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Osteology of the Thoracic Limb of Geoffroy's Cat (*Leopardus geoffroyi*) and Jaguar (*Panthera onca*)

Osteología del Miembro Torácico del Gato de Geoffroy (*Leopardus geoffroyi*) y del Jaguar (*Panthera onca*)

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SUMMARY: The thoracic limbs of felines are essential for hunting, climbing, jumping, and swimming. This study examines the osteology of wild American felids, addressing the limited knowledge about their anatomy and locomotor apparatus.The findings are relevant for both medical and surgical interventions. Thoracic limbs from five Geoffroy's cats (*Leopardus geoffroyi*) and four jaguars (*Panthera onca*) were analyzed using dissection, radiography, computed tomography, and osteological maceration. The studied felids lacked a tubercle on the scapular spine, and the clavicle was small and not connected to the skeleton. The humerus presented a supracondylar foramen for the median nerve and brachial artery. Jaguars showed a more developed medial styloid process, and both species had well-defined radius and ulna bones, with a larger interosseous space in Geoffroy's cats. Both species had seven carpal bones and five metacarpal bones, which were more robust in the jaguar. The presence of a sesamoid bone associated with the abductor longus muscle of the first digit (digit I) suggests enhanced manipulation and grasping ability. The phalanges were short, with surfaces adapted for tendon insertion. The middle phalanx was absent in the first digit, and the distal phalanx was associated with curved claws, possibly related to claw retraction. In conclusion, notable anatomical differences exist between jaguars and Geoffroy's cats, likely reflecting the distinct locomotor and predatorydemands associated with capturing prey of different sizes.

KEY WORDS: Bones; Fauna; Felines.

INTRODUCTION

Felids (*Felidae*) are a family of placental mammals within the order *Carnivora*, currently comprising 38 species worldwide. They are characterized by a slender body, acute hearing, a short snout, and excellent eyesight. The *Felidae* family includes two subfamilies, *Felinae* and *Pantherinae*, both represented in this study (Stains, 1984; Martin, 1998; Morales-Mejía *et al*., 2010).

Geoffroy's cat (*Leopardus geoffroyi*, d'Orbigny & Gervais, 1844) is a mammalian species belonging to the subfamily Felinae. Its size is only slightly larger than that of a domestic cat. It has a carnivorous diet that primarily consists of small rodents and birds, and secondarily of other locally abundant small vertebrates, including fish (Gonzales & Lanfranco, 2012).

The species occurs in southern Bolivia, Paraguay, southern Brazil, Uruguay, Argentina, and southern Chile. In Uruguay, it is distributed throughout the country. Geoffroy's cat inhabits closed forests, riparian forests, park-like woodlands, and shrublands, and may even occupy suburban areas. It is currently classified as "Least Concern" by the IUCN, although regional populations are declining. In Uruguay, it is listed as "Susceptible" and considered a priority species for conservation (Gonzales & Lanfranco, 2012).

The jaguar, or *jaguareté* (*Panthera onca*, Linnaeus, 1758), in contrast to Geoffroy's cat, belongs to the subfamily *Pantherinae.* It is native to the Americas, ranging from southern Mexico to northern Argentina. Historically, it was distributed throughout Uruguay, with the last confirmed records dating back to 1904, including occasional sightings in the city of Montevideo. Jaguars inhabit rainforests, swamps, and dry grasslands, showing a preference for dense forests. The species is closely associated with water, being an excellent swimmer, and often lives along riverbanks (Gonzales & Lanfranco, 2012).

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The jaguar is a large and robust felid—the largest of all American species. It has a massive head and relatively short limbs. Its carnivorous diet includes large mammals such as deer, peccaries, and capybaras, as well as other vertebrates like caimans, fish, and turtles (Gonzales & Lanfranco, 2012).

Unlike Geoffroy's cat, the jaguar is classified as "Near Threatened" (NT) by the IUCN, and its populations are in decline. In Uruguay, it is considered extinct; however, the most recent survey, conducted in 2014, reported 26 captive *Panthera onca* individuals housed across eight zoological institutions (Rodríguez Lucchese & Rohrer Meneses, 2014).

The thoracic limbs of felids facilitate jumping and represent one of their most important tools for chasing and capturing prey. Differences in feeding and hunting habits may lead to morphological adaptations in their anatomy. The main supporting muscles and bones involved in these activities are located in the forearm and manus regions (Sánchez *et al*., 2019).

Scientific research on native felids has primarily focused on ecology, reproduction, and nutrition, with limited literature available on the anatomy of wild American felids, and even less on their locomotor apparatus, including the myology, osteology, neurology, and angiology of the limbs (Sánchez *et al*., 2019).

Anatomical descriptions related to osteology are particularly valuable for performing medical or surgical procedures on exotic mammals, as these species are especially prone to trauma (e.g., fracture surgeries involving bones such as the femur). Detailed anatomical knowledge is therefore essential for any intervention in this region in wild species.

Studies suggest that felids specialized in hunting large prey have relatively more robust forelimbs than those specialized in small prey (Meachen-Samuels & Van Valkenburgh, 2009; Viranta *et al*., 2016). Other studies have associated the development of specific anatomical structures of the thoracic limbs with the distances traveled during pursuit, as well as with the use of these limbs for grasping and manipulation (Julik *et al*., 2012) or climbing (Gonyea, 1978).

Research on the locomotor apparatus has been conducted in various felid species and may be extended to the two species analyzed in the present study. For instance, anatomical and functional characteristics of the caudal radiocarpal aponeurosis have been described in tigers, lions, and domestic cats (*Panthera tigris*, *Panthera leo*, and *Felis catus*) (Graziotti & Victorica, 1997).

This study aims to describe the bones of the thoracic limb and to compare possible anatomical differences—such as the presence or absence of bony landmarks or the number of carpal bones—that may provide insights into adaptations related to prey type and the behavioral activities of each species.

MATERIAL AND METHOD

Animals: The anatomical study was conducted on specimens of both species. Geoffroy's cats were obtained from rural areas of the departments of Canelones, Maldonado, Lavalleja, and Rocha. A total of six animals of both sexes were used. Three adult jaguar specimens were examined: two from the *Estación de Cría de Fauna Autóctona de Pan de Azúcar* (Maldonado, Uruguay; 34°3'S, 55°1'W; approximately 200 m altitude) and one from the Villa Dolores Zoo (Montevideo, Uruguay). All specimens had died of natural causes and showed no pathologies or traumas affecting the structures under study.

Methods: The primary method used for anatomical study was simple dissection, which was performed on all specimens. All animals were radiographed using Vetter Rems 150 equipment at the Veterinary Hospital Center, Facultad de Veterinaria, Universidad de la República, Uruguay.

Computed tomography (CT) of the thoracic limb was performed on four *Leopardus geoffroyi* specimens and one *Panthera onca* specimen using a Toshiba Asteion 4 scanner at the same facility. A dorsopalmar view of the jaguar's thoracic limb (carpus) was obtained with radiographic settings of 60 kV and 10 mAs. Frontal (craniocaudal) and lateral (mediolateral) views of the elbow were acquired with exposures of 65 kV and 10-15 mAs.

CT imaging was conducted using a 4-slice CT scanner (Toshiba Asteion, Toshiba Medical Systems, Japan). Technical parameters included a tube voltage of 120 kV, tube current of 80 mAs, rotation time of 1 s, spiral pitch factor of 1, and a slice thickness of 1 mm. The image matrix was 512 × 512 pixels. Images were reconstructed using both soft tissue and bone algorithms and reformatted in sagittal and dorsal planes, as well as volume-rendered (VR) views. The images were reviewed on a PACS workstation using bone window settings (WW = 2700, WL = 350).

Three-dimensional (3D) surface reconstructions of the bone structures were generated using RadiAnt DICOM Viewer® 2023.1, focusing on specific anatomical regions described later.

The complete anatomical study of the thoracic limb bones benefited from integrating these three techniques, each providing a unique and complementary perspective for understanding their structural complexity. Dissection provided the foundation, radiography offered a general overview, and CT allowed detailed three-dimensional visualization.

All thoracic limb bones from both species were processed by removing skin, muscles, tendons, ligaments, articular cartilage, and other joint components. The maceration technique was then applied to describe, compare, and photographically document each bone. All dissections were performed by the same person to minimize bias.

Specimens were immersed in water for an average of 7-10 days, with daily checks to ensure complete cleaning of the bones. They were kept in sealed containers at room temperature, and maceration was carried out using anaerobic bacterial activity.

The terminology used for anatomical descriptions followed the Veterinary Anatomical Nomenclature (International Committee on Veterinary Gross Anatomical Nomenclature, 2017) and the Atlas of X-ray Anatomy of the Dog and Cat (Schebitz & Wilkens, 1977). When necessary, new terms were proposed to ensure precise anatomical descriptions.

RESULTS

Results in Geoffroy's cat (*Leopardus geoffroyi*)

The scapula was a flat, triangular bone, although it appeared somewhat rounded in this species. It had two faces (lateral and medial), three margins (dorsal, cranial, and caudal), and three angles (cranial, caudal, and ventral) (Fig. 1).

The lateral surface was divided into two similarly sized fossae by the spine of the scapula. The scapular spine terminated in the acromion, which was a prominent process. The acromion was flattened laterally to form a hamate process, with an additional prominence forming the suprahamate process (Fig. 1).

The ventral margin, caudal to the glenoid cavity, contained a shallow cavity that articulated with the head of the humerus. Cranial and dorsal to the glenoid cavity, the supraglenoid tubercle projected and was well developed (Fig. 1).

The medial aspect contained the subscapular fossa, the serratus fossa, and the coracoid process, located in the ventral angle, cranial to the glenoid cavity, and medial to the supraglenoid tubercle (Fig. 1). In this species, both the coracoid process and the suprahamate process were prominently developed (Fig. 1).

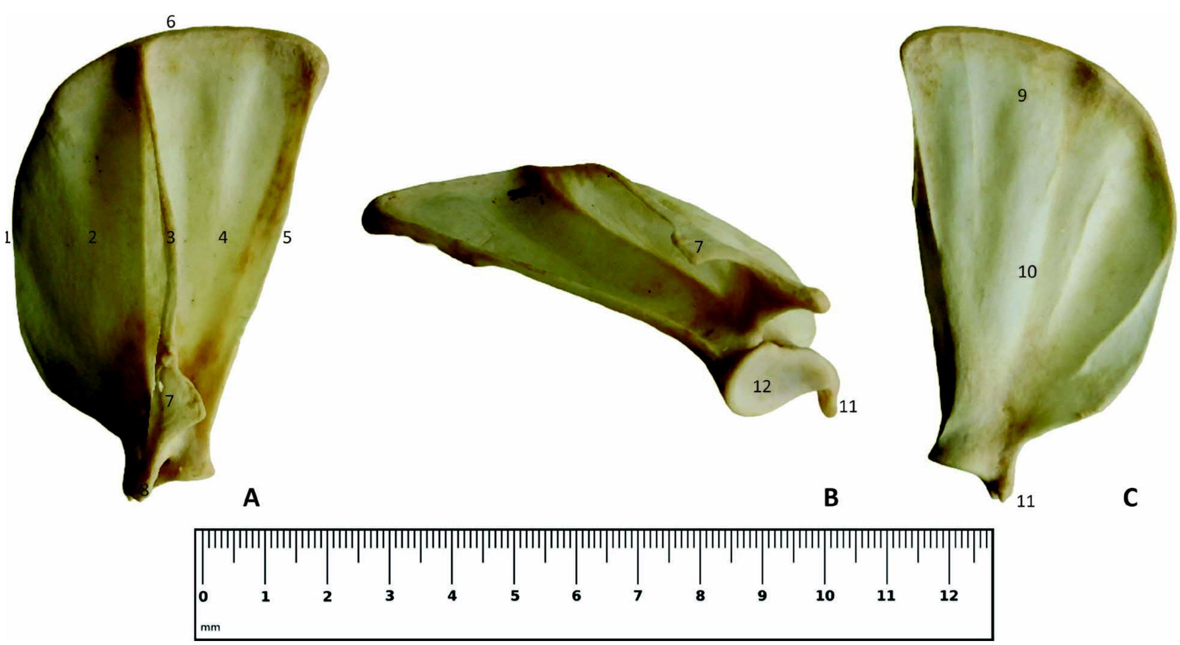

Fig. 1 (A). Lateral view of the left scapula of *Leopardus geoffroyi*. (B). Medial view of the left scapula of *Leopardus geoffroyi*. (C). Ventral view of the right scapula of *Leopardus geoffroyi*. 1: Margo cranialis. 2: Fossa supraspinata. 3: Spina scapulae. 4: Fossa infraspinata. 5: Margo caudalis. 6: Margo dorsalis. 7: Processus suprahamatus. 8: Acromion. 9: Facies serrata. 10: Fossa subscapularis. 11: Processus coracoideus. 12: Cavitas glenoidalis.

The clavicle was a flat, straight bone, slightly curved at its end near the scapula. It had no connection to the skeleton and was visible on radiographs (Fig. 2).

Fig. 2. Radiograph of the clavicles of *Leopardus geoffroyi*.

The proximal limb of the humerus presented a well-developed humeral head (Fig. 3). Caudally, the humerus exhibited a deep olecranon fossa. The medial and lateral epicondyles projected on either side of the distal humerus, adjacent to the olecranon fossa (Fig. 3).

The lateral side of the humerus bore the greater tubercle, while the medial side carried the lesser tubercle. The intertubercular groove separated the two tubercles. The greater tubercle was more developed than the lesser tubercle in this species (Fig. 3).

The distal articular condyle consisted of two structures: medially, the trochlea articulated with the ulna, and laterally, the capitulum articulated with the radius (Fig. 3). A supracondylar foramen was located medial to the distal end of the humerus and was considerably large in this species (Fig. 3).

Caudal and lateral to the greater tubercle, a small line called the tricipital line extended to the deltoid tuberosity (Fig. 3). The body of the humerus bore the deltoid tuberosity cranio-laterally, which was poorly developed in this species (Fig. 3). The medial aspect included the tuberosity of the teres major, also poorly developed (Fig. 3).

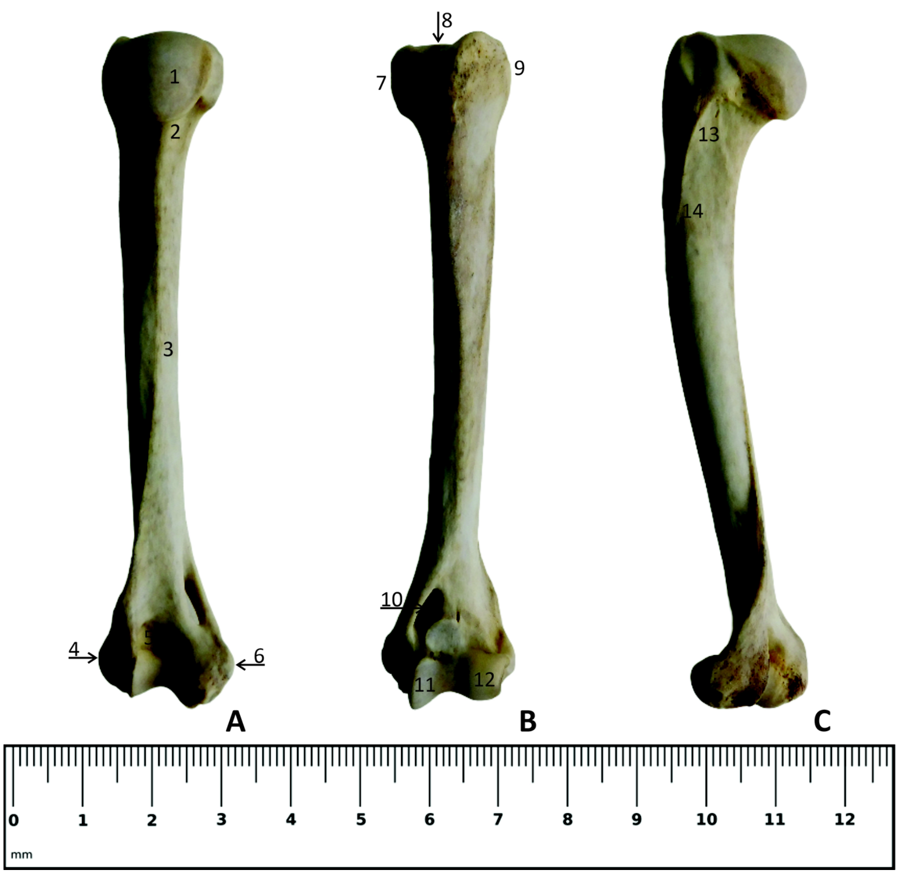

Fig. 3 (A) Caudal view of the left humerus of *Leopardus geoffroyi*. (B) Cranial view of the left humerus of *Leopardus geoffroyi*. C Lateral view of the left humerus of *Leopardus geoffroyi*. 1: Caput humeri. 2: Collum humeri. 3: Corpus humeri. 4: Epicondylus lateralis. 5: Fossa olecrani. 6: Epicondylus medialis, 7: Tuberculum minus. 8: Sulcus intertubercularis. 9: Tuberculum majus. 10: Foramen supracondylare. 11: Trochlea humeri. 12: Capitulum humeri. 13: Linea m. tricipitis. 14: Tuberositas deltoidea.

The radius had relatively few bony landmarks. Its proximal end was transversely widened, forming a head located on a short neck (Fig. 4). The body was compressed cranio-caudally. The cranial surface was smooth but interrupted by prominent grooves near the distal end, while the caudal surface was rough, particularly toward the distal end of the bone (Fig. 4).

The distal end possessed a slightly concave, ovoid articular surface. Medial to this surface, the radius extended to form a small eminence called the styloid process (Fig. 4).

The ulna had a body that tapered slightly toward the distal end and extended along the entire length of the radius, from which it was separated by an interosseous space. The proximal end projected caudally to form the olecranon (Fig. 4).

The cranial edge of the proximal end bore a pointed anconeal process, which fit into the olecranon fossa of the humerus. The anconeal process was located dorsal to the trochlear notch, which articulated with the trochlea of the humerus. Distal to the proximal end, a small facet accommodated the articular surface of the radial head (Fig. 4).

Fig. 4. (A) Cranial view of the right radius of *Leopardus geoffroyi*. (B) Lateral view of the right ulna of *Leopardus geoffroyi*. 1: Caput radii. 2: Collum radii. 3: Corpus radii. 4: Processus styloideus medialis. 5: Olecranon. 6: Processus anconeus. 7: Incisura trochlearis. 8: Corpus ulnae. 9: Processus styloideus latus.

At its distal end (or head), the ulna possessed a small articular facet for the radius, which continued as the lateral styloid process that articulated with the ulnar carpal bone. The lateral styloid process was well developed in Geoffroy's cat (Fig. 4).

The manus consisted of three parts: the carpus, metacarpus, and digits, including phalanges and sesamoid bones (Fig. 5). The carpal bones were arranged in a dorsopalmar orientation, with four identifiable surfaces—two articular and two lateral (medial and lateral edges). They were organized into two rows.

The proximal row articulated with the forearm and consisted of three bones. Two were positioned directly between the forearm bones and the distal row, while the third, located caudal to the ulna, had no connection with the distal row; this was the accessory bone (Fig. 5).

The intermediate-radial bone (os scapholunatum) resulted from the fusion of the radial (scaphoid) and intermediate (lunate) bones and was the largest carpal bone. The dorsal and abaxial surfaces were convex and rough, whereas the palmar surface displayed a rounded prominence known as the radial tubercle (Fig. 5).

The ulnar bone (os pyramidale) was situated between the ulna and the distal row of carpal bones. Its articular surface for the forearm bones was concave. On the palmar aspect, it bore one facet for articulation with the accessory bone and two facets for contact with the intermediate-radial bone. Distally, it articulated with metacarpal V (Fig. 5). The accessory bone (os pisiforme) had one articular surface for the ulnar carpal bone and another for the ulna. It was elongated and slightly constricted at its midsection (Fig. 5).

The bones of the distal row lay between the proximal row and the metacarpals. In this species, four bones were present, numbered I-IV from medial to lateral. Carpal I (os trapezium) was well developed, though smaller than carpal II. It had a single small facet articulating with metacarpal I (Fig. 5). Carpal II (os trapezoideum) had a proximal surface articulating with the intermediate-radial bone, and its axial surface articulated with the ulnar bone. The abaxial surface was convex and textured, bearing a small contact area with carpal I. On the palmar side, it displayed a prominent tubercle. Distally, it articulated with metacarpal II and had a minor facet for metacarpal III (Fig. 5).

Carpal III (os capitatum) primarily articulated with metacarpal III but also formed minor articulations with metacarpals II and IV. Its proximal surface abutted the intermediate-radial bone. The dorsal surface was rough, and the palmar surface bore a tubercle (Fig. 5). Carpal IV (os hamatum) was the largest bone of the distal row. Its proximal end articulated mainly with the ulnar bone, with a smaller area contacting the intermediate-radial bone. On the axial side, it shared a facet with carpal III. Distally, it articulated with metacarpals IV and V through two separate facets (Fig. 5).

The sesamoid bone of the abductor digitorum longus muscle I was located on the medial side of the carpus, at the palmar facet of carpal I, and was well developed in Geoffroy's cat (Fig. 5).

The metacarpus consisted of five bones, numbered I-V from medial to lateral. They were small but elongated. In cross section, metacarpal I was mostly cylindrical; metacarpals III and IV were square, while II and V were triangular (Fig. 5).

Metacarpal I was the shortest, while the third and fourth metacarpals were longer than the second and fifth. Each bone had a proximal base, a body, and a distal head. The distal head articulated with the proximal phalanx via a well-developed articular surface.

The bodies of all metacarpals tapered from base to head; however, in metacarpal I, the taper was less pronounced, giving it a more uniform shape.

Fig. 5. **A.** Dorsal view of the left carpus, metacarpus and digits of *Leopardus geoffroyi*. **B.** Reconstructed dorsal view of the hand of *Leopardus geoffroyi*. (C) Radiograph of the left thoracic limb of *Leopardus geoffroyi*. 1: Os carpi intermedium radialis. 2: Os carpi ulnare. 3: Os carpi accessorium. 4: Os carpale I. 5: Os carpale II. 6: Os carpale III. 7: Os carpale IV. 8: Ossa metacarpalia I. 9: Phalanx proximalis of digit I. 10: Phalanx distalis of digit I. 11: Ossa metacarpalia proximalis II, III, IV and V. 12: sesamoidea. 13: Phalanx proximalis II, III, IV and V. 14: Phalanx media II, III, IV and V. 15: Phalanx distalis II, III, IV and V. 16:Os sesamoideum m. abductoris digiti I.

The skeleton of each digit consisted of three phalanges—proximal, middle, and distal—with the middle phalanx absent in digit I. Thus, digits II-V had three phalanges, while digit I had only two (Fig. 5).

The distal phalanx had a base that articulated with the middle phalanx. The base bore two processes: an extensor process dorsally and a flexor process on the palmar aspect. The flexor process was particularly well developed in Geoffroy's cat. At its distal end, the phalanx possessed an ungual process, also well developed in this species, which supported the claw (Fig. 5).

The digital skeleton was completed by two proximal sesamoid bones on the palmar side of each metacarpophalangeal joint. In this species, no proximal sesamoids were present in digit I, and no distal sesamoids were found in the interphalangeal joints. Dorsal sesamoids were not evident on the dorsal surfaces of the metacarpophalangeal joints (Fig. 5).

Comparative anatomy with the jaguar (*Panthera onca*) (Table I)

The lateral surface of the scapula was divided into the supraspinous and infraspinous fossae by a well-developed scapular spine. The jaguar's scapula exhibited a rhomboid shape due to the pronounced development of the supraspinous fossa, which caused the cranial edge to become convex and project cranially. The supraglenoid tubercle (tuberculum supraglenoidale) was poorly developed (Fig. 6).

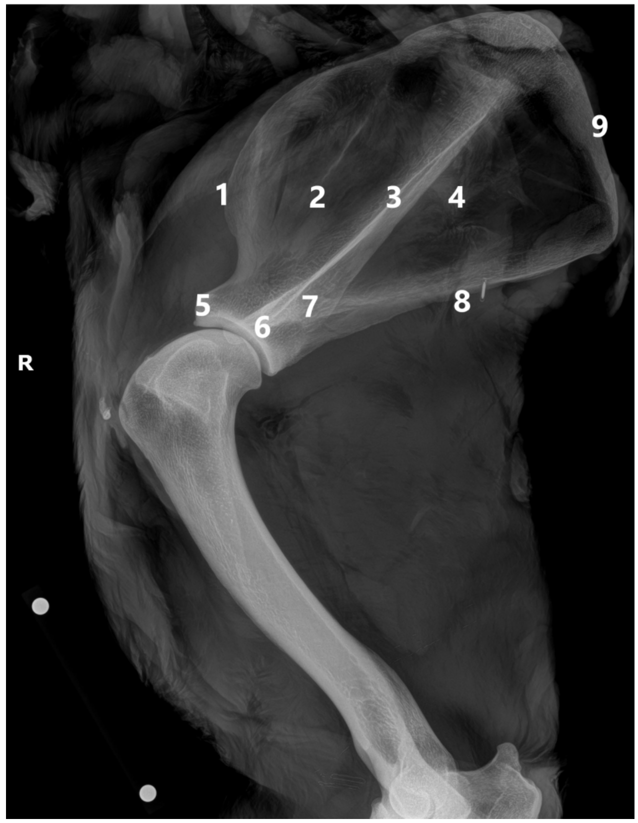

Fig. 6. Lateral view of the left scapula of *Panthera onca.* 1: Margo dorsalis. 2: Fossa supraspinata. 3: Spina scapulae. 4: Fossa infraspinata. 5: Tuberculum supraglenoidale. 6: Acromion. 7: Processus suprahamatus. 8: Margo caudalis. 9: Margo dorsalis.

The clavicle was relatively smaller than in Geoffroy's cat and appeared more curved. Its end nearest the scapula was widened and rounded. As in Geoffroy's cat, the clavicle had no skeletal connection and was visible on radiographs.

The proximal portion of the humerus was flattened and compressed cranio-caudally, although this narrowing did not extend distally. The greater tubercle was markedly developed and slightly exceeded the height of the humeral head (Fig. 7). The medial epicondyle at the distal end of the humerus was particularly prominent. Medially, a relatively small supracondylar foramen was present (Fig. 8).

The radius and ulna appeared slightly twisted overall. The radius was gently curved, with its proximal end oriented laterally and its distal end medially, creating a wide

Table 1: Comparative table detailing the main differences of the thoracic limb bones of *Leopardus geoffroyi* and *Panthera onca*.

Structure	*Leopardus geoffroyi*	*Panthera onca*
Scapula	Well-developed coracoid and suprahamate processes.	More robust and prominent processes.
Humerus	Moderately developed greater tubercle; large supracondylar foramen.	Shorter and more robust. Very prominent greater tubercle; supracondylar foramen present but less developed.
Radius and Ulna	Less robust structure.	More robust bones; olecranon more projected.
Carpus	No particular features.	Similar, but with prominent development of the abductor digiti I sesamoid.
Metacarpus	Varied cross-sectional shapes (cylindrical, square, triangular); smaller diameter.	Similar conformation but generally larger diameters.
Phalanges	Well-defined, no notable features.	More robust and larger in diameter.
Apparent function	Thoracic limb adapted for agile and climbing locomotion.	Robust thoracic limb functionally adapted for capturing large prey.

interosseous space along its entire length (Fig. 9). The medial and lateral styloid processes were highly developed, projecting toward thedistal ends of both bones. The ulna bore a distinct olecranon tuberosity (Fig. 10).

In the first segment of the manus, the sesamoid bone of the tendon of the abductor digiti I longus was notably large (Figs. 11 and 12). In the second and third segments of the manus, the bones did not differ in number or arrangement (Figs. 12 and 13). The proximal sesamoids retained similar characteristics and topography, while dorsal sesamoids were absent, as observed in Geoffroy's cat.

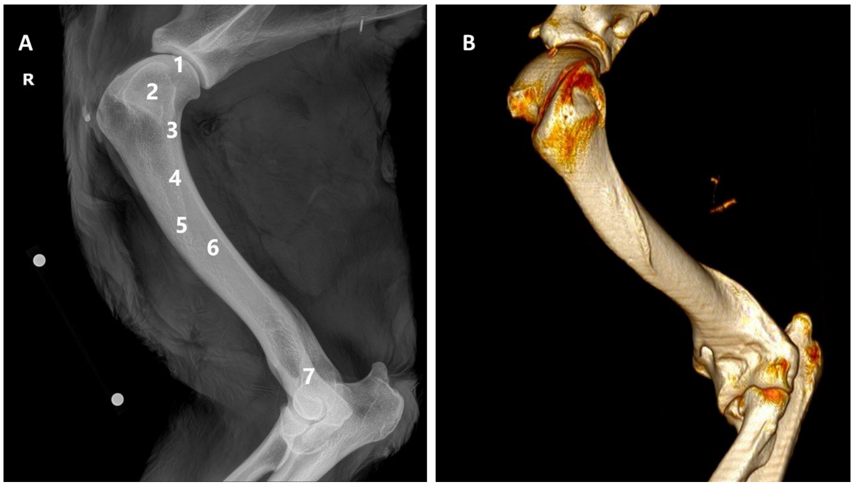

Fig. 7. **A.** Lateral view of the left humerus of *Panthera onca.* **B.** Computed tomography image of the lateral view of the left humerus. 1: Caput humeri. 2: Tuberculum majus. 3: Collum humeri. 4: Linea m. tricipitis. 5: Tuberositas deltoidea. 6: Corpus humeri. 7: Epicondylus lateralis.

Fig. 8. Cranial view of the left humerus of *Panthera onca*.1: Epicondylus medialis. 2: Epicondylus lateralis.

Fig. 9. **A.** Cranial view of the right radius and ulna of *Panthera onca.* **B.** Computed tomography image of the cranial view of the left radius and ulna.1: Corpus ulnae. 2: Corpus radii. 3: Processus styloideus lateralis. 4: Processus styloideus medialis.

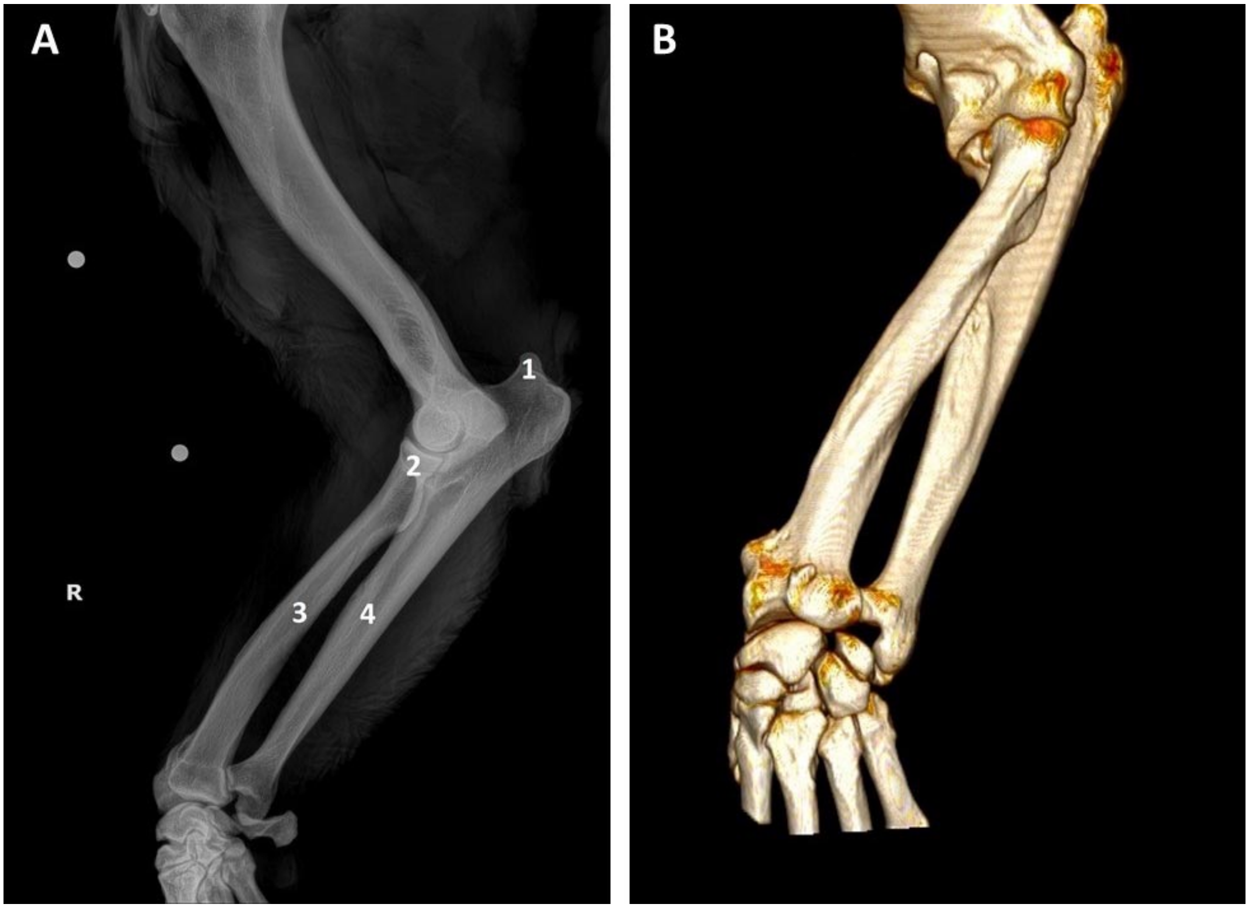

Fig. 10. **A.** Lateral view of the left radius and ulna of *Panthera onca*. **B.** Computed tomography image of the lateral view of the left radius and ulna. 1: Tuber olecrani. 2: Caput radii. 3: Corpus radii. 4: Corpus ulnae.

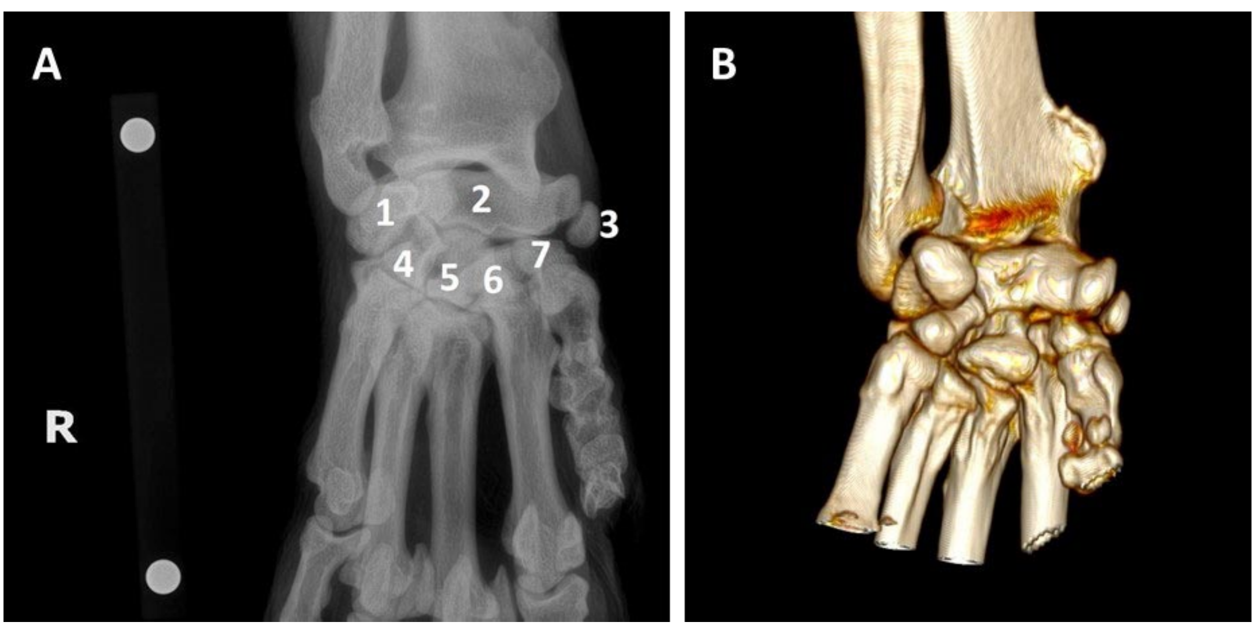

Fig. 11. **A.** Dorsal view of the right carpus of Panthera onca. **B.** Computed tomography image of the same view. 1: Os carpi ulnare. 2: Os carpi intermedium. 3: SOs sesamoideum m. abductoris digiti I. 4: Os carpale IV. 5: Os carpale III. 6: Os carpale II. 7: Os carpale I.

Fig. 12. Lateral view of the left carpus of *Panthera onca*. 1: Os carpi accessorium.

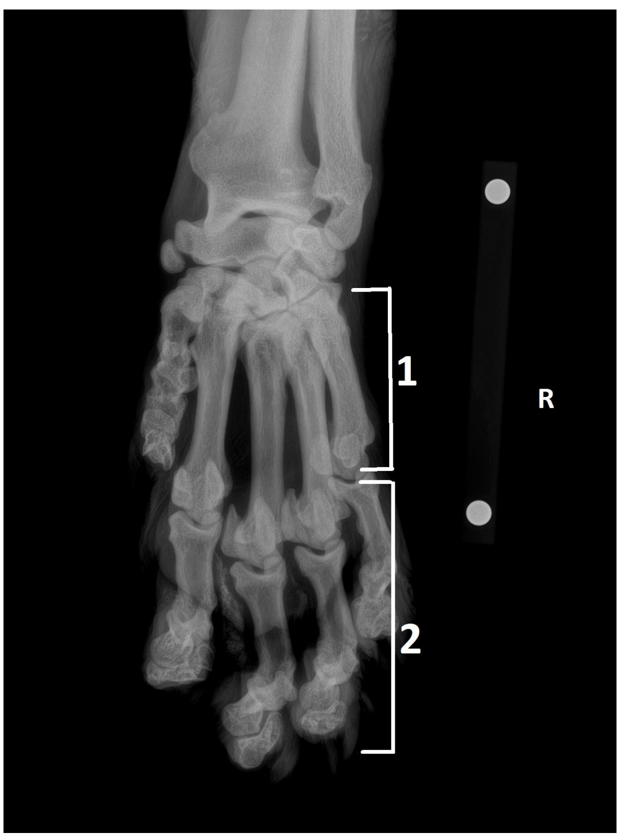

Fig. 13. Dorsal view of the right hand of *Panthera onca.* 1: Ossa metacarpalia I–V. 2: Phalanx proximalis, media y distalis of digits I–V (digit I lacking the phalanx media).

DISCUSSION

The comparative osteological analysis of the thoracic limbs in *Leopardus geoffroyi* and *Panthera onca* reveals notable morphological differences that likely reflect their distinct ecological roles and predatory strategies. The more robust and prominent development of certain bony landmarks in the jaguar—such as the greater tubercle of the humerus and the medial epicondyle—suggests adaptations for subduing large prey, consistent with its role as an apex predator. In contrast, Geoffroy's cat exhibited more gracile structures, including a less developed deltoid tuberosity and a smaller medial epicondyle, which may be associated with the pursuit and capture of smaller, more agile prey. These findings support previous hypotheses linking limb morphology to prey size and hunting behavior in felids, and emphasize the functional implications of musculoskeletal specialization relative to ecological niche.

Regarding the scapular spine, the scapular spine tubercle was absent in both species, a feature also described in lions (*Panthera leo*) (Nzalak *et al*., 2010). In both species, the clavicle was a small, curved bone with no skeletal attachment and was visible on radiographs (de Souza Junior *et al*., 2020). Both Geoffroy's cat and the jaguar presented a supracondylar foramen on the medial side of the humerus, allowing the passage of the median nerve and brachial artery, a feature also recorded in lions (Nzalak *et al*., 2010).

In the forearm, both species displayed well-defined radius and ulna bones, forming a marked interosseous space that may facilitate pronation and supination of the limb, thus enabling precise and agile movements. Lions, like jaguars, also possess a well-developed medial styloid process (Nzalak *et al*., 2010).

The jaguar, Geoffroy's cat, and lions share the presence of seven carpal bones (Nzalak *et al*., 2010). The well-developed sesamoid of the abductor digiti I longus muscle observed in both Geoffroy's cat and the jaguar suggests an enhanced ability for manipulation and grasping.

Both species had five metacarpal bones arranged from medial to lateral, with the third and fourth metacarpals being longer than the others, a characteristic also found in lions (Nzalak *et al*., 2010). The proximal epiphyses of the metacarpals exhibited wide articular surfaces, as previously noted in other felid species (Morales-Mejía *et al*., 2010).

In both *Leopardus geoffroyi* and *Panthera onca*, the phalanges were relatively short and exhibited prominent surfaces for tendon insertion. Each of the five digits possessed a proximal phalanx that was dorsally convex and palmarly concave, as previously described in lions (Nzalak *et al*., 2010). The middle phalanx was absent in digit I. The remaining phalanges displayed a gentle lateral curvature along their shafts, extending to the phalangeal head, which may allow greater flexion of the distal phalanx (Dyce *et al*., 2009).

The distal phalanx bore an ungual process associated with a curved claw, a configuration that facilitates claw retraction. The more developed ungual process in *Leopardus geoffroyi* compared with *Panthera onca* may indicate a greater specialization for claw retraction, likely associated with the capture of smaller prey (Dyce *et al*., 2009).

Differences in limb morphology among felid species are evident in their skeletal proportions. For example, cheetahs, adapted for high-speed pursuit, possess much longer and more slender limbs—particularly in the forearm and lower limb—compared to more robust species such as jaguars. Jaguars, like *Leopardus geoffroyi*, exhibit shorter and sturdier limbs adapted for strength, climbing, and stealth rather than sprinting. This contrast is especially evident in the radius-to-humerus ratio: cheetahs typically exhibit a ratio close to 1.0, indicating an elongated forearm, whereas jaguars have a ratio closer to 0.9, reflecting a more compact and powerful limb structure optimized for ambush hunting rather than long-distance chases (Turner, 1997).

CONCLUSION

The comparative osteological analysis of the thoracic limbs in *Leopardus geoffroyi* and *Panthera onca* reveals distinct morphological traits closely linked to their ecological niches and predatory strategies. The more gracile and elongated structures in *Leopardus geoffroyi*—including a relatively less developed medial epicondyle and deltoid tuberosity—may reflect adaptations for agility and speed, favoring the capture of small, fast-moving prey. In contrast, the robust bone morphology observed in P. onca, including a pronounced greater tubercle of the humerus and well-developed epicondylar regions, is consistent with adaptations for strength and the subjugation of large, resistant prey.

These anatomical differences support the hypothesis that forelimb morphology in felids is functionally shaped by prey size, hunting technique, and environmental interactions. Understanding these functional adaptations is therefore crucial for conservation planning. In the case of *Leopardus geoffroyi*, whose populations are declining despite its current IUCN status as "Least Concern," recognizing the anatomical and ecological requirements of the species can inform habitat management and conflict mitigation strategies, particularly in fragmented or peri-urban environments where the species persists.

For *Panthera onca*, currently extinct in the wild in Uruguay, this anatomical knowledge highlights the importance of reintroduction efforts into habitats with sufficient structural complexity to support ambush hunting and the availability of large prey. Moreover, it has practical implications for veterinary care and captive management programs, where detailed knowledge of limb morphology can assist in diagnosing and treating traumatic injuries and in planning orthopedic surgeries.

Future research could examine whether *Leopardus geoffroyi* populations inhabiting more disturbed or fragmented landscapes exhibit morphological plasticity in limb structure, potentially as an adaptive response to variations in prey availability or hunting terrain.

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DELMIRO, W.; VÁSQUEZ, D.; SORRIBA, V.; DOS SANTOS, D. & VÁSQUEZ, N. Osteología del miembro torácico del gato de Geoffroy (*Leopardus geoffroyi*) y del jaguar (*Panthera onca*). *Int. J. Morphol., 43(6)*:1857-1868, 2025.

RESUMEN: Los miembros torácicos de los felinos son esenciales para la caza, la escalada, el salto y la natación. Este estudio examina la osteología de félidos silvestres americanos, abordando el conocimiento limitado sobre su anatomía y aparato locomotor. Los hallazgos son relevantes tanto para intervenciones médicas como quirúrgicas. Se analizaron los miembros torácicos de cinco gatos de Geoffroy (*Leopardus geoffroyi*) y cuatro jaguares (*Panthera onca*) mediante disección, radiografía, tomografía computarizada y maceración osteológica. Los félidos estudiados carecían de tubérculo en la espina de la escápula, la clavícula era pequeña y no estaba conectada al esqueleto. El húmero presentaba un foramen supracondíleo para el nervio mediano y la arteria braquial. Los jaguares mostraban una apófisis estiloides medial más desarrollada, y ambas especies tenían radio y cúbito bien definidos, con un espacio interóseo mayor en los gatos de Geoffroy. Ambas especies tenían siete huesos carpianos y cinco metacarpianos, que eran más robustos en el jaguar. La presencia de un hueso sesamoideo asociado al músculo abductor largo del primer dedo (dedo I) sugiere una mayor capacidad de manipulación y agarre. Las falanges eran cortas, con superficies adaptadas para la inserción de tendones. La falange media estaba ausente en el primer dedo, y la falange distal se asociaba a garras curvas, posiblemente relacionadas con la retracción de las mismas. En conclusión, existen diferencias anatómicas notables entre los jaguares y los gatos de Geoffroy, que probablemente reflejan las distintas exigencias locomotoras y depredadoras asociadas a la captura de presas de diferentes tamaños.

PALABRAS CLAVE: Huesos; Fauna; Felinos.

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