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THE POST-CRANIAL MYOLOGY OF TARENTOLA ANNULARIS FAMILY: GECKONIDAE
I - AXIAL MUSCLES (CERVICAL REGION)
(With 4 Figs.)

By
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العضلات خلف الجمجمة للبرص الأسود : تارينتولا أنيولاريس ،
عائلة : جيكونيـــــدي
(ـ العضلات المحورية (منطقة العنـــــــق)

محمد وهبـــة ، عبد الحميد خليـــل ، ناهـد شوقـــــــــــي

يقدم هذا البحث دراسة على عضلات منطقة العنق ممثلة لجزء من العضلات المحورية للجسم ، والتي سوف تقدم تباعا في مجموعة بحوث متتالية · قد وصفت ١٤ عضلة فـــي منطقة الرقبة ، كما نوقش الدور الوظيفي لكل منهم مع مقارنة لبعض الحالي الأخرى ·

SUMMARY

The anatomical relationships of the myology of the neck region of Tarentola annularis was the aim of the present study. Fourteen cervical muscles were described in detail. The cervical bending muscles of the head in the three directions are: (1) the levators (M## 1,2,3) and the laterally bending (M## 7,8) and depressor muscles (M## 10,11,12,13).

INTRODUCTION

In fact, the work of CAMP (1923) was good enough to draw the attention towards the myology of lizards. In his work, Camp made some speculations about the possibility of the presence of some systematic significance for some muscles of lizards. Consequently, the aim of the present work is to examine those speculations of Camp. Going through the literature concerning the myology of lizards revealed that most, if not almost all, of those work are concerned with some groups of muscles, for functional anatomical purposes and not morphological or comparative anatomical targets (ADAMS, 1939; ALI,

1950; DELLIT, 1934; EDGEWORTH, 1935; GANS, 1988; HAINES, 1939 & 1946; HAXTON, 1947; HOWELL, 1933; McMURRICH, 1903; MINER, 1925; STRAUS, 1942). Consequently, at an earlier stage, it was found useful to start with a basic comparative morphological detailed study of the post-cranial musculature of a common Egyptian lizard. The lizard examined at that early stage was Uromastyx aegyptia (KHALIL, et al. 1977) because it is common, large and not adapted to a special type of movement. In that study, it was depended on the human myology presented by GRAY (1967) and that was again due to the lack of complete work on the myology of lizards. However, the approach to the subject was modified to serve the purpose of an academic vertebrate comparative anatomist and not a medical human anatomist. In the study of Uromastyx the significance of origin and insertion of the muscle, the joint on which the muscle plays, functional modifications and finally the homology of the muscle were of great importance. The terms used in human anatomy were changed, although referred to, and instead terms were introduced denoting origin and insertion of each muscle. Also, the groups of muscles were classified in a way similar to that applied in the field of osteology such as axial or appendicular musculature.

The present paper represents the first one of serial articles on the post-cranial myology of Tarentola annularis. The post-cranial muscles will be described according to the following order:

I- Axial muslces of the cervical, trunk and caudal regions.
II- Pectoral muscles.
III- Pelvic gridle muscles.
IV-Fore limb muscles (Upper arm region).
V- Fore limb muscles (Fore arm region).
VI-Fore limb muscles (Hand region).
VII- Hind limb muscles (Thigh region).
VIII- Hind limb muscles (Shank region).
IX-Hind limb muscles (Foot region).

MATERIAL and METHODS

The lizard examined in the present work is: Tarentola annularis, Geoff. It belongs to family Geckonidae, and in fact it is the largest Egyptian gecko. It is a nocturnal animal, and as all geckos it is able to perform quick and elegant movement, it is able to walk or run on vertical walls and on ceilings. Those characters surely have great reflection on the myological structure.

Muscles were exposed under stero-dissecting binocular, first photographed and then they were drawn.

RESULTS

1 - Cranio-spinal (Semispinals capitis of Gray's):

(Figs. 1 a,b & c; 2 b and 3 a,b)

The cranio-spinal is covered by the large dorsal head of the cranio-costal muscle (3). So, the latter muscle must be dissected for exposing the cranio-spinal muscle. The cranio-spinal is in the form of a thin sheet, which originates on median region of a connective tissue sheet covering the post-temporal foramen as well as a median area of the supraoccipital and its processus ascendence. Further, that muscle collects some fibers from the neural spines of the second, third, fourth and fifth cervical vertebrae where it gives two ligaments, each of which is biforcated posteriorly. The inner branch of the median ligament is attached on the neural spine of the seventh cervical vertebra, while the corresponding one of the lateral ligament is attached on that of the eighth one. The outer branch of the median ligament is fused with the inner branch of the third unit of the dermo-costal muscle (16) of the trunk region, while the outer branch of the lateral ligament has the same condition of attachment but with the fourth unit of the dermo-costal muscle.

2 - The cervical inner semispinal units:

(Fig. 2a)

Careful examination of the cervical musculature of Tarentola annularis shows that the inner semispinal muscle units, similar to those of Uromastyx (KHALIL, et al. 1977), are not found. However, different semispinal muscle units are present. In the present case, both of the first, second and third semispinal units are quite similar in form and relationships. Each of them is a feather-like muscle, the dorsal fibres of the first unit originate on the neural spines of both the axis and third cervical vertebrae, while its ventral fibres originate on the connective tissue that separates the semispinal from the cranio-costal muscle (3). Again, the first unit is inserted by a relatively stout and short tendon on the postzygapophsis of the atlas. The second unit of the inner semispinal muscle extends between the third and fourth cervical neural spines and the second postzygapophysis, while the third unit extends between the fourth and fifth cervical neural spines and third postzygapophysis.

The posterior most semispinal cervical muscle units (fourth and fifth units) are quite similar to the anterior three cervical units in being vertically located and feather-like. However, those two posterior units are relatively stronger and have a greater longitudinal extension than the anterior three units. The dorsal fibres of the fourth unit originate by a slender and relatively long tendon on the neural spine of eighth cervical (last) vertebra, while its ventral fibres originate on the connective tissue that separates the semispinal units from the cranio-costal muscle units. The fourth semispinal

unit is inserted by a relatively long and stout tendon on the postzygapophysis of the fourth cervical vertebra; the reader can notice the long extension of that muscle.

The fifth semispinal unit is quite similar to the fourth, but it originates on the neural spine of the first dorsal vertebra and is inserted on the postzygapophysis of the fifth cervical one.

3 - Cranio-costal (Longissimus capitis of Gray's):

(Figs. 1 a,b,c & 3 a,b)

The cranio-costal muscle consists of two elements; a dorsal element (3a) and ventral one (3b) (Fig. 1c). These elements are extensive muscles, and they form the greatest part of the neck musculature. The dorsal element (3a) originates on the prezygapophysis of the last five cervical and first dorsal vertebrae. That element (3a) extends forwards to be inserted on the posterior edge of the parietal and its processus parietalis (Fig. 1b). It also gives anteriorly a broad and sheet-like ligament which becomes inserted on the lateral side of the anterior rim of the parietal as well as a small region of the post-frontal. The ventral element (3b) originates on the prezygapophysis of the third to sixth cervical vertebrae (Fig. 3a), and is inserted on the posterior surface of the paroccipital process (Fig. 1b). It is obviously clear that division of the cranio-costal muscle into two completely elements as well as the complete independence of those elements of the ribs, add to the potentiality of head movements.

4 - Cervical vertebral adductor (Longissimus cervices of Gray's):

A muscle, similar to that found in Uromastyx was not found in Tarentola annularis.

5 - Suprascapulo-atlas (Levator scapulae of Gray's):

(Fig. 3 b,c)

The suprascapulo-atlas is also a fan-shaped muscle, that originates on the antero-dorsal surface of the suprascapula as well as on the clavicle just at its connection with the suprascapula. The suprascapulo-atlas is inserted, by its anterior narrow end, on the transverse process of the atlas. It is a suspensorial muscle of the suprascapula.

6 - Costo-atlas (Ilio-costal cervices of Gray's):

(Figs. 1c & 3b)

As previously described in Uromastyx (KHALIL, et al. 1977), the costo-atlas muscle may be considered as an anterior extension of the ilio-costal muscle of the trunk region (17).

The costo-atlas is a fan-shaped muscle that is directed by its narrow end anteriorly. It originates on the lateral side of the connective tissue which separates it from the cranio-costal muscle (3), in the region of the third up to the seventh cervical vertebrae. It is inserted by a dorsal ligament on the minute transverse process of the

atlas, and a ventral but stronger ligament on the basisphenoid bone. The characteristic attachment of that muscle on the basi-sphenoid of Tarentola adds to the ability of the ventral bending (depression) of the head of that animal, when compared with other Lizards: Uromastyx, Agama and Chamaeleon.

7 - Dorsal cranio-vertebral muscle (Rectus capitis of Gray's):

(Fig. 1 a,b,c, & 3 a,b)

The dorsal cranio-vertebral is a fan-shaped muscle, which consists of two completely separate components. The anterior component (a) originates on the lateral sides of both the neural arch of the atlas and the neural spine of the axis. That anterior component is inserted on the postero-dorsal surface of the supraoccipital (Fig. 1 a). The posterior component (b) of the dorsal cranio-vertebral muscle originates on the lateral sides of the neural spines of each of the axis, third and fourth cervical vertebrae, and is inserted on the posterior surface of the paroccipital process just dorsal to the insertion of element (3b) of the cranio-costal muscle (Fig. 1 a).

8 - Sternocleidomastoid:

(Figs. 1 b, 3 b & 4 a)

It is a thick, strong and extensive muscle. It originates by two heads, a superficial head and a deeper one. The former head arises by a strong broad sheet which is attached to the anterior edge of the sternum and ventral surface of episternum. The deeper head, which is dorsal to the first one, originates on the anterior edge of a middle section of the clavicle. The two heads of the sternocleidomastoid muscle are fused together to become inserted on a postero-dorsal area of the quadrate (notice the absence of the supra-temporal arcade in geckos as in snakes). It appears that the place of insertion of that muscle on the posterior surface of the quadrate, as well as the loss of the post-orbital bar and the supra-temporal arcade (like snakes) have given that muscle a different function, or may be an additive function to its homologue in Uromastyx. That function is the backward pulling of the very freely movable quadrate which allows the gecko to have a wider mouth opening than in other lizards.

9 - Cervical costo-vertebral (Anterior part of the intercostal of Gray's):

(Figs. 2b, 3b & 4b)

The fibres of the cervical costo-vertebral muscle originate on the anterior edge of the first separate cervical rib (4th cervical vertebra) and then extend anterioly to be inserted on the lateral side of th centrum of the axis.

10- Lateral cranio-vertebral (Obliquus capitis of Gray's):

(Figs. 2b & 3a)

It is a triangular sheet-like muscle, that originates on the lateral sides of the anterior three cervical vertebrae just below the zygapopyses, and is inserted on the tip of the cranial tubera.

11- Omohyoid (Omohyoideus of Gray's):

(Figs. 2c, 3b & 4a)

It is a thin, wide and delicate sheet-like muscle, that extends antero-medially. It originates on the anterior edge of the lateral half of the clavicle, and its insertion extends along the posterior surface of the hyoid corpus up to the posterior end of the first ceratobranchial of the hyoid apparatus.

12- Sternohyoid (Sternohyoideus of Gray's):

(Figs. 3b, 4a & 6)

It is a broad sheet-like muscle, originating by a ligament attached to the lateral side of the anterior apex of the sternum that gives origin to both the sternohyoid (12) and sternocleidomastoid (8). The sternohyoid also collects muscle fibers that originate on the lateral arm of the episternum. The insertion of the sternohyoid is, quite similar to that of Uromastyx (KHALIL, et al. 1977), on the posterior edge of the first ceratobranchial of the hyoid apparatus.

13- Ventral cranio-vertebral:

(Fig. 4b)

That muscle originates on a mid-ventral line extending along the anterior eight body vertebrae, and is inserted by a short tendon on the ventral cranial tubera.

14- Constrictor colli:

It is a sheet-like muscle that externally covers the neck on both sides. Ventrally it originates on a median longitudinally extending ligament, that runs between the corpus of the hyoid and anterior median tip of the episternum. Dorsally it is inserted along the mid-dorsal line of the neck on a vertical connective tissue median septum which is connected to the successive neural spines.

DISCUSSION

In the case of cervical musculature, the component muscles could be classified into three groups according to their function. The first group comprises muscles which could levate the head away from the substratum. The second group of muscles are capable of bending the neck towards the lateral sides. Finally, the third group comprises those muscles which depress the head towards the substrate.

The levator muscles of the head must be characterized by originating on the vertebral column or the median region of the vertebral portion of a rib and inserted on the posterior surface of the skull at a level above the occipital condyle. The higher the level of the point of insertion of that muscle in respect to the level of the condyle

the greater will be the efficiency of that muscle in levating the head. That definition applies to three anterior axial muscles which are: the cranio-spinal (1), inner semispinal (2), and cranio-costal (3).

Cranio-spinal (1) extends between the cervical neural spines and the supraoccipital. The length of the muscle and its tendons could give an idea about the strength of pull it can exert. In Tarentola, that muscle is attached to the last two cervical vertebrae and is less in length than that of Uromastyx (KHALIL, et al. 1977) and Agama (WAHBA, et al. 1992).

In general, muscle units of the inner semispinal (2) curve the cervical region upwards. Since the first of those units is attached to the postzygapophysis of the axis then that muscle has a definite levator effect on the head. Judging from the length of the extension of the cranio-costal muscle (3) as well as the angle of pull, one can refer to a relatively high efficiency of that muscle in Tarentola.

The lateral bending of the head is affected by the dorsal cranio-vertebral (7) and sternocleidomastoid (8) muscles. Those two muscles extend between a place lateral to the occipital foramen magnum and the neural arches or spines of the anterior cervical vertebrae (the dorsal cranio-vertebral (7), or the pectoral girdle; sternocleidomastoid, (8). In the case of Tarentola M#8 is inserted on the posterior surface of the qudrate (lateral-most position), hence the arrangement found in those two lizards is the most efficient in laterally bending the head.

The depressor muscles of the head are the lateral cranio-vertebral (10), omohyoid (11), sternohyoid (12), and ventral cranio-vertebral (13). The muscle numbered (10) is a minor muscle which extends between the lateral sides of the neural arches of the anterior cervical vertebrae and the ventral tubera of the skull. Apparently, that muscle has a very weak depressor effect on the head.

The omohyoid (11) and sternohyoid (12) muscles extend between the sternum and clavicle and the first cerato-brancial, while the ventral cranio-vertebral (13) extends between the ventral surface of the cervical vertebrae and the ventral tubera of the skull (basioccipital and basisphenoid). The depressor effect of those muscles is very clear.

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EXPLANATION OF LETTERING

AX.-axis, B.OC.-basioccipital, CB. 1&2.-first and second ceratobranchials. C.V. 3-8.-third to eighth cervical vertebrae, D.V. 1-3: first to third dorsal vertebrae, E.B. 1&2: first and second epibranchials, E.OC.-Exoccipital, FR.-frontal, HY.A.-hyoid arch, HY.C.-hyoid corpus, IL.-ilium, JU.-jugal, MX.-maxilla, NA.-nasal, P.FR.-prefrontal, P.OC.-paroccipital process, P.OT.-prootic, PR.-parietal, PR.LI.-processus lingulis, PT. pteryogoid, PT.FR.-post-frontal, QU.-quadrate, S.OC.-supraoccipital, ST.-sternum, TA.-tabular bone, TU.-tubera, 1st-4th D.R.-first to fourth dorsal ribs, 3rd-4th C.R.-third to fourth cervical ribs.

EXPLANATION OF FIGURES

Fig. 1: a) Dorsal view of the skull of Tarentola annularis showing the attachments of muscles numbered 1, 3 and 7.

b) Posterior view of the skull showing the attachments of musles 1, 3, 7 & 8.

c) Dorsal view of the cervical and anterior part of the trunk regions to show the superficial and deep muscles.

Fig. 2: a) Lateral view of the anterior part of the vertebral column to show the cervical units of muscle numbered 2.

b) Lateral view of the anterior part of the vertebral column showing muslces numbered 1, 9, 10 & 18.

c) Ventral view of the hyoid apparatus to show the attachments of muscles numbered 11 & 12.

Fig. 3: a) Lateral view of the anterior part of the vertebral column to show the attachments of muscles numbered 1, 3, 7, 9, 10 and 16.

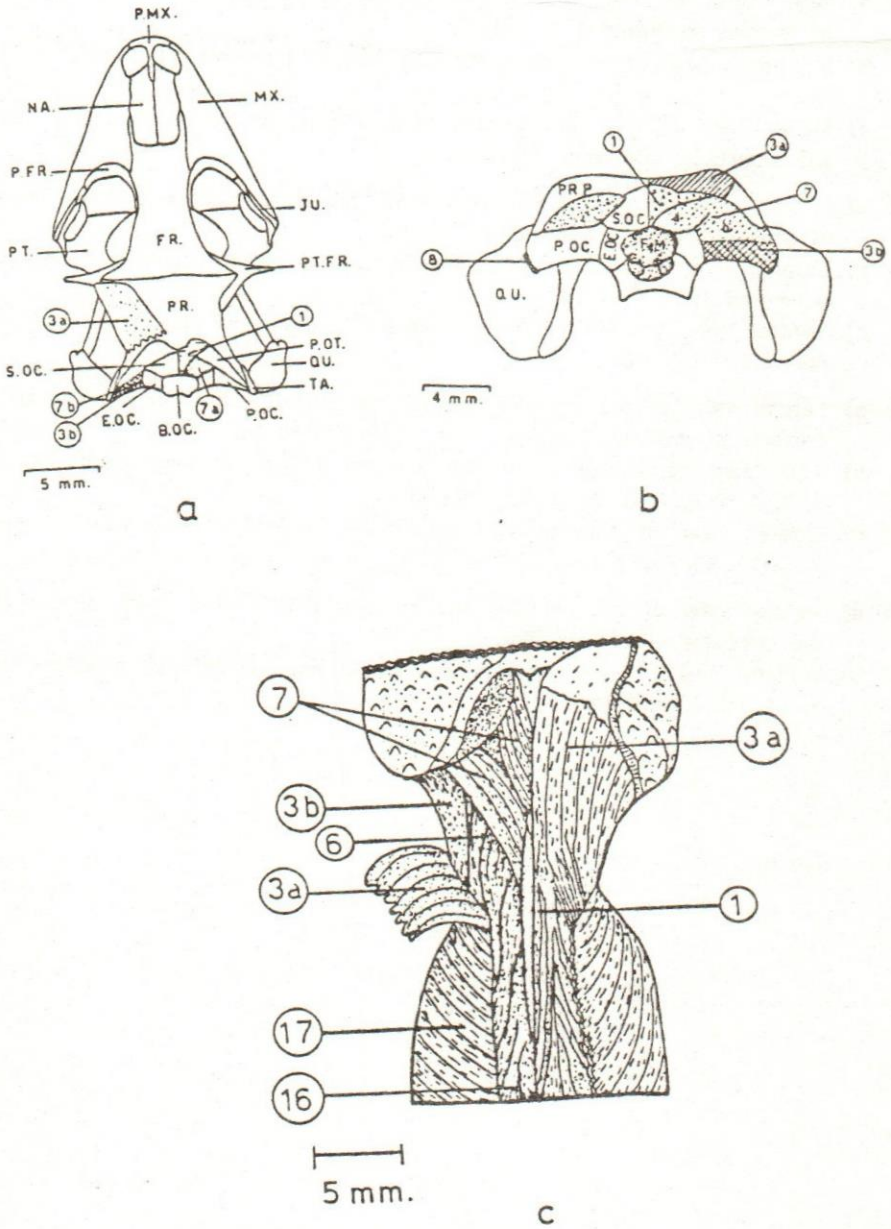
b) Transverse hand section of the cervical region showing muscles numbered 1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 13 and 14.

c) Lateral view of the cervical and trunk region showing muscles numbered 5, 6, 17, 18, 19, 20, 21, 27 and 32.

Fig. 4: a) Ventral view of the cervical and anterior part of the trunk regions showing the different related muscles.

b) Ventral view of the cervical and trunk regions showing muscles numbered 9, 13, 18, 23 and 24.

Fig.(1)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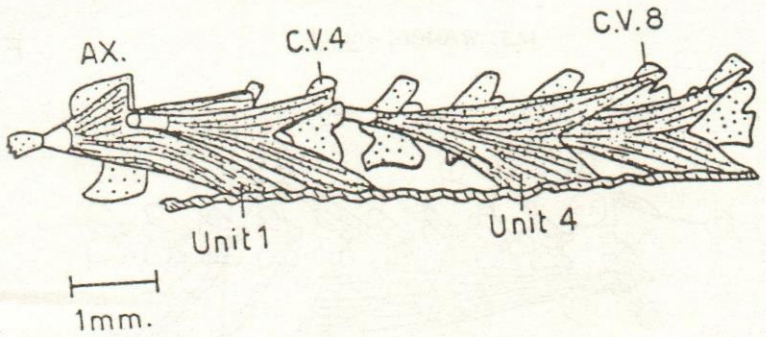
MYOLOGY, CERVICAL, LIZARD

Fig.(2)



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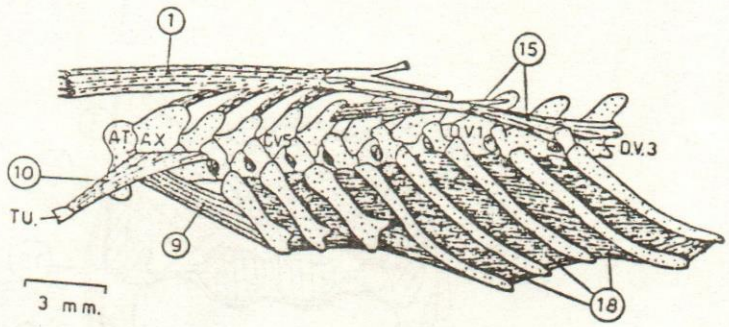

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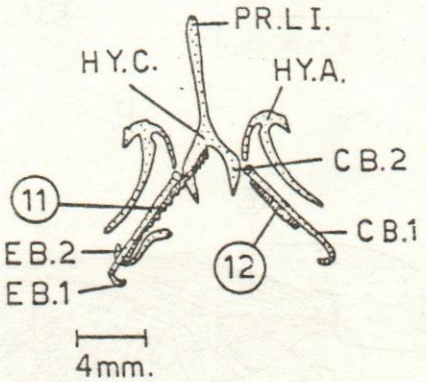

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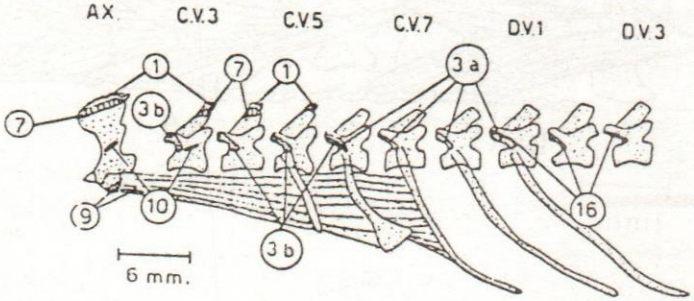
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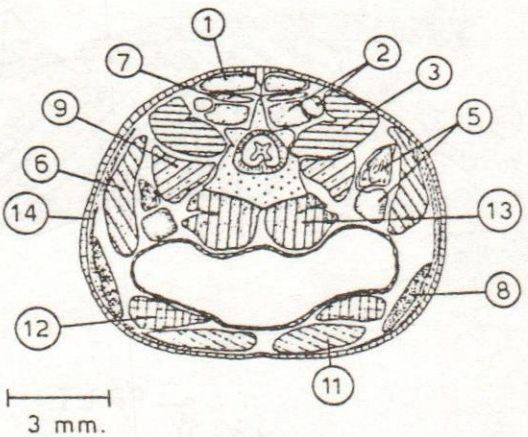
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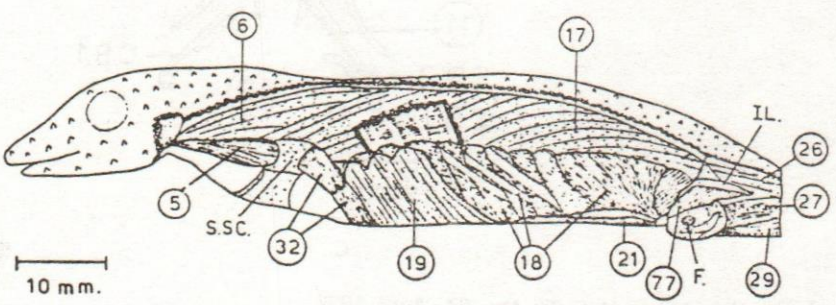
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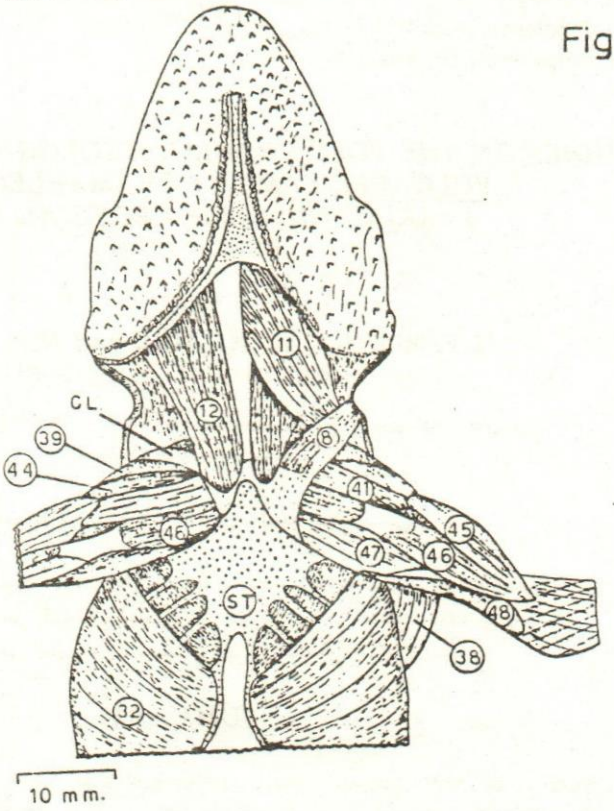
MYOLOGY, CERVICAL, LIZARD

Fig.(4)

a



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