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The post-cranial osteology of Chilonycteris psilotis

by

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Although general chiropteran anatomy has been discussed by many authors (FLOWER, 5; FLOWER and LYDEKKER, 6; MILLER, 8); the literature remains sketchy in its consideration of the osteology of *Chilonycteris*. MILLER (8) and WINGE (11) note the type of humeroscapular articulation and certain other structures on the humerus. ALLEN (1) reviews the wing membranes and their support by the phalanges and (2) the structure of the pelvis and hind limb. DOBSON (4) gives complete measurements for selected skeletal elements (i.e., forearm, metacarpals, phalanges, tail, tibia, foot and thumb). WALTON and WALTON (10) discuss pectoral and pelvic elements.

The complete description of the skull and teeth of *Chilonycteris* is reviewed by MILLER (8). Cranial elements are, therefore, not considered in this paper.

This study is descriptive; any comparisons made with other bats are to further illuminate osteological characters exhibited by *Chilocycteris psilotis*

METHODS

With the aid of a low power binocular microscope, male and female specimens of *Chilonycteris psilotis* were examined and described. All specimens were obtained from approximately 10 km S Cartagena (fort at Boca Chica), Bolivar, Colombia. A male specimen of *Chilonycteris parnellii* (USNM 313054) was also available for the sake of comparison. Skeletal element nomenclature follows VAUGHAN (9). Generic and specific nomenclature follows that used by the particular author cited.

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VERTEBRAL COLUMN. There is a marked dorsal arching of the thoracolumbar section of the vertebral column. Although there is fusion of the vertebrae in the thoracolumbar and sacral regions, the last cervical vertebra is free from the first thoracic. The amount of fusion is related to the age of the specimen (DOBSON, 4). The number of vertebrae in each region is as follows: seven cervical, twelve thoracic, five lumbar, five sacral and seven caudal. Within the Phyllostomatidae, there is a wide variation in the number of vertebrae in each region. In the thoracic region, *Macrotus californicus* has twelve (VAUGHN, 9), *Phyllostoma hastatum* (cf. *Phyllostomus hastatus)* has thirteen and *Artibeus perspicillatus* (cf., *Artibeus jamaicensis)* twelve (DOBSON, 4). In the lumbar region, *Macrotus* has six (9) and *Phyllostoma* (cf., *Phyllostomus)* five (BELL, 3). In the caudal region, *Macrotus* has seven (9).

The first cervical vertebra (atlas) is oval, flattened anteroposteriorly and has large, wing-shaped transverse processes (Fig. 1). The lateral tips of these processes are rounded and arched anteriorly. The ventral surface of the atlas is elongated anteroposteriorly and the articular facets for the axis are dorsad to the neural canal.

The second cervical vertebra (axis), seen ventrally, is expanded anteroposteriorly, but the neural arch is compressed anteroposteriorly (Fig. 1). The transverse processes are rudimentary and a large foramen is present in the base of each process. There is a short, but distinct, neural spine. The odontoid process is small and hooks dorsad. The centrum appears as a ridge on the ventral surface. There are two posteriorly directed processes from the lateral margins of the base of the centrum.

The posterior five cervical vertebrae are somewhat dorsoventrally compressed. The centra and neural arches are reduced. Neural spines are absent on all five vertebrae as in other bats (4). Transverse processes are reduced greatly, but they gradually increase their anteroposterior breadth from vertebrae three through seven. Cervical vertebrae three and four bear two posteriorly directed processes from the lateral margins of the base of the centrum. Vertebrae six and seven bear two posteriorly directed processes equidistant laterally from the dorsal-most part of the neural arch. The cervical region shows a distinct flexure and forms an obtuse angle with the thoracic region.

The twelve thoracic vertebrae have moderately developed centra and low neural arches with a flattened dorsal surface. The neural canal is, therefore, in the form of an inverted triangle with the apex at the centrum. The neural spines are consistently absent as in other bats (4). Thoracic vertebrae one through ten bear two posteriorly directed processes equidistant laterally from the top of the neural arch. The first five thoracic vertebrae are dorsoventrally flattened. Posteriorly, the vertebrae become laterally compressed. Thoracic vertebrae ten through twelve are fused with one another and with the first lumbar vertebra. This fusion appears to be a function of age (4).

The five lumbar vertebrae are generally more robust and more laterally compressed than the thoracic. Centra and neural arches are well developed. Transverse processes are absent on the first lumbar vertebra and poorly developed on the second, fourth and fifth. They are broadest anteroposteriorly on the third. On lumbars four and five, they are directed forward, but laterally on two and three. The first two lumbars are fused to the last three thoracic vertebrae. There is a separate distinct ventral ridge on lumbar vertebrae three through five.

The five sacral vertebrae are laterally compressed and their neural spines are fused into a urostyle-like structure (10). The centra of the first two vertebrae are laterally compressed and the size of each centrum is steadily reduced through the region. The third through the fifth centra are represented by a ridge which gradually diminishes caudally. Sutures between vertebrae are absent but intervertebral foramina are present between vertebrae one, two and three. The first two sacrals retain transverse processes which fuse with the ilia to form the sacroiliac joint and the last two sacral vertebrae have bony lateral outgrowths which fuse with the ischia as a sacroischial joint (Fig. 6). The posterior half of vertebra four also enters the sacroischial joint. Sacral vertebrae three and four have slight bony lateral outgrowths, and sacral three is completely free from connection with the innominates.

The tail is short and contains seven caudal vertebrae. All the caudal vertebrae lack true processes as DOBSON (4) notes. The first, however, has a neural spine and transverse processes are represented by mere ridges. Each caudal vertebra, except the first, is of smaller diameter in cross section through the middle of the bone than at either end. The first two caudals are very short; the third is equal in length to the first two combined and the third through the fifth are essentially equal in length. The sixth is approximately three-quarters the length of the fifth and the seventh is equal to one-half the length of the sixth.

STERNUM. The manubrium has three main parts: two lateral processes and a vertical process. The vertical process in profile resembles the blade of a hatchet (Fig. 2). The length of the ventral margin of the vertical process exceeds the anteroposterior length of the presternum (10). Lateral processes are expanded and articulate with the proximoventral end of the clavicle and the first costal cartilage. The body of the sternum has a median ridge which is only slightly raised, the greatest height opposite the level of ribs seven and eight (Fig. 2). The posterior portion of the sternum is laterally compressed between the seventh costal cartilage and the posterior tip.

RIBS. There are thirteen ribs. Rib one articulates with the seventh cervical vertebra and the first thoracic and unites ventrally with the first costal cartilage. The first costal cartilage connects the rib and the lateral process of the manubrium. The costal cartilage of rib two articulates with the sternum where the body of the sternum joins the manubrium. The first and thirteenth ribs are approximately of equal length. Ribs five and six are the longest. Ribs three, four, five, six and seven are linked to the body of the sternum by their respective costal cartilages. The tuberculum of each rib articulates with the tubercular facet of each thoracic vertebra and the capitulum with the successive demifacets.

PECTORAL GIRDLE AND LIMB. The infraspinous fossa of the scapula contains three facets (10). The supraspinous fossa is approximately one-third the size of the infraspinous fossa. The spine is short and deflected anteromedially over the supraspinous fossa and reaches its greatest height above the scapular surface approximately one-half the distance between the vertebral border of the scapula and the base of the acromion process (Fig. 2). The coracoid process is approximately one-fourth the size of the clavicle and is directed ventrolaterally and gradually tapers, but is not pointed at its tip (10). Between the two lateral facets of the infraspinous fossa is a low secondary spine (Fig. 2) fusing anteriorly into the axillary border, but raised into a prominent tuberosity immediately posterior to the glenoid fossa. The posterior tip of the scapula has a small cartilaginous tip. The subscapular fossa bears four distinct facets and the anterior portion of the vertebral border bears a ventrally directed flange which extends from the medial portion of the base of the coracoid process to the intersection of the scapular spine and the vertebral border (10).

The clavicle articulates with the lateral process of the manubrium on the anterolateral margin. It exceeds in length the entire sternum by approximately one-fourth. The facet for articulation of the clavicle on the lateral process of the manubrium is approximately one-half the size of the glenoid fossa of the scapula. The clavicle hooks ventrally at its distal tip to articulate with the dorsal surface of the scapula immediately above the base of the coracoid process.

The humerus is approximately one-half the length of the radius. Although it is generally accepted that no secondary articulation exists between the humerus and scapula (8), there does exist a condition which is interesting. The anterodorsal rim of the glenoid fossa is suppressed so that the greater tuberosity of the humerus can be rolled into this region. The small depression thus formed in the rim of the glenoid fossa does not allow a humero-scapular lock as VAUGHAN (9) describes, but, rather, restricts the motion of the humerus so as to cause the distal end of the humerus to circumscribe a long oval. It would seem that in this bat, the humero-scapular association has assumed the rotational capacity usually associated with the radius-ulna complex. The humerus is straight and the shaft is rounded in cross section proximally, but distally the posterior surface is flat. The greater tuberosity is closely applied to the head and projects medially slightly beyond the head. The lesser tuberosity is set off from the head and is larger than the greater tuberosity (10). The lesser tuberosity projects medially to the level of the head. The head is elliptical in shape, dorsoventrally compressed and set at an angle so that the apex points toward the greater tuberosity (10). The pectoral-deltoid flange reaches its greatest height at the level of the lateral boundary of the head. It tapers very slightly distally and abruptly ends. Its length covers the proximal one-fifth of the anterodorsal face of the shaft. The bicipital groove is not deep, but it is represented as a low point in the ridge connecting the greater tuberosity and the pectoral-deltoid flange.

The distal articular surfaces are displaced laterally so that the trochlea is in line with the shaft and the lateral epicondyle extends well above the dorsolateral boundary of the shaft. The medial epicondyle is partially covered by, and bears a well developed spinous process. The spinous process is displaced from the medial epicondyle similar to that of *Macrotus* (9), but extends beyond the most distal boundary of the trochlea.

The radial fossa is weakly developed. On the posterior face of the distal end of the humerus between the lateral and medial epicondyles lies a smooth surface over which moves the sesamoid bone, ulnar patella, in the tendon of the triceps. This is noted by DOBSON (4) as being present in all bats. A second small sesamoid bone covers the lateral epicondyle (Fig. 4).

The radius is twice as long as the humerus. The proximal epiphysis is approximately one-third broader than the diameter of the shaft. The shaft arches forward through the proximal one-third to one-half. The proximal epiphysis is directed cephalad from the proximal end of the shaft, and the posterior surface is smooth for articulation with the ulna. The flexure fossa is deep (Fig. 4). It is not enclosed medially but is directed from anterior to posterior surfaces. There is a narrow ridge on the anteromedial surface which extends along the proximal one-fourth of the shaft. The radius is rectangular in cross section.

The distal epiphysis is narrower than the proximal epiphysis and the articulating surface is deeply concave. On the anterior surface, a distinct ridge is formed by the fusion of the styloid and pseudostyloid processes (Fig. 4). These processes are not separate as they are in most bats (9). The posterior pseudostyloid process is a broad, prominent process on the posteromedial rim (Fig. 4). On the anterior surface, just proximad to the styloid-pseudostyloid ridge, there are three low, rounded tuberosities. On the posterolateral surface immediately proximal to the epiphysis there is a short, distinct flange which begins abruptly but tapers distally.

DOBSON (4) notes that the ulna is rudimentary in all bats and is ankylosed with the radius at some point along the posterior surface of the radius. The proximal portion of the ulna is robust, whereas the remainder of the shaft is laterally flattened and threadlike (8). The ulna terminates and is ankylosed with the radius at a point on the posterior surface two-fifths of the distance down the shaft. The oval concave articulating surface of the proximal epiphysis is expanded transversely to the shaft (Fig. 4). The olecranon process is quite distinct and is joined to the ulnar patella by means of a ligament. From the medial side of the proximal epiphysis there extends a short, broad, square-ended medial articular process. The square end of this process contacts the medial ridge of the trochlea of the distal epiphysis of the humerus.

The lunar and cuneiform fit against one another and both are rounded proximally to fit into the deeply concave articulating surface of the distal epiphysis of the radius. The medial surface of the cuneiform is slightly rounded and fits into the concave lateral surface of the lunar. The dorsal surface of the lunar has a slight depression which receives the styloid-pseudostyloid ridge. This depression appears to be the remainder of the two grooves present in other bats which receive the styloid and pseudostyloid processes, respectively (9).

Upon full extension of the manus, there is no effective lock mechanism at the radio-lunar junction. Movement is not limited to just the horizontal plane as in other bats (9) and the joint is weakened. On the posteroventral surface of the lunar, there is a deep groove for accommodation of the posterior pseudostyloid ridge.

Located three-fifths of the way down the posteromedial surface of the radius is a small sesamoid bone. The ligament connects the distal tip of the ulna and the ventral surface of the lunar.

The scaphoid bone is fused to the lunar as one bone (Fig. 5). The cuneiform is, however, separate from the lunar (Fig. 5). BELL (3) and DOBSON (4) describe the lunar, scaphoid and cuneiform as a single bone in all bats.

The pisiform is a small, short bone. It is approximately one-half the size of the lunar. This bone is small in all bats (5). WINGE (11) notes that the pisiform is forced out of its typical position to the lower side of the carpus in all bats. In *Chilonycteris,* the narrow pisiform bridges the ventral surface of the carpus across the distal portion. Its distal end joins the ventral surface of the proximal end of the fifth digit and the proximal end joins the ventral surface of the trapezium. The half-moon shaped trapezium rests in a shallow depression on the dorsomedial surface of the lunar. The trapezoid has a distinct ridge on its ventral surface which rests in a shallow groove of the dorsal surface of the base of the second metacarpal. The distal part of the magnum fits between metacarpals two and three. The unciform fits distally between metacarpals three and four. There is a sesamoid bone present on the ventral surface of metacarpal four at the proximal end.

The metacarpals are deeply grooved at the proximal ends and have convex ridges which fit these grooves in the neighboring metacarpal. In this manner, they fit tightly against one another. The second and third metacarpals are round in cross section, the fourth is laterally flattened so that it appears oval in cross section and the fifth is laterally compressed.

The phalangeal formula is 2-1-3-2-2. In *Chilonycteris parnellii,* however, the formula is 2-1-3-3-3 with the final phalanx of digits four and five being cartilaginous. The former formula is noted by FLOWER (5) for the Phyllostomatidae in general.

On digits one, three, four and five, there are two small sesamoid bones embedded side by side in the cartilage of the ventral surface of the metacarpophalanx joint. Digit one has a single sesamoid bone embedded at the joint of the two phalanges (Fig. 5). In digits two-five the segments are arranged in order from the longest to the shortest: digit 2, metacarpal, phalanx; digit 3, metacarpal, phalanx 3, phalanx 1 (this differs slightly from the findings of DOBSON, 4, who found the order to be, metacarpal, third, second and first phalanx); digit 4, metacarpal, phalanx 1, phalanx 2; digit 5, metacarpal, phalanx 1, phalanx 2. All digits narrow distally and curve slightly ventrad through each element. The second digit is narrowest through its length of all digits.

PELVIC GIRDLE AND LIMB. The innominate is large and sturdy with strong ridges (10), and expanded dorsoventrally. It is set almost level on the sacrum and fused to the first two sacral vertebrae to form the sacroiliac joint (Fig. 6). The iliac crest is free from fusion but articulates medially with the last lumbar vertebra. The bones of the innominate are laterally flattened.

The ilium is flattened dorsoventrally, triangular in cross section, and broadest and thickest at the anterior end (10). The gluteal fossa is broad and faces dorsad, but the iliac fossa is absent. Ventrally, the ilium is flat, but slightly concave to form a ventrolaterally directed fossa.

In males only, an ossified symphysis pubis is present. The pubes arch proximad from the symphysis in a dorsolateral direction. Projecting from the anterior edge of the pubis is a well-developed pubic spine. It is dorsoventrally compressed and arches slightly mediad for a distance over one-half the length of the ilium. ALLEN (2) notes that the pubic spine of *Chilonycteris davyi* (= *Pteronotus davyi)* is equal in length to the ilium. WALTON and WALTON (10) describe the pubic spine in the Phyllostomatidae as well developed in all subfamilies.

The dorsal ramus of the ischium is short, narrow, dorsoventrally compressed and the distal one-half is ankylosed to the sacrum as is the round dorsal ischial tuberosity (sacroischial joint). The narrow ascending ischial ramus arches dorsomediad and cephalad from the symphysis. Small round ventral ischial tuberosities are present at the base of these rami.

The oval obturator foramen is narrowest at the ventral junction of pubis and ischium. The small acetabulum faces posterolaterad. There are no lateral or medial rims and a small sesamoid bone is embedded in the anterior dorsolateral cartilaginous rim (Fig. 6).

The hind limb of bats is short; it rarely equals the length of the forearm (BELL, 3).

The head of the femur projects proximad from the proximal end of the bone, lies slightly anterior to the long axis of the bone and is globular in shape (Fig. 7). The articular surface extends around three-fourths of the surface area of the head. The greater trochanter is knob-like, extends only slightly beyond the base of the head and is directed laterad. The lesser trochanter is broad and rounded and extends only slightly beyond the base of the head. The lesser trochanter is slightly lower than the greater trochanter. The trochanters are spaced close together (Fig. 7) and the depression between the two is shallow (2). A long, low medial ridge arises distal to the lesser trochanter (Fig. 7). It originates on the anterior surface but is present for the most part on the medial surface.

The shaft of the femur is relatively straight, but does arch slightly caudad in the proximal fifth of the bone. Approximately two-fifths of the way distad along the lateral surface of the shaft is a short, low lateral ridge. It originates opposite the distal end of the medial ridge. The distal epiphysis extends slightly posterior to the main axis of the shaft and is slightly broader than either lateral or medial condyles, and the intercondylar fossa is deep (Fig. 7).

The patella is a thick rectangular sesamoid with rounded corners (Fig. 7). The outer surface is slightly convex. Located dorsolaterally to the lateral condyle of the tibia is a small triangular tibial sesamoid bone (Fig. 7). It is embedded in the cartilage of the knee.

The tibia is more lightly built than the femur and of approximately the same length. The lateral condyle of the tibia is larger than the medial condyle and extends laterally beyond the main axis of the shaft; the cnemial crest is round and distinct. It connects with the patella by ligaments. The shaft of the tibia is triangular in cross section and a prominent tubercle is present on the posterior surface of the shaft near the proximal end. Medially, a short prominent ridge arises from the distal surface of the medial condyle. A low posterolateral ridge spans the entire length of the shaft and originates from a point opposite the middle of the medial ridge. A long, low ridge arises just distad to the cnemial crest and extends along the anterior surface of the shaft well beyond the middle of the shaft. The short, blunt distal epiphysis or medial malleolus is expanded slightly. It articulates with the astragalus.

The fibula is slender and incomplete (Fig. 7). The proximal one-fifth is cartilaginous and joined to the lateral condyle of the tibia at its proximal end. The distal epiphysis is thicker than the rest of the bone. The lateral malleolus is bordered proximolaterally and proximomedially by two projections, each of which is preceded by a short, low ridge. The lateral malleolus articulates with the astragalus.

The tibia articulates with the dorsomedial surface of the astragalus and the fibula with the proximal end. The astragalus articulates distally with the navicular and the cuboid. The astragalus and calcaneus are elongated as they are in all bats (4, 9). The calcaneus is longer and larger than the astragalus. The calcaneus articulates proximally with the calcar and distally with the cuboid. The distal articulating surface is deeply notched.

The calcar is laterally compressed and elliptical in cross section. It is long, approximately the same length as the femur. WINGE (11) notes that the length of the calcar is associated with the tail length: the shorter the tail, the longer the calcar. The proximal end of the calcar is pointed, laterally flattened and hollowed out for articulation with the calcaneus (Fig. 8). It is completely ossified, but this may be a function of age (4).

The cuboid is elongated with the proximal end expanded laterally and dorsoventrally. There is a shallow concavity in the lateral surface in which an oval, large sesamoid bone lies. Another sesamoid bone is present in the cartilage of the ventral surface of the cuboid. The navicular is crescent-shaped. Of the three cuneiform bones, the external cuneiform is the largest and the middle the smallest. The external and internal cuneiforms contact one another at the proximal ends. The medial tarsal bone is small and lies on the ventro-lateral surface of the internal cuneiform.

The metatarsals are elongate (Fig. 8). The phalangeal formula is 2-3-3-3-3. A round, disk-like sesamoid bone is found embedded in the cartilage of the dorsal surface of the metatarso-phalanx joint of each digit. GRASSÉ (7) notes the presence of two sesamoid bones at this joint in most bats. A small crescent-shaped sesamoid bone is found embedded in the cartilage of the dorsal surface of the phalanx 1-phalanx 2 joint of digits two through five. A tiny round sesamoid bone is embedded in the cartilage of the dorsal surface of the phalanx 2-phalanx 3 joint of digits two-five (Fig. 8).

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SUMMARY

The vertebral column in *Chilonycteris* is fused in the thoracolumbar and sacral regions. The sternum, ribs and clavicle are not unusual in appearance. The vertical process of the manubrium resembles the blade of a hatchet. There are thirteen ribs and the clavicle is one and one-fourth times as large as the sternum.

The scapula has a short spine, a coracoid process which is one-fourth the size of the clavicle, and there is a low secondary spine present.

The forelimb is somewhat unique in construction. There appears to be a partial secondary articulation of the humerus with the scapula without the humero-scapular lock mechanism usually involved. Due to this construction, the humerus ascribes a long oval in flight. There is a weakened articulation of the radius with the carpus so that the wrist does not lock in place upon extension of the manus. This allows movement of the wrist in more than one plane during flight.

The pelvis is relatively sturdy in construction and solidly fused to the vertebral column at sacroiliac and sacroischial joints.

The hind limb shows no unusual specializations. The femur, tibia and calcar are all the same length. Sesamoid bones are abundant in the foot and are found more often there than in the manus.

All secondary fusions in the post-cranial skeleton (e.g., vertebral column, symphysis pubis, calcar) appear to be a function of age.

RESUMEN

En *Chilonycteris* la columna vertebral está fusionada a las regiones toracolumbar y sacral. La apariencia del esternón, de las costillas, y de la clavícula es característica del género. Hay trece costillas y la clavícula es una y un cuarto veces más grande que el esternón. La escápula tiene una espina corta, el proceso coracoide, que mide la cuarta parte de la clavícula, y una espina

baja secundaria. El proceso vertical del manubrio se asemeja al filo de una hacha.

La construcción del antebrazo es algo peculiar. Parece haber una articulación secundaria parcial sin que exista un mecanismo que trabe el húmero con el escapular. Debido a esta construcción, el húmero describe un óvalo alargado durante el vuelo. Existe también una articulación débil del radio con el carpo, de modo que la muñeca no se traba al extenderse la mano, lo que permite que ésta se mueve en más de un plano durante el vuelo.

La construcción de la pelvis es relativamente fuerte y está sólidamente fusionada a la columna vertebral en las regiones sacroilíaca y sacroisquial.

La extremidad posterior no muestra nada fuera de lo común. El fémur, la tibia y el calcar son del mismo tamaño. Los huesos sesamoides son más abundantes en el pie que en la mano.

Todas las fusiones secundarias en el esqueleto post-cranial (columna vertebral, sínfisis del pubis, calcar) parecen ser fenómenos de la edad.

LITERATURE CITED

1. ALLEN, H.
1889. On the taxonomic values of the wing membranes and of the terminal phalanges of the digits in the Cheiroptera. *Proc. Acad. Nat. Sci. Phila.,* 41: 313-340.

2. ALLEN, H.
1893. A monograph of the bats of North America. *Bull. U.S. Nat. Mus.,* 43: 14-29.

3. BELL, T.
1836. Cheiroptera, p. 591-594. *In* R. B. Todd, ed., *The cyclopaedia of anatomy and physiology.* Sherwood, Gilbert and Piper, London.

Fig. 1. A., Anterior view of the atlas
B., Anterior view of the axis
C., Lateral view of the axis

Fig. 2. A., Dorsal view of the right scapula, a., spine; b., acromion process; c., clavicle; d., coracoid process; e., glenoid fossa; f., secondary spine of the infraspinous fossa.

B., Ventral view of the sternum. a., clavicle; b., expanded first costal cartilage; c., lateral process of the manubrium; d., vertical process of the manubrium; e., second costal cartilage; f., body of the sternum.

C., Lateral view of the sternum. a., vertical process of the manubrium.

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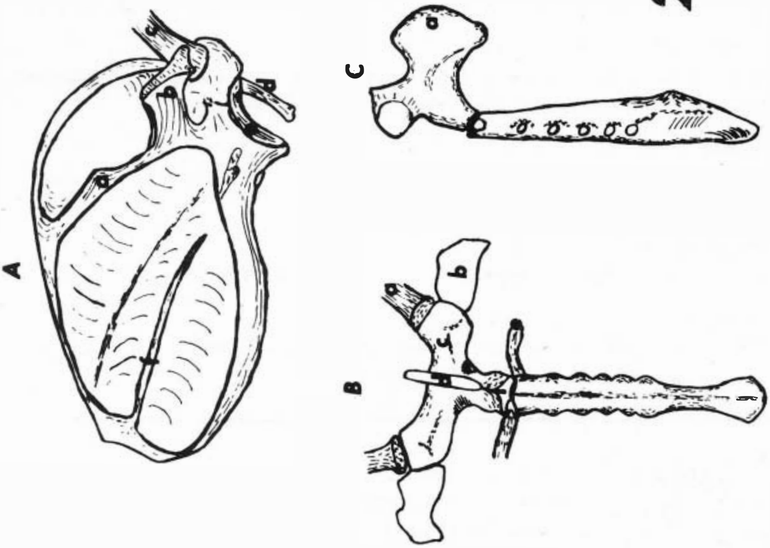

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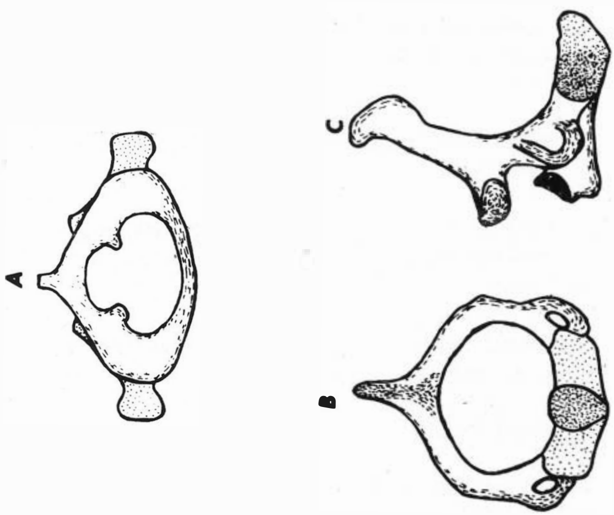


4. DOBSON, G. E.
1878. *Catalogue of the chiroptera in the collection of the British Museum.* British Museum (Natural History), 567 pp.

5. FLOWER, W. H.
1885. *Osteology of the Mammalia.* MacMillan and Co., London, 382 pp.

6. FLOWER, W. H. & R. LYDEKKER
1891. The order Chiroptera, p. 641-679. *In* W. H. Flower, ed., *Mammals living and extinct.* Adam and Charles Black, London.

7. GRASSÉ, P. P.
1955. Anatomie, p. 1729-1773. *In* P. P. Grassé, ed., *Traité de Zoologie.* Masson et Cie., Paris.

8. MILLER, G. S.
1907. The families and genera of bats. *Bull. U.S. Nat. Mus.*, 57: 1-282.

9. VAUGHAN, T. A.
1959. Functional morphology of three bats: *Eumops, Myotis, Macrotis. Univ. Kans. Publ. Mus. Nat. Hist.*, 12: 1-153.

Fig. 3. A., Anterior view of the proximal end of the right humerus. a., greater tuberosity; b., lesser tuberosity; c., pectoral-deltoid flange.

B., Anterior view of the distal end of the right humerus. a., radial fossa; b., spinous process; c., trochlea; d., capitulum; e., lateral epicondyle.

C., Dorsal view of the proximal end of the right humerus, a., head; b., greater tuberosity; c., pectoral-deltoid flange.

Fig. 4. A., Dorsolateral view of the right elbow. h., humerus; l., lateral condyle of the humerus; r., radius; s., sesamoid bone; u., ulna; up., ulnar patella.

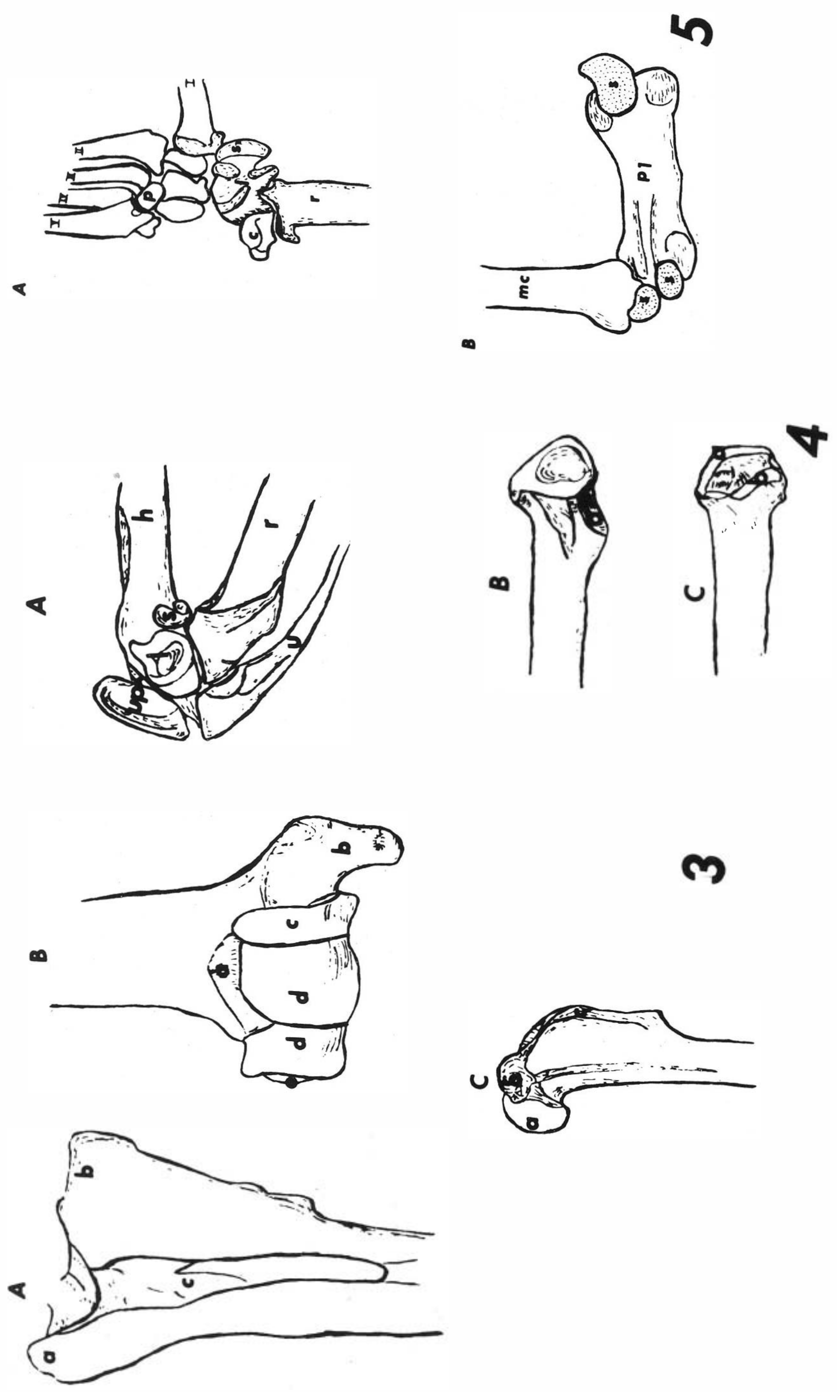
B., Ventral view of the proximal end of the right radius. a., flexure fossa.

C., Posterior view of the distal end of the right radius. a., styloid-pseudostyloid ridge; b., posterior pseudostyloid process.

Fig. 5. A., Ventral view of the right wrist. c., cuneiform; 1., lunar; p., pisiform; s., scaphoid*.

*scaphoid is fused with the lunar.

B., Ventral view of the right thumb (metacarpal and first phalanx, only). mc., metacarpal; p1., first phalanx; s., sesamoid bone.



10. WALTON, D. W. AND GLORIA M. WALTON
1968. Comparative osteology of the pelvic and pectoral girdles of the Phyllostomatidae (Chiroptera: Mammalia). *Bull. Grad. Res. Center, S.M.U.*, 17: 1-35.

11. WINGE, H.
1941. *The Interrelationships of the Mammalian Genera*. Translated by E. Deichmann and G. M. Allen, C. A. Reitzels. Forlag, Copenhagen, pp. 253-319.

Fig. 6. A., Lateral view of the pelvis. a., acetabulum; dit., dorsal ischial tuberosity; il., ilium; o., sesamoid bone; of., obturator foramen; ps., pubic spine; s., sacrum.

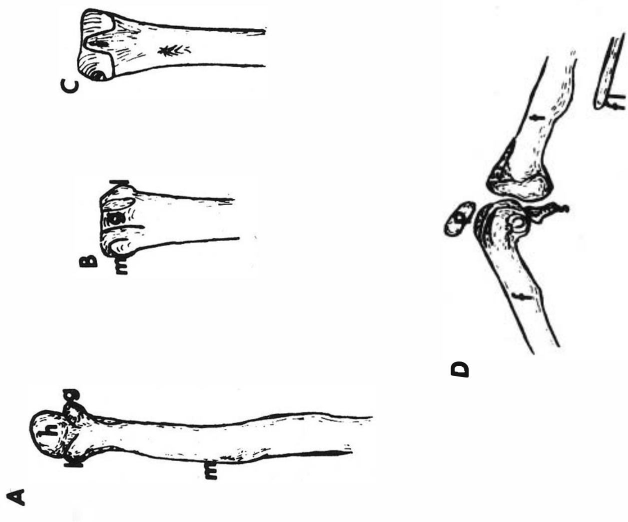
B., Dorsal view of the pelvis. il., ilium; o., sesamoid bone; ps., pubic spine; s., sacrum; sil., sacroiliac joint; sis., sacroischial joint.

Fig. 7. A., Posterior view of the proximal end of the right femur. g., greater tuberosity; h., head; l., lesser tuberosity; m., medial ridge.

B., Anterior view of the distal end of the right femur. g., patellar groove; l., lateral condyle; m., medial condyle.

C., Posterior view of the distal end of the right femur. i., intercondylar fossa.

D., Dorsolateral view of the right knee. f., femur; fl., fibula; p., patella; s., sesamoid bone; t., tibia.



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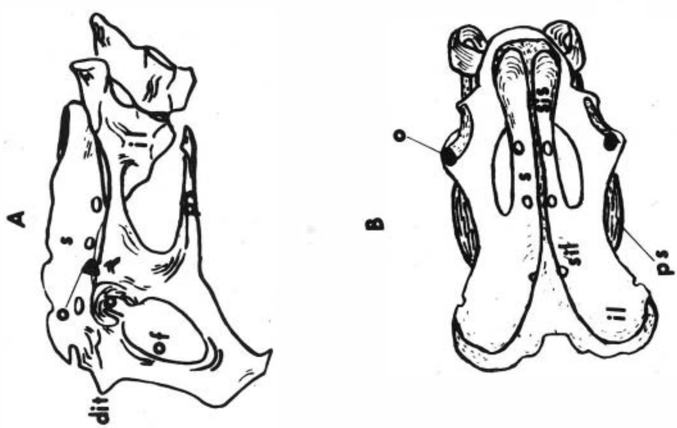

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Fig. 8. A., Dorsal view of the right hind foot. mt., metatarsal; p1 first phalanx; p2., second phalanx; p3., third phalanx; s., sesamoid bone.

B., Anteromedial view of the distal end of the right tibia, fibula and calcar. cal., calcar; fl., fibula; t., tibia.

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