

**CHIMPANZEE (*PAN TROGLODYTES* - LINNÉ, 1758):
ZONOSKELETON, STILOPODIUM, AND THORACIC ZEUGOPODIUM – CASE STUDY
CIMPANZEUL (*PAN TROGLODYTES* - LINNÉ, 1758):
ZONOSCHELET, STILOPODIUM ȘI ZEUGOPODIUM TORACIC – STUDIU DE CAZ**

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ABSTRACT | REZUMAT

The study aims to describe the morphological characteristics of the thoracic limb long bones in chimpanzees (*Pan troglodytes*). The genus *Pan* is part of the Primates order, including the common chimpanzee and the bonobo (*Pan paniscus*). The appendicular skeleton study provides valuable data in comparative studies between primate species from the *Hominoidea* superfamily, including humans and other mammal species. In the specialised literature, the anatomy of this species, especially the osteology, includes a small amount of data and needs to include detailed aspects of the limbs' long bones. These bones can provide clues for the recognition of the respective species. For the study, bones of the thoracic limb from an adult chimpanzee found in the collection of the Anatomy discipline were used. The following conclusions emerged: the scapula presents an excessively developed acromion, dorsally presents the articular surface for the clavicle, the supraglenoid tubercle detaches at a distance from the glenoid cavity, the presence of an S-shaped clavicle, the humeral lateral epicondyle continues proximally with a very well-marked supracondylar crest, the radius presents a single glenoid cavity, articular surface for the humerus, the ulna has an obvious olecranon, and the trochlear notch presents two articular surfaces separated by a reduced median ridge.

Keywords: chimpanzee, scapula, humerus, radius, ulna

Studiul își propune să descrie caracteristicile morfologice ale oaselor lungi de la membrul toracic al cimpanzeului (*Pan troglodytes*). Genul *Pan* face parte din ordinul *Primates* și include cimpanzeul comun și bonobo (*Pan paniscus*). Studiul oaselor de la nivelul scheletului apendicular oferă date utile în studiile comparative între speciile de primat din superfamilia *Hominoidea*, inclusiv față de oameni cât și față de alte specii de mamifere. În literatura de specialitate, anatomia acestei specii, mai ales osteologia, cuprinde un număr redus de date și are nevoie să includă aspecte detaliate ale oaselor lungi de la nivelul membrului toracic de la un cimpanzeu adult, exemplar aflat în colecția disciplinei de Anatomie. S-au putut desprinde următoarele concluzii: spata prezintă un acromion excesiv de dezvoltat, dorsal prezintă suprafața de articulație cu clavicula, tuberculul supraglenoidal se desprinde la distanță de cavitatea glenoidă, prezența claviculei cu aspectul literei S, epicondilul lateral al humerusului se continuă în sens proximal cu o creastă supracondiliană foarte bine evidențiată, radiusul prezintă o singură cavitate glenoidă pentru articularea cu humerusul, ulna are un olecran evident, incizura trochleară prezintă două suprafețe articulare despărțite de un redus relief median.

Cuvinte cheie: cimpanzeu, spata, humerus, radius și ulna

Carl Linné, in 1758, in the 10th edition of *Systema Naturae*, used the name "Primates". The genus *Pan*, the common chimpanzee and the bonobo are part of the *Primates* order. Because the characteristics are very similar to the ones of the genus *Homini*, they also share the same family, *Homininae* (10, 11).

The chimpanzee is the primate most closely related to humans. They are social beings who live in large groups, have an elaborate communication system, and use facial expressions, gestures, and vocalisation (2).

Over time, it has been observed that all primates, regardless of which genus they belong to and the degree of evolution, stand on their hind limbs, proving that they have a significant tendency towards bipedalism (2). Depending on age, the common chimpanzee's locomotor behaviour varies. For an adult chimpanzee, the primary locomotion type is knuckle-walking, a form of quadrupedalism. Infants and young chimpanzees have forelimb-dominated positional behaviours as they cling, climb, or hang on lians (8). This type of locomotion, quadrupedalism, is correlated with scapular shape, which in chimpanzees is shorter and wider than in bonobos (9). However, locomotion in this species is more complex than that, and various gaits blend, from bipedal to tripedal and quadrupedal, for-

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ming a continuous movement (6).

Specialised literature offers data on many of the *Pan* genus's general characteristics: the use of the hind limbs in locomotion, stereopsis due to front-facing eyes and wide binocular overlap, brain development, hand development, and opposable thumb evolution, the increase in life span in captivity versus into the wild, sociability, body language, expressions and vocalizations (7, 12, 13, 17, 18). There is also data on the skeletal system: skull morphology, the growth and changes of the facial bones, the development of the limb bones, comparisons between the skeletons of *Pan* and *Gorilla* species, and the morphological characteristics of the teeth (3, 5, 14, 15, 16, 19).

More detailed data from the specialised literature regarding the morphological characteristics of the limb bones needs to be collected. However, they are essential in differentiating between the primate species and identifying differences with other species.

MATERIALS AND METHODS

The thoracic limb skeleton, only the long bones from an adult male chimpanzee (*Pan troglodytes*) deceased of natural causes, were used as study material. The study material belongs to the Anatomy discipline collection. The most interesting aspects resulting from the morphological description were photographed. Nomina Anatomica Veterinaria (N.A.V.) 2017 and Terminologia Anatomica 2019 were followed during the study.

RESULTS AND DISCUSSIONS

The scapula is a flat, triangular bone that shows a developed scapular spine on the dorsal surface, which divides the entire surface into two fossae, supraspinous and infraspinous. The scapular spine has a relatively triangular appearance, having two surfaces, superior and inferior, and three edges, one anterior adherent to the scapula, another dorsal, and the third ventral, both relatively rectilinear. A very long acromion detaches from the aboral extremity of the scapular spine and exceeds the glenoid cavity (Fig. 1).

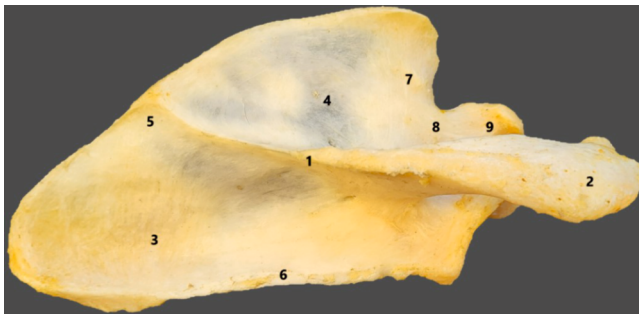


Fig. 1. Chimpanzee right scapula (*Pan troglodytes*) - lateral view (original). 1. Scapular spine; 2. Acromion; 3. Infraspinous fossa; 4. Supraspinous fossa; 5. Dorsal border; 6. Caudal border; 7. Cranial border; 8. Scapular notch; 9. Supraglenoid tubercle.

The caudal extremity of the acromion is widened and curved dorsally, and the distal extremity, dorsally, presents an articular surface for the clavicle. The supraspinous fossa, smaller than the infraspinous, has a relatively straight dorsal edge. The scapular notch marks a reduced scapular neck at the base of the coracoid process (Fig. 1). The infraspinous fossa is wide in the proximal extremity and narrow towards the distal extremity. The lateral surface of the infraspinous fossa is slightly uneven. In the distal extremity of the infraspinous fossa is a first-order vascular foramen.

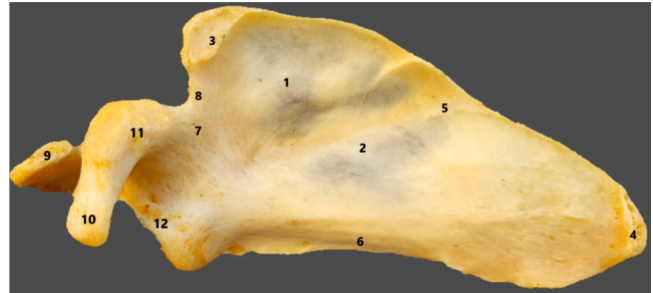


Fig. 2. Chimpanzee right scapula (*Pan troglodytes*) - medial view (original). 1. Subscapular fossa; 2. Ridge for muscular insertion; 3. Cranial angle; 4. Caudal angle; 5. Dorsal border; 6. Caudal border; 7. Cranial border; 8. Scapular notch; 9. Acromion - articular surface for the clavicle; 10. Coracoid process; 11. Supraglenoid tubercle; 12. Ventral angle.

The costal face of the scapula presents an obvious subscapular fossa with numerous muscle insertion ridges (Fig. 2). The lateral edge is thickened and slightly wavy. The cranial angle is elongated, and the caudal one is rounded. The voluminous ventral angle presents an oval-shaped glenoid cavity for articulation with the humerus. The supraglenoid tubercle detaches at a distance from the glenoid cavity. From this tubercle, the long and curved medially coracoid process detaches (Fig. 3).



Fig. 3. Chimpanzee right scapula (*Pan troglodytes*) - ventral angle (original) 1. Glenoid cavity; 2. Acromion; 3. The coracoid process.

The clavicle is a long bone, arranged transversely,

located between the sternal manubrium and the acromion. It is curved at both ends, with a S shape (Fig. 4). The lateral extremity of the clavicle is widened and presents an articular surface for the acromion. The medial extremity of the clavicle is thick and has a relatively circular articular surface for the sternum. The body of the clavicle is slightly flattened in the lateral extremity and relatively cylindroid in the medial portion and the middle third. The ventral surface presents, in the central portion, a reduced muscle insertion groove. Lateral to the groove, there is a tuberosity for ligament insertion.



Fig. 4. Chimpanzee right clavicle (*Pan troglodytes*) – ventral surface (original) 1. Lateral extremity; 2 Tuberosity for ligament insertion; 3. Articular surface for the humerus; 4. Medial extremity.

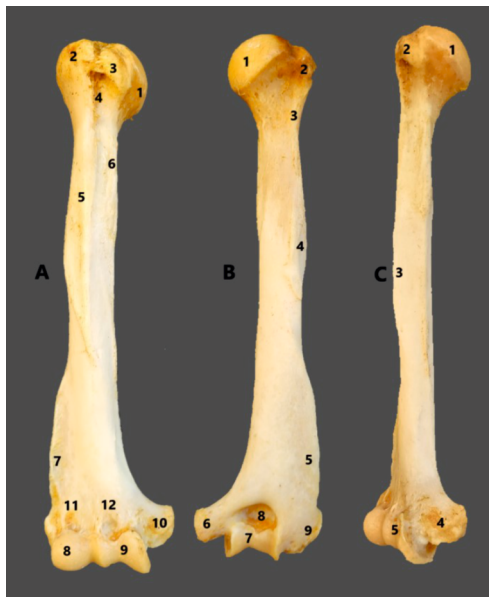


Fig. 5. Chimpanzee right humerus (*Pan troglodytes*)
A. Cranial aspect – 1. Humeral head; 2. Greater tubercle; 3. Lesser tubercle; 4. Intertubercular groove; 5. Crest of the greater tubercle; 6. Crest of the lesser tubercle; 7. Lateral supracondylar crest; 8. Condyle; 9. Trochlea; 10. Medial epicondyle; 11. Radial fossa; 12. Coronoid fossa.
B. Caudal aspect – 1. Articular head; 2. The greater tubercle; 3. The crest of the greater tubercle; 4. Deltoid crest; 5. Lateral supracondylar ridge; 6. Medial epicondyle; 7. Trochlea; 8. Olecranon fossa; 9. Condyle
C. Medial aspect – 1. Humeral head; 2. Lesser tubercle; 3. Deltoid crest; 4. Medial epicondyle; 5. Trochlea.

The humerus is a long bone presenting the articular, spheroidal head in the proximal extremity. The hu-

meral head is slightly medio-caudal and supported by a pronounced neck. Laterally, the greater tubercle has prominent surfaces for muscle insertion. The lesser tubercle is elongated in a dorso-ventral direction and has a rough surface for muscle insertion. The intertubercular groove is arranged vertically, starting from the proximal extremity and ending in the cranio-medial part of the body. It is delimited cranially by the crest of the greater tubercle and medio-caudal by the crest of the lesser tubercle (Fig. 5).

The body is cylindrical in the proximal extremity and triangular in the distal one. On the cranio-lateral side, it shows an evident deltoid tuberosity. On the cranio-medial side is a rough surface of muscle insertion, and on the caudal side is a small vascular foramen. The distal extremity of the body presents a lateral epicondyle that continues with a very well-highlighted supracondylar crest. The distal articular surface has a trochlea located medially and a condyle situated laterally. The trochlea has unequal rims, and the medial one is more developed, high, and has a sharp edge. The trochlear rims have a slightly oblique arrangement on the caudal face (Fig. 5).

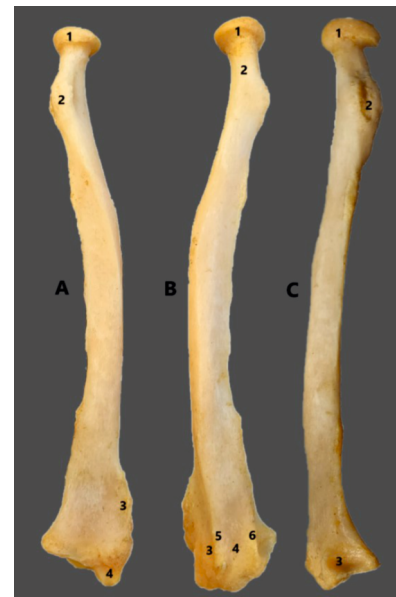


Fig. 6. Chimpanzee right radius (*Pan troglodytes*)
A. Caudal aspect – 1. Radius head; 2. Radial tuberosity; 3. Radial ridge; 4. Radial styloid process.
B. Cranial aspect – 1. Radius head; 2. Radial neck; 3,4. Tendinous grooves; 5, 6. Vertical ridges
C. Lateral aspect – 1. Radius head; 2. Radial tuberosity; 3. The articular surface for the ulna.

The condyle has a rounded articular surface. An intermediate groove separates the two articular formations (Fig. 5). On the cranial surface, in the distal extremity, above the articular surfaces, two fossae can be observed, one medial, wide, the coronoid fossa, and the other lateral, smaller, the radial fossa. On the caudal surface, in the distal extremity, above the trochlea, there is the olecranon fossa, where the anco-

neal process enters during the forearm extension. The epicondyles are located on the lateral and medial sides, in the distal extremity of the humerus. The lateral epicondyle is smaller than the medial one. The radius and ulna are long bones articulated only at the extremities, creating a large interosseous space. At the proximal extremity, the radial head presents a single glenoid cavity for the humeral condyle. Below the neck of the radius is a rough prominence, the radial tuberosity, and the insertion site of the biceps brachii muscle (Fig. 6). The radial shaft is slightly cylindroid in the proximal extremity and triangular in the middle and distal third. The middle third of the body shows a pronounced curvature laterally. On the medial edge, a ridge-like rough surface can be observed. A reduced tuberosity for muscle insertion can be observed on the lateral surface in the middle third. In the distal extremity of the radius, there are four tendinous grooves, two arranged cranially and two arranged cranially-laterally. A prominent ridge can be observed in the lateral part of the distal extremity, which ends distally with the styloid process of the radius. The articular surface with the radius can be observed in the medial part of the distal extremity (Fig. 6). The radial articular surface for the carpal bones appears like a transversely elongated glenoid cavity.



Fig. 7. Chimpanzee left ulna (*Pan troglodytes*)

A. Medial aspect - 1. Olecranon; 2. Ulnar shaft; 3. The articular surface for the radius; 4. The styloid process of the ulna.

B. Lateral aspect - 1. Olecranon; 2. Anconeal process; 3. The trochlear notch; 4. Radial notch; 5. Ulnar shaft; 6. The articular surface for the radius.

The proximal extremity of the ulna presents an obvious olecranon, provided with an evident and rough olecranon tuberosity (Fig. 7). The olecranon has a prominent beak, the anconeal process. From the anconeal

process descends the trochlear notch, two articular surfaces separated by a reduced median ridge. Laterally, the base of the trochlear notch is the radial notch (Fig. 8). The body of the ulna is concave in the cranial direction and slightly flattened along its entire length. The medial and caudal edges have a smooth surface, and the lateral edge has a small ridge on its surface for muscle insertion. The distal extremity of the ulna presents in the lateral part a cylindroid articular surface for the radius, and on the medial side, the styloid process of the ulna, with the appearance of a conical extension, with the tip pointing downwards (Fig. 7).



Fig. 8. Chimpanzee left ulna (*Pan troglodytes*) – proximal extremity (original). 1. The trochlear; 2. Radial notch; 3. Anconeal process.

CONCLUSIONS

The scapula has an excessively developed acromion, with the caudal extremity widened and recurved; it presents an articular surface for the clavicle. The supraglenoid tubercle detaches at a distance from the glenoid cavity. The clavicle is an S-shaped, long bone. The humerus has two tubercles, from which two crests descend and delimit the intertubercular groove, cranially the crest of the greater tubercle and medio-caudal, the crest of the lesser tubercle. The deltoid tuberosity is evident. The lateral epicondyle has a well-marked supracondylar crest. The coronoid fossa is medial and wide, and the radial fossa is lateral arranged and smaller. The radius presents a single glenoid cavity for the humeral condyle. The radial tuberosity is well-defined. In the distal extremity of the radius are four tendinous grooves. The radial articular surface for the carpal bones has the appearance of a transversely elongated glenoid cavity. The proximal extremity of the ulna presents an obvious olecranon, provided with an evident and rough tuberosity. From the anconeal process descends the trochlear notch,

two articular surfaces separated by a reduced median ridge. Laterally, there is a radial notch at the base of the trochlear notch.

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