Anatomical peculiarities of the broad-snouted caiman's limb bones *(Caiman latirostris)*

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Abstract

The aim of the study was the highlight of the specific characters of the limb bones in broad-snouted caiman, and for that, the investigations were conducted on the bones which were collected from a dead broad-snouted caiman that belonged to Bârlad Zoo. It was a male caiman, 24 years old. For the analysis, the bones were prepared by boiling and cleaning. It was noticed the particular conformation of the girdles, in case of the thoracic one, the scapula and the coracoid bone being almost similar developed, and both of them form the glenoid cavity to joint with humerus. It exist also an elongated interclavicular bone. The humerus is curved, ulna is more massive than the radius, between them existing a large radio-ulnar arcade, these aspects being similar to birds. There are 5 carpal bones, 3 in the proximal row, and 2 in the distal one, the radial carpal bone being merged with the intermediate one, resulting the most developed carpal bone. The thoracic metapodium includes 5 metacarpal bones, the 5th one being more reduced. The ilium is dorsally placed to ischium, the two bones participating to form the acetabular cavity (foramen). The pubis, more reduced, is cranially placed to ischium with which it articulates. The femur is very curved, and caudo-medially is highlighted the 4th trochanter. The fibula is well developed, but the tibia is more massive, and between them is a large interosseous space. The pelvic basipodium includes the calcaneum and astragalus, well developed, in the proximal row and two bones in the distal row. The 5th metatarsal bone is rudimentary, the others being well developed. The acropodium includes 5 digits for the thoracic limb and 4 in the pelvic one, the number of the phalanges having one more than the number of the digit, except the 5th digit of the thoracic limb. The conformation of the limb caiman bones is generally similar to other crocodiles.

Keywords: *peculiarities, limb bones, caiman*

Introduction

The apendicular skeleton, thoracic and pelvic one, has a common structure in vertebrates which includes 4 major parts: *the girdle* (zonoskeleton) *(Cingulum)*, the *stylopodium*, the *zeugopodium* and the *autopodium*. The last one is divided in 3 subsegments: *basipodium*, *metapodium* and *acropodium*. Generally, the girdles include 3 bones: scapula, coracoid bone and the clavicle for the thoracic girdle and ilium, ischium and pubis for the pelvic one. The thoracic stylopodium is represented by the humerus and the pelvic one by the femur and patella. The zeugopodium includes two bones: radius and ulna in case of the thoracic limb and tibia and fibula in the pelvic one. The thoracic basipodium is formed by the carpal bones and the pelvic one by the tarsal bones. The metapodium includes the metacarpal (thoracic limb) and metatarsal bones (pelvic limb) and the acropodial bones are represented by the phalanges and the sesamoid bones (1,8). Major different characters in the structure of the limb skeleton can be observed between the vertebrate classes, but sometimes significant characters can be found until the genus level or as interspecific peculiarities in a genus species. The most significant differences can be observed for the acropodium, these segments being far for the trunk, and as consequences undergoes important changes in relation to the living conditions. These peculiarities are closely correlated with the locomotion and ground touch type of the animals, and as results, some bones can disappear or are rudimentary, other merge etc.

The caimans are small-sized crocodiles, the broad-snouted caiman being a South American crocodilian (Brazil, Bolivia, Argentina, Uruguay, Paraguay) of medium size (11) (for their group), generally 1,5-2 m long, part of the *Reptilia Class*, *Crocodylia Order*. This order includes big, predatory and semi-aquatic reptiles, namely the real crocodiles *(Fam. Crocodylidae)*, alligators and the caimans *(Fam. Alligatoridae)* and the gavials *(Fam. Gavialidae)* (5, 13, 14). Besides this order, *Reptilia* includes also *Chelonia Order* (tortoises), *Sauria Order* (lizards) and *Ophidia Order* (snakes) (4, 7). These are species adapted both to the aquatic and terrestrial environment. The locomotion, in case of many species is easier in the aquatic environment, because they possess short legs, except for the snakes which have no legs, and that makes the terrestrial locomotion heavier. Anyway, there are many morphological peculiarities in this group, the knowledge of them being important zoologically, but also clinically, many species making part from pets, but also for those animals which are kept in captivity in zoo parks and can present various pathologies.

Materials and methods

The studies were caried out on a broad-snouted caiman (*Caiman latirostris*), which was purchased from Bârlad Zoo after his death. It was a male caiman, 24 years old, 1.5 m long.

After the dissection, the limb bones were collected and prepared for examination. They were boiled and cleaned of debris and then systematically analyzed and described using the reference terms from N.A.V. *(Nomina Anatomica Veterinaria).*

Results and discutions

Thoracic girdle includes the scapula *(Scapula)* and the coracoid *(Coracoideum)* bone, similarly developed, both of them participating with an articular surface to form a large glenoid cavity for the humeral head. The scapula and the coracoid bone are flat bones, the scapula being ventro-cranially oriented and the coracoid ventro-caudally. The lateral face is slightly convex, the medial one slightly concave, the scapula having a relatively constant width until the distal third where exist a neck, the caudal notch being deeper. The coracoid bone is a little shorter than the scapula, but wider ventrally where it presents a rounded border and, on the cranial border a deep and large notch. Near the jointing side with scapula it presents a foramen, described as coracoidal foramen *(Foramen coracoideus)* (6, 10) (fig. 1., 2.).

It exist also an interclavicle *(Interclavicula)* (9), which is elongated, but placed cranially to the sternal cartilages (9).

The humerus *(Humerus)* has a relatively twisted and curved diaphysis and wide extremities. The proximal articular surface is an elongated head, and the distal one includes two wide condyles (a trochlea) above of them, caudally, existing a superficial olecranon fossa. Laterally, can be observed a prominent deltoid crest that has a nipple aspect (fig. 3., 4.).

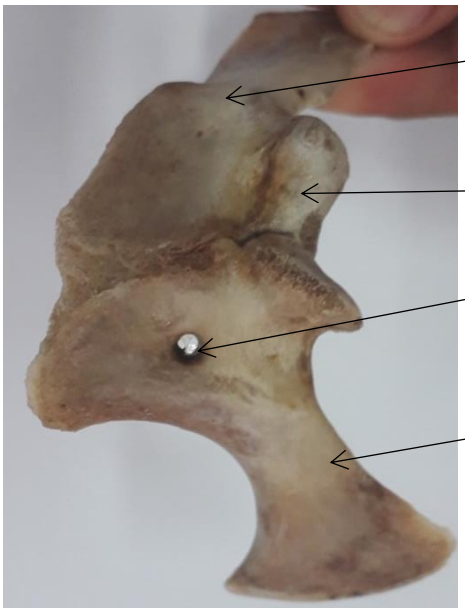

Fig. 1. Scapula and coracoid bone of caiman; caudo-lateral aspect

Fig. 2. Scapula and coracoid bone of caiman; medial aspect

At the level of the zeugopodium can be observed that the ulna *(Ulna)* is more developed than the radius *(Radius)*, the two bones being in contact at the extremities and between them exist a large radio-ulnar arcade, as in birds. The body of the ulna is curved and the olecranon is reduced. The radius is short, his diaphysis is more straight and thinner. The articular surfaces of the two bones have a wavy aspect, convex-concave and elongated transversally (fig. 5.).

Fig. 3. Humerus of caiman; cranial aspect

Fig. 4. Humerus of caiman; caudal aspect

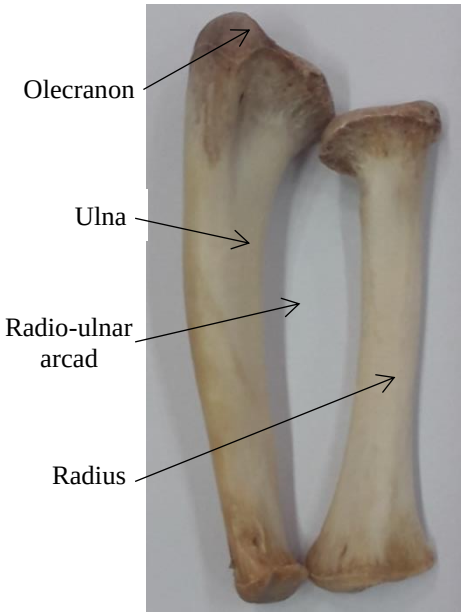

Fig. 5. Radius and ulna of caiman, cranial aspect

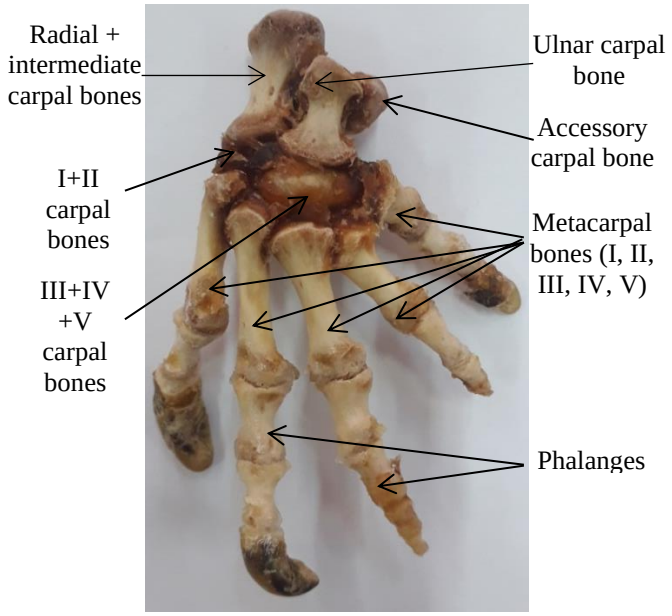

Fig. 6. Carpal, metacarpal bones and the phalanges in caiman, dorsal aspect

The thoracic basipodium includes the two rows of carpal bones: the proximal and the distal one. The proximal row comprises the accessory carpal bone (IV) *(Os pisiforme)*, the ulnar carpal bone (III) *(Os triquetrum)*, and the radial carpal bone (I) *(Os schaphoideum)* merged with the intermediate carpal bone (II) *(Os lunatum)*, the two bones forming the most developed carpal bone *(Os scapholunatum)*. The dorsal faces of the ulnar and radial+intermediate carpal bones have a semilunar aspect because of the lateral notches (fig. 6.). The distal row includes two bones, flattened, having rounded faces (except the proximal and the distal one), a medial bone, more reduced which represents the merged I and II carpal bones (9), and a lateral one, bigger, representing the III, IV and V carpal bones (9) which are also merged. Between the ulnar carpal bone and lateral carpal bone from the distal row exist a cartilage that represents the central carpal bone (10).

The thoracic metapodium presents 5 metacarpal bones *(Ossa metacarpalia I-V)*. The 5th metacarpal bone is reduced, short, the most developed being the 2nd (the longest) and the 3rd (the thickest) metacarpal bones. The bones make joint proximally, in the rest existing a large space between them (fig. 6.).

The acropodium represents the skeleton of the digits (I-V) *(Ossa digitorum manus)*. Each finger has a phalanx more than his number, except the 5th one that has three phalanges. The last phalanx is reduced in contrast with the size of the claw and has a conical shape with a blunt apex (fig. 6.).

The pelvic girdle comprises the ilium *(Os ilium)*, ischium *(Os ischii)* and pubis *(Os pubis)* that don't weld. The ilium is the most developed being thicker, dorsally placed to the ischium, having the dorsal border slightly rounded and caudally becomes narrower and

has a terminal prominence. On the lateral face presents a crest that dorsally delimits a fossa which finishes in the acetabular foramen *(Foramen acetabuli)*. The medial face makes joint with the sacral vertebra the sacro-iliac joint contact being a strong one. The ischium, ventrally placed to ilium and acetabular foramen, has a ventro-caudal direction. It's more elongated, thinner and narrower, the extremities (proximal and distal one) being wider and is medially curved. On the cranial border, closely to the acetabular foramen presents an articular surface for pubis. Between ilium and ischium results the acetabulum which is perforated, being transformed into the acetabular foramen (fig. 7.). The pubis is more reduced, cranially placed to ischium in a ventro-cranial position. Near the articular surface for ischium the body is narrower, forming the neck, then becomes wider ventrally where presents a rounded border with a cartilage. The lateral face is slightly convex, the medial one being slightly concave (Fig. 8.).

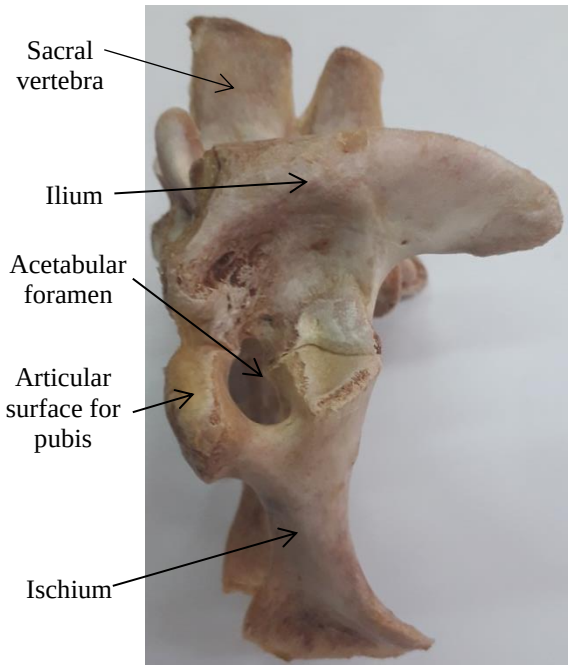

Fig. 7. Ilium and ischium of caiman, lateral aspect

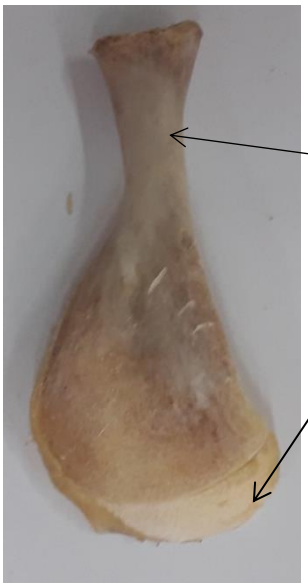

Fig. 8. Pubis of caiman, lateral aspect

The femur bone *(Os femoris)*, as the humerus, has a twisted and more curved body that reflects the complex and combined movements of the limbs at crocodiles, at the proximal extremity having an elongated articular head and distally, the articular surface comprises a large trochlea cranially that continues with two condyles caudally. In the proximal third, caudo-medially can be observed a prominence described in crocodiles as the 4th trochanter *(Trochanter quartum)* (2, 12) (fig. 9., 10.).

The pelvic zeugopodium comprises the tibia *(Tibia)* and fibula *(Fibula)*, between them existing, as in the case of the thoracic zeugopodium, a large interosseous space. Tibia is more massive than the fibula, being thicker proximally and more flattened distally. The proximal articular surface has a triangular shape, is almost planiform and continuous,

slightly convex, and the distal one is very convex having a condylar aspect coming in contact with the astragalus. The fibula, well developed, has a slightly flattened body, wider at the extremities. His articular surfaces, proximal and the distal one, are convex, elongated, as the condyles.

Fig. 9. Femur of caiman, cranio-lateral aspect

Fig. 10. Femur of caiman, caudo-medial aspect

The tarsus comprises four bones: the calcaneum *(Calcaneus)* and the astragalus *(Talus)* in the proximal row and the cuboid *(Os cuboideum)* and a cuneiform *(Os cuneiforme)* bone in the distal row. The calcaneus is slightly elongated latero-plantary, excavated proximally and laterally and presents a concave proximal articular surface for fibula. The talus is relatively spherical, has two concave proximal articular surfaces, one deep for tibia and the other, more superficial for fibula. The bones from the distal row have similar sizes, being slightly flattened proximo-distally, the others faces being rounded (fig 11., 12.).

The metatarsal bones *(Ossa metatarsalia I-V)* are similar with the metacarpal bones, but more elongated. There are four metatarsal bones well developed (I-IV), the 5th one being rudimentary (fig. 12.).

The pelvic acropodium *(Ossa digitorum pedis)* includes 4 digits (I-IV), each one having a one more phalanx than his number (the I digit has 2 phalanges, the IV digit has 5 phalanges) (fig. 12).

In relation with the legs morphology of the crocodiles, the most of the bones are short.

It can be observed that the autopodium, particularly the acropodium is well developed, to support the body weight, but also in relation with the locomotion, especially

for the aquatic environment in correlation with the interdigital membrane that exist in case of the pelvic limbs.

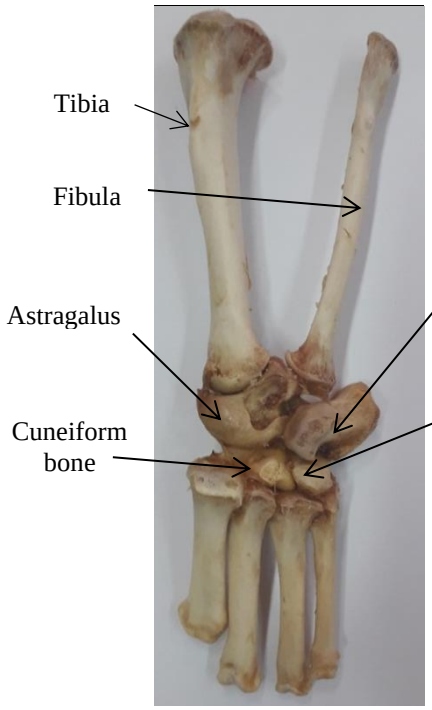

Fig. 11. Tibia, fibula, tarsal and metatarsal bones of caiman, dorsal aspect

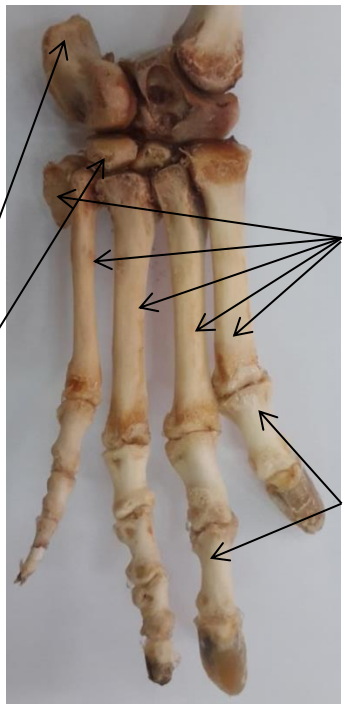

Fig. 12. Pelvic autopodium in caiman, dorsal aspect

Conclusions

1. The bones of the caimans, particularly the broaud-snouted caiman, have a similar conformation with that of the other crocodiles, especially from the caiman group, fewer characteristics being proper.

2. In relation with other vertebrate it can be noted the similarities with the birds, especially in case of the stilopodium and zeugopodium bones.

3. Because of the combined movements, the most of the bones are curved, especially in case of the stilopodium and zeugopodium and also, the articular surfaces are elongated.

4. The bones of the girdles are relatively massive and strong and the autopodium is well developed.

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