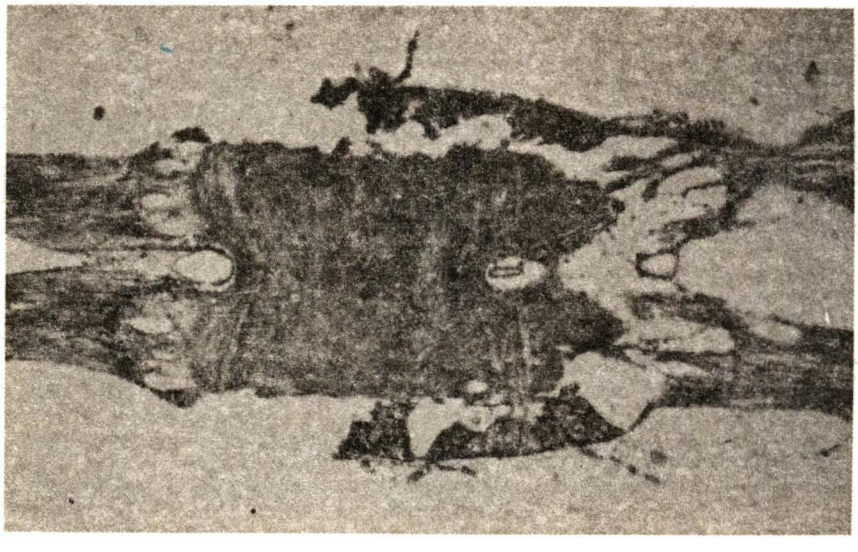

Fig 11. Longitudinal section of the last metasomian ganglion.

b. Histology.

In all vertical or longitudinal sections of prosoma, mesosoma and metasoma ganglia two types of architecture can be noticed:

1. A homogeneous mass occupying the central and the dorsal portion of the ganglion. This mass resembles the white matter present in the vertebrate central nervous system (fig. 5, 8, 10).

2. A cellurar layer that is mostly located ventrally. In some ganglia the cellular layer extends, to some degrees, into the lateral portion and in such cases it may be taken as the border line of the ganglion (fig. 4,5). In cellular layer of each ganglion two groups of cells are distinctly discernible.

a. Small size cells with dense chromatin in the nucleus and without prominent cytoplasm. This group of cells could also be subdivided into two kinds, one with heavy dense chromatin in the nucleus, similar to lymphocytes of vertebrates, and the other with less dense chromatine (fig. 7).

b. Big size cells with prominent cytoplasm and nuclei. The nuclei in this group contain a dense basophilic and eccentric nucleoli, and a central homogeneous eosinophilic mass (fig. 7).

Only in the supra-esophagian ganglionic mass a row of cellular layer, mostly small cells with dense chromatin could be noticed in the dorsal portion (fig. 3,5).

The connecting nerve cord contains cellular elements that resemble Schwann cells in the vertebrate.

Conclusion

The results of the present study on the central nervous system of the two families of scorpion occuring in Iran does not correspond to the

current view of scorpions, in adult stage, having 18 ganglia in the whole nervous system. The total number of ganglia was found to be 16 only; 2 supra-esophageal, 6 sub-esophageal and 8 separate ganglia. The difference in number has arisen in our finding 6 sub-esophageal and 2 supra-esophageal ganglia instead of 9 and 1 ganglia, respectively reported by other authors.

The present study-confirm that the last metasomian ganglion is a fused double one.

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