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STUDIES ON THE POST-CRANIAL MYOLOGY OF TARENTOLA ANNULARIS, AGAMA MUTABILIS AND CHAMAELEON VULGARIS
I - AXIAL MUSCLES: CAUDAL REGION
(With 4 Figs.)

By

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العضلات خلف الجمجمة في كل من البرص الأسود^(١)، قاضي
الجبيل^(٢) والحرباء .
(- العضلات المحورية (المنطقة الذيلية)

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يقدم هذا البحث دراسة مقارنة لتشريح عضلات المنطقة الذيلية في كل من السحالي
موضوع البحث . وقد وجد أن العضلة رقم (١٦) تمتد محوريا حتى نهاية الذيل في
حالة الحرباء ، بينما تصل إلى خط البتر الذاتي في حالة البرص الأسود أما في كل
من قاضي الجبل والضب المصري فلا توجد هذه العضلة . ويمكن أن يمثل هذا الاختلاف
فروقا وظيفية تناسب تكيفها المعيشي مع بيئاتها . كما تميزت الحرباء بوجود عضلة
بطنية جديدة تمتد حتى نهاية المنطقة الذيلية ويمكنها أن تساعد في الالتفاف البطيء
للذيل على فروع الأشجار .

1- Tarentola annularis

2- Agama mutabilis

3- Chamaeleon vulgaris.

SUMMARY

Comparative study on the myology of the caudal muscles of three lizards with different mode of life was given in the present paper. The dermo-costal muscle (16) extends up to the end of the caudal region in case of Chamaeleon, and up to the first plane of cleavage of the tail of Tarentola. Such posterior extension is not found in Uromastix and Agama which may represent a type of functional adaptations. A new ventral muscle is present in the tail of Chamaeleon to help in the ventral coiling of that region.

M.T. WAHBA, et al.**INTRODUCTION**

The phenomenon of caudal autotomy in lizards has attracted the interest of many investigators than any other type in the field of reptilian anatomy. Most of those studies dealt with skeletal adaptations and morphological changes associated with the regenerated tails (BRYANT and BELLAIRS, 1967; BELLAIRS, 1969; ETHERIDGE, 1967; FURIERI, 1956; HUGHES and NEW, 1959; MADERSON, 1971; PRATT, 1946; RUSSELL and BAUER, 1988; QUATTRINI, 1953; WERNER, 1967 and WOODLAND, 1920). At the same time, the structure and function of the caudal muscles still have little attention (MIVART, 1870; ALI, 1941, 1948, 1950; KHALIL, et al. 1977).

The aim of the present paper is to deal with the anatomical features of tail muscles of three common Egyptian lizards: Tarentola annularis, Agama mutabilis and Chamaeleon vulgaris. These lizards are characterized by divergent habitat life and mode of locomotion. It represents another one of the authors' project on studying the post-cranial muscles of the above mentioned lizards (WAHBA, et al. 1992 a,b).

MATERIAL and METHODS

The three lizards examined in the present work; Tarentola annularis, Agama mutabilis and Chamaeleon vulgaris were collected from the northern coast of the Western Province of Egypt. Specimens were fixed in formalin solution. Muscles were exposed by normal dissection under the stereo-dissecting binocular. Dissected parts were first photographed and then were drawn.

RESULTS**25- Caudal myotomes:**

(Figs. 1 b & 3 a,b)

With the exception of Chamaeleon, the caudal myotomes of the other two species studied have the same morphological and anatomical relationships which again are similar to those of Uromastix aegyptia (KHALIL, et al. 1977). Generally, they consist of successive segments with intersegmental septa of connective tissue separating them. The intersegmental septa extend either antero-ventrally or antero-dorsally to get attached to the transverse process of the vertebra in front. The prehensile tail of Chamaeleon, however, has a different muscular arrangement. In this case, two segmented muscles are identified; dorsal and ventral. The dorsal segmented muscle has its units extending dorsal to the transverse processes, and each of those units runs between the dorsal side of a transverse process and the tip of the transverse process of the third vertebra

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in front. The ventral segmented muscle has its units extending below the transverse processes, and is inserted by a ligament on the fifth vertebra in front.

26- Ilio-caudal:

Tarentola annularis (Figs. 2 a & 3 a,c)

It is a longitudinal muscle, which originates on the posterior side of the transverse ligament that extends between the posterior tip of the ilium and the postzygapophysis of the first sacral vertebra (L.SI.), as well as on the median surface of the posterior half of the hind limb of the ilium. That muscle is inserted on the dorsal surfaces of the lateral halves of the transverse processes of the anterior four caudal vertebrae.

Agama mutabilis (Figs. 1 b & 3 b)

The ilio-caudal muscle has the same relations of that of Tarentola, but its fibers are inserted on the dorsal surface of the nine anterior caudal vertebrae.

Chamaeleon vulgaris (Fig. 4 a,b)

The ilio-caudal muscle is relatively shorter than those of Tarentola and Agama. It extends on the lateral side of the most proximal region of the tail. It originates by a strong ligament on the posterior surface of the ilium. The ilio-caudal is inserted on the connective tissue lateral to the dermo-costal muscle (16), and the connective tissue which covers the caudo-femoral muscle (28) at the region of the anterior three caudal vertebrae.

27- Pelvi-caudal:

Tarentola annularis (Fig. 1 a)

It is a longitudinally extending muscle, which is located lateral to the caudal centra and ventral to the caudal transverse processes. It originates on the ilio-ischiatic ligament, and is inserted on the ventral surface of the anterior four caudal vertebrae.

Agama mutabilis and Chamaeleon vulgaris (Figs. 3 b & 4 a)

The pelvi-caudal muscle has the same anatomical relationships of that of Tarentola.

28- Caudo-femoral:

Tarentola annularis (Figs. 2 a & 3 c)

It is another longitudinal muscle which extends ventral to the pelvi-caudal muscle (27). It originates on the ventral sides of the centra of the anterior four caudal vertebrae and the lateral side of the chevron bones. It is inserted anteriorly by a strong tendon which is biforked just below the proximal end of the femur. The median branch of that tendon is inserted on the anterior surface of the proximal end of the femoral

shaft, while the lateral branch is inserted on the ventral surface of the knee joint. It is a retractor muscle of the femur.

Agama mutabilis (Figs. 1 b & 4 b)

It is also, as in Tarentola, a longitudinal muscle which extends below the transverse process and lateral to the caudal chevrons. Its proximal narrow end gives a strong biforked ligament anteriorly. The median branch is the shorter one, and is attached on the preaxial side of the proximal end of the femoral shaft. The lateral branch is longer, and extends below the ventral surface of the femoral shaft to be inserted on the knee joint. That muscle originates on the lateral sides of the seven anterior chevrons and the ventral surface of the centra of the three anterior caudal vertebrae.

Chamaeleon vulgaris (Fig. 4 b)

It has the same arrangement of Tarentola and Agama with the difference that the muscle originates on the six anterior caudal vertebrae.

29- Ischio-caudal:

Tarentola annularis (Fig. 4 c)

It is a longitudinal muscle that extends along the ventral side of the caudal region up the autotomy plane. Proximally, that muscle is attached by a strong tendon to the dorsal surface of the ischiatic spine. Distally, it is attached on the ventral vertical septum of connective tissue, which is in turn attached on the tips of the chevron bones in the region of the fourth, fifth and sixth caudal vertebrae (plane of autotomy). It is obviously clear that, the ischio-caudal muscle is a powerful depressor of the tail.

Agama mutabilis (Figs. 2 b & 4 d).

The ischio-caudal muscle is a strong muscle which extends along the ventral side of the proximal third of the caudal region. Proximally, it is attached by a strong tendon on the dorsal side of the ischiatic spine. Distally, it is attached on the tip of the anterior five chevron bones.

Further, in the case of Agama there is a new muscle (Fig. 4 d) which is wedged between the ischio-caudal and the caudo-femoral muscles. That muscle is not found in the case of Tarentola and Uromastyx. It is a segmented muscle which is composed of five overlapping units located in the region of the fifth to seventh caudal chevrons. Each unit originates medially on the ventral median septum and laterally on a septum median to the caudal myotome (25). The insertion is achieved by a long tendon. The tendon of the ventral-most unit is attached to the ventral tip of the first caudal chevron, while that of the dorsal-most unit is attached to the fifth chevron.

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Chamaeleon vulgaris (Figs. 2 c & 4 b)

It has the same anatomical relationships, but there is a new segmented muscle which is ventrally located and extending up to the distal tip of the prehensile tail of Chamaeleon. Each segment extends between anterior chevron to the fifth or sixth posterior chevron bone. The posterior attachment or insertion of each of those muscle units is by a relatively long tendon.

DISCUSSION

The lizards studied in the present work have different modes of life. Chamaeleon is an arboreal animal, while Agama is a good runner on the substratum and finally Tarentola is a very active nocturnal animal which can adhere itself to the vertical walls and is able to move on ceilings. The tail region of those animals serves different functions according to the requirements of each life type. The tail of Chamaeleon is slender, prehensile and adapted for grasping support by coiling and uncoiling in a dorso-ventral direction (MIVART, 1870 and ALI, 1948). In case of Agama, the tail is adapted for walking, running and is important as a stabilizing organ in the elevated head posture. At last, in Tarentola, the tail is characterized by the passive defense process, i.e, autotomy (EL-TOUBI and KHALIL, 1955; WOODLAND, 1920 and WERNER, 1971).

The result of the anatomical relations, of the caudal muscles of the above mentioned lizards, showed the following notes. The units belonging to the inner and outer semispinal (15) and dermo-costal (16) muscles extend in the tail region but not up to its end. In the case of Tarentola annularis, those units extend up to the first caudal vertebra that has a cleavage plane (caudal autotomy), while in the case of Chamaeleon vulgaris those units extend up to the posterior-most tip of the prehensile tail, thus expressing a functional adaptation. Further, a new ventral muscle, which consists of component units, is only found in the case of Chamaeleon along the tail region. That muscle affects the coiling action of the tail (depressor movement). Thus, the ventral muscle has an antagonistic action to that of the dorsal muscles mentioned above. It ought to be mentioned that Agama possesses only five anterior units of that tail depressor muscle. That condition may represent in Agama an intermediate stage between Chamaeleon and other lizards. Further, there is a new muscle (29) which is not found in case of Tarentola and Uromastyx. That new muscle is found between the ischio-caudal and caudo-femoral muscles. The ilio-caudal muscle (26), which may be an important one in walking and running lizards, was found dorsal in position in Tarentola and Agama, but it is lateral and short in case of the arboreal Chamaeleon.

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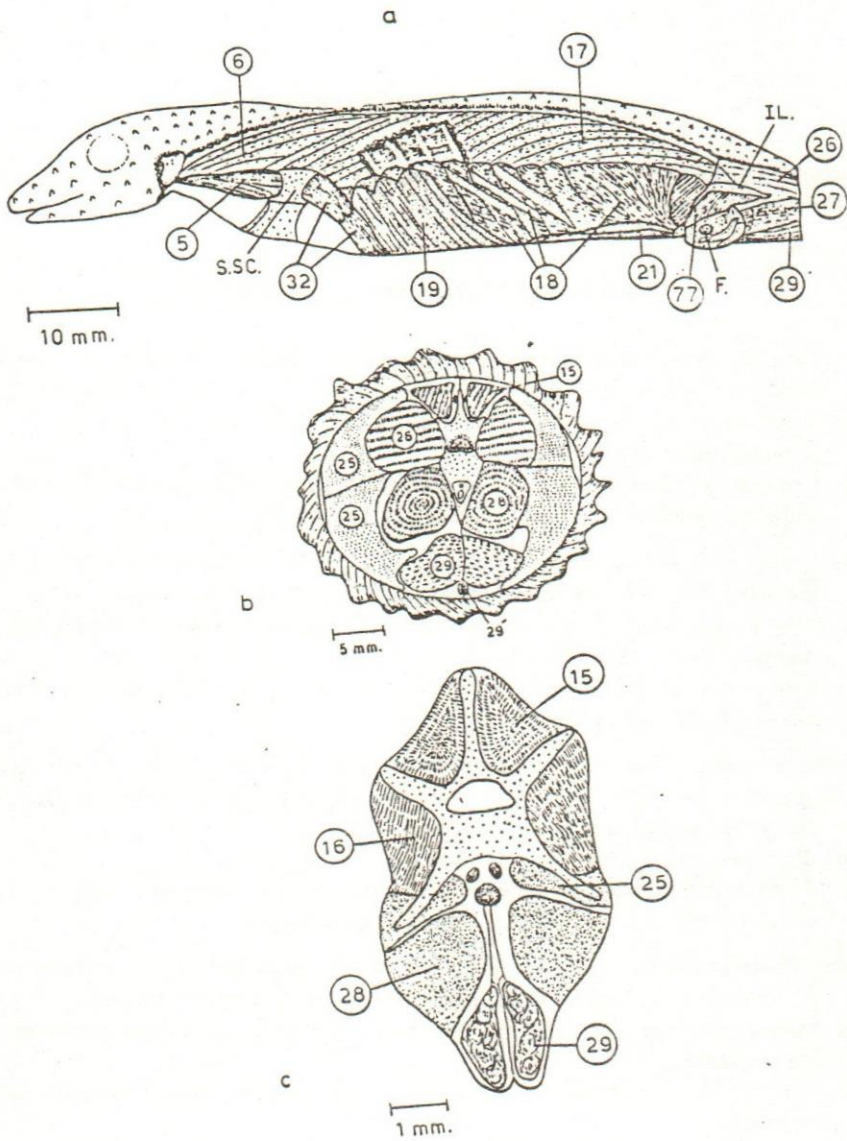
EXPLANATION OF LETTERING

F.-femur, FB.-fibula, IL.-ilium, I.P.F.-ischio-pubic fenestra, ISC.-ischium, L.-ilio-pubo-ischiatic ligament, PB.-pubis, S.SC.-suprascapula, TI.-tibia.

EXPLANATION OF FIGURES

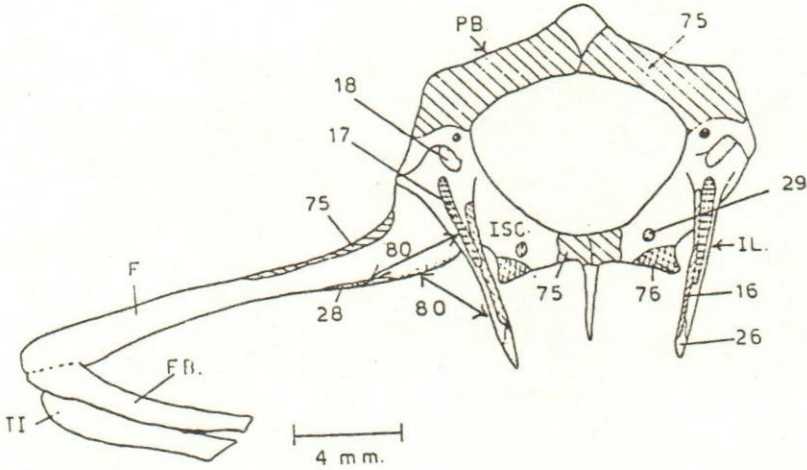
- Fig. 1:** **a:** Lateral view of the cervical and trunk regions of *Tarentola annularis* to show the related muscles.
b: Transverse hand section of a proximal caudal region of *Agama mutabilis* showing the related muscles.
c: Transverse hand section of a proximal caudal region of *Chamaeleon vulgaris* showing muscles numbered 15, 16, 25, 28 and 29.
- Fig. 2:** **a:** Dorsal view of the pelvic girdle and the femur articulated with it of *Tarentola annularis* to show the attachments of different related muscles.
b: The dorsal view of the pelvic girdle of *Agama mutabilis* showing the attachments of the related muscles.
c: Inner view of the pelvic girdle of *Chamaeleon vulgaris* showing the attachments of the related muscles.
- Fig. 3:** Postero-dorsal view of the thigh region, a posterior part of the trunk and an anterior part of the caudal regions showing the different related muscles:
a: *Tarentola annularis*.
b: *Chamaeleon vulgaris*.
c: Postero-dorsal view of the hind caudal regions and hind limb of *Tarentola annularis* showing the different related muscles.
- Fig. 4:** **a,b:** Postero-dorsal views of the hind trunk, anterior caudal and thigh regions of *Chamaeleon vulgaris* illustrating the different related muscles.
c: Ventral successive muscles of the thigh and proximal caudal regions of *Tarentola annularis*.
d: Ventral deep muscles of the thigh and ventral caudal muscles of *Agama mutabilis*.

Fig.(1)

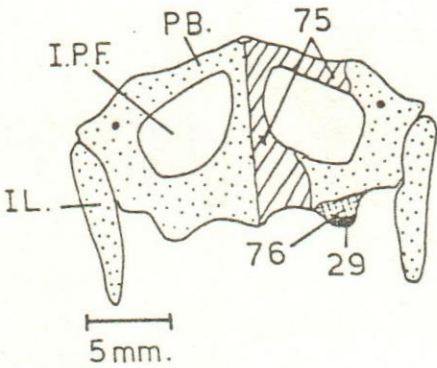


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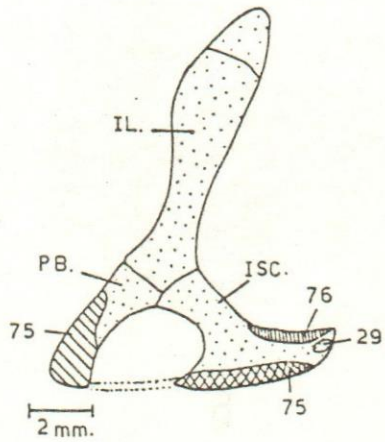
Fig.(2)



a

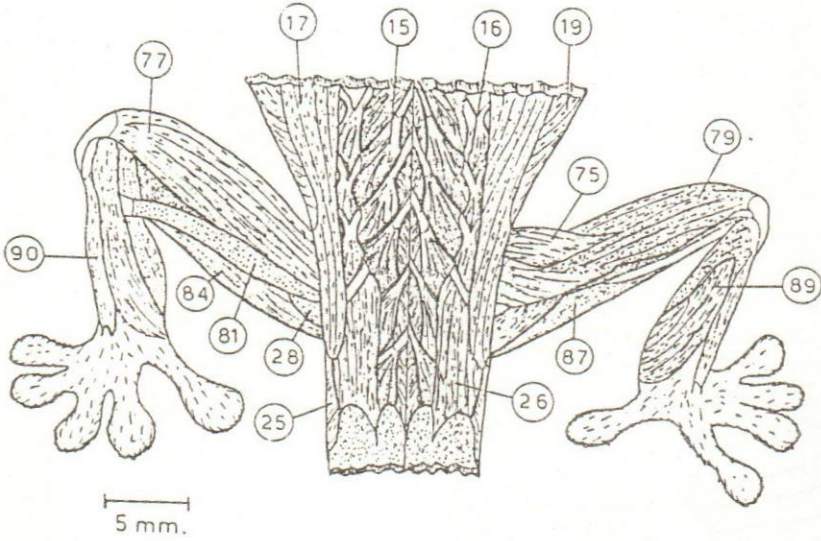


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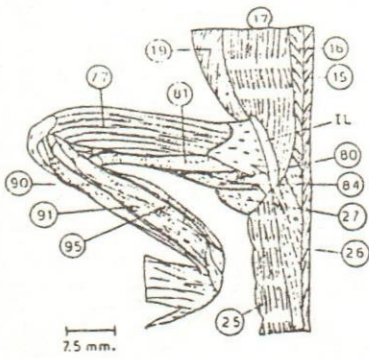


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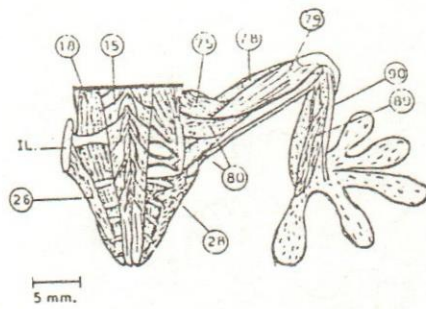
Fig.(3)



a

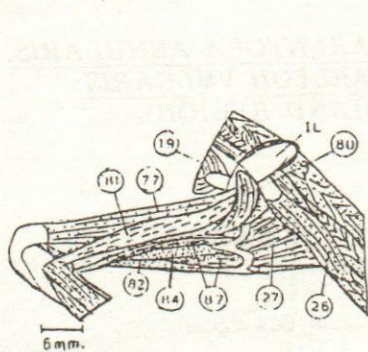


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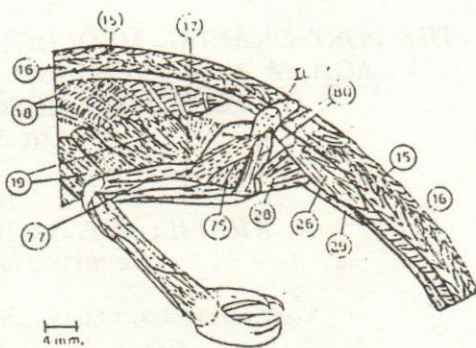


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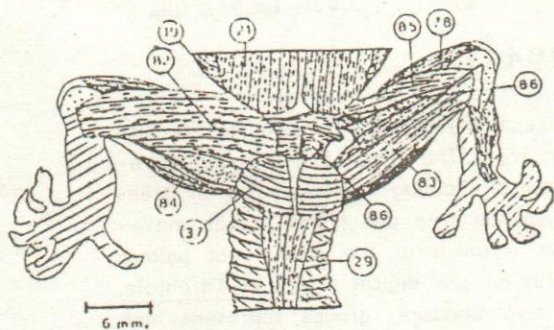
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Fig.(4)



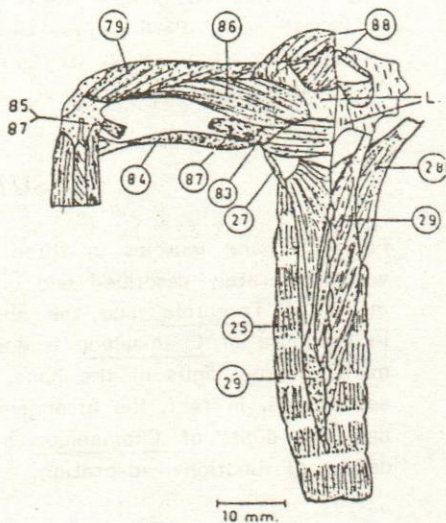
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