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THE OSTEOLOGY OF *AULACOCEPHALODON PEAVOTI* BROOM

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ABSTRACT

The skull and skeleton of the anomodont reptile *Aulacocephalodon peavoti* are figured and described. A restoration based on the mounted skeleton in Walker Museum is presented.

INTRODUCTION

The purpose of this paper is to figure and describe the skull and skeleton of the specimen of *Aulacocephalodon peavoti* mounted in Walker Museum, University of Chicago. This specimen was originally identified as *Dicynodon* (*Aulacocephalodon*) *tigriceps*, and, under this name, a preliminary account was given by Olson.[1] Upon reexamination it appears that the specimen must be referred to *Aulacocephalodon peavoti* Broom, a closely related species. This species was named by Broom in 1921,[2] and at that time placed in a new genus, *Bainia*. Subsequently Broom, recognizing the priority of Seeley's genus *Aulacocephalodon*, referred his species to that genus.

The specimen described in the present paper, University of Chicago, No. 1532, was found on the Toverwater farm near Murraysburg, South Africa, in the lower *Cistecephalus* zone.

DESCRIPTION

SKULL

A well-preserved skull of this species of *Aulacocephalodon* was described by Broom[3] in 1921 and refigured by him in 1933. His account and figures of the dorsal and lateral surfaces are quite com-

[1] E. C. Olson, "A Mounted Skeleton of the Mammal-Like Reptile *Dicynodon tigriceps*," *Jour. Geol.*, Vol. LXIII (1935), pp. 1063–66.

[2] R. Broom, "On Some New Genera and Species of Anomodont Reptiles from the Karroo Beds of South Africa," *Proc. Zoöl. Soc. London* (1921), pp. 659–61.

[3] *Ibid.*

plete and accurate and nothing can be added to them from the specimen under consideration. The general shape of the new skull and the arrangement of the elements, so far as this can be determined, are shown on Figures 1*A* and 2*A*.

The palate has been exposed but the sutures are so obscure that the limits of most of the elements cannot be determined. The essential features of this portion of the skull are shown in Figure 1*B*. The maxillaries and premaxillaries are toothless, and there is no indication that any teeth were ever present. In the canine region of the maxillary, however, there is a large, rough projection of bone, which, if covered with a tough substance, would have acted as an efficient substitute for teeth.

TABLE 1

PRINCIPAL SKULL MEASUREMENTS

Greatest length.....	470 mm	Interorbital width...	105 mm
Greatest width.....	410	Intertemporal width.	85

On the posterior part of the figure of the palate the positions of the external openings of the fallopian canal, the fenestra ovalis, and the jugular foramen are indicated. The fallopian canal for the seventh cranial nerve is large. It appears to lie just above the suture between the proötic and basisphenoid. The fenestra ovalis, which lies back and slightly medial to the opening for Nerve VII, is rather small for such a large skull. The stapes is absent. The jugular foramen is large and appears to lie between the basioccipital and exoccipital.

The brain case has been partially exposed but the preservation is such that only a general description of it is possible. The cavity of the brain is very high and narrow. The anterior margin of the proötic is nearly vertical and is marked by a very shallow proötic incisure and a poorly defined dorsal, venous notch. Anterior to the proötic, the supraoccipital and the parietal project ventrally to form the lateral walls of a groove leading from the otic portion of the brain case to the pineal opening. It is impossible to determine the structure anterior to the pineal opening.

The basisphenoid is a broad, deep bone marked ventrally by strong tubera. The rostral portion, the parasphenoid, projects for-

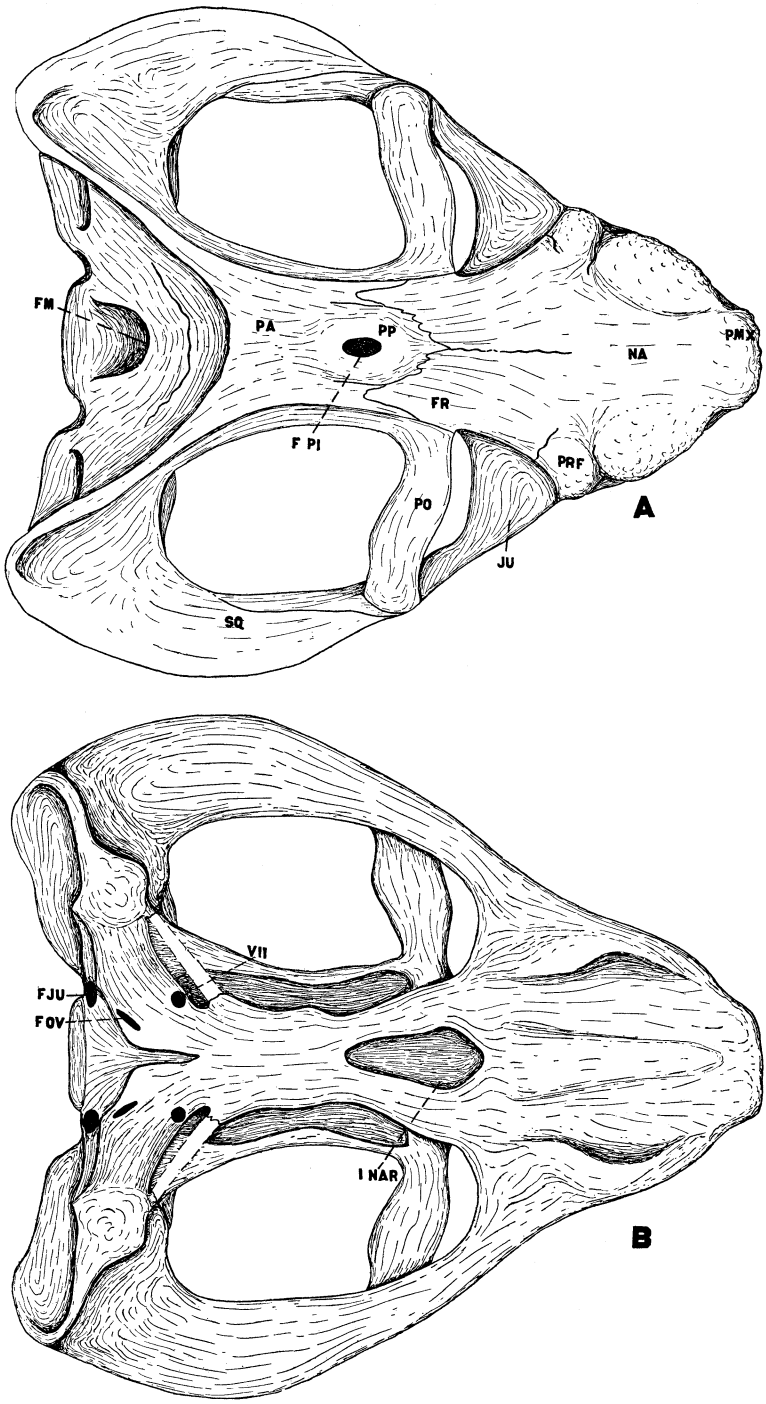

FIG. 1.—Skull of *Aulacocephalodon peavoti*. *A*, Dorsal aspect; *B*, Ventral aspect. *F JU*, jugular foramen; *FM*, foramen magnum; *F OV*, fenestra ovalis; *F PI*, pineal foramen; *FR*, frontal; *IN*, internal nares; *JU*, jugal; *PA*, parietal; *PMX*, premaxillary; *PO*, postorbital; *PP*, preparietal; *PRF*, prefrontal; *NA*, nasal; *SQ*, squamosal; VII, fallopian canal for cranial nerve VII. × about $\frac{1}{4}$.

ward and slightly upward to about the level of the pineal opening. The pterygoid lies beneath the anterior portions of this bone.

LOWER JAWS

The lower jaws are essentially complete and their shape, shown in Figure 2*B*, is quite clear. The sutures between the elements are very obscure and only a few can be made out with any certainty. The

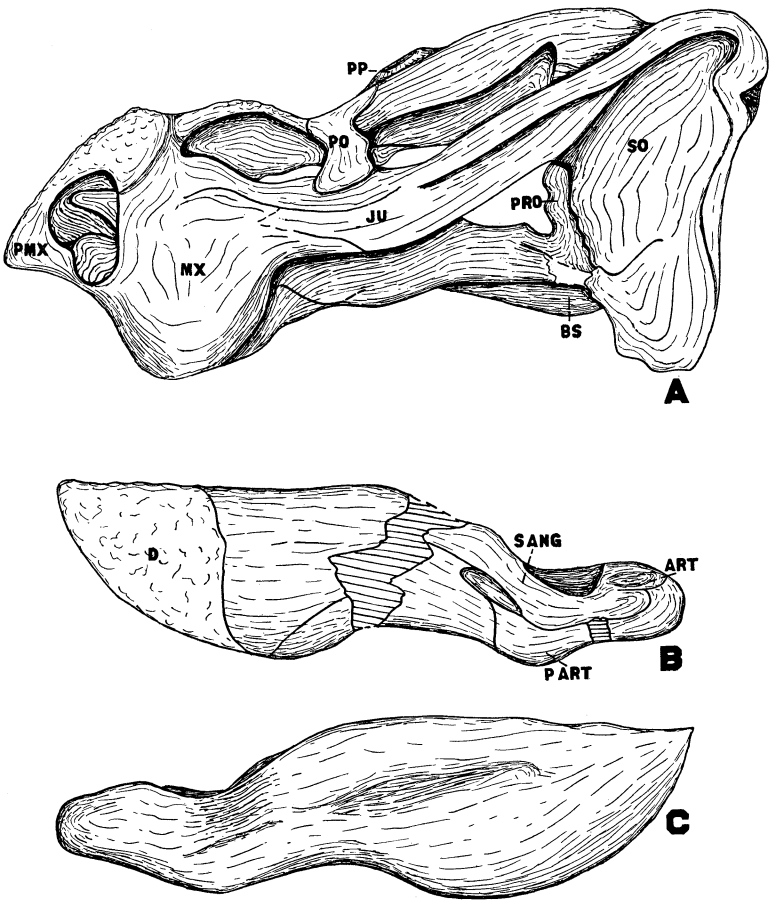

FIG. 2.—Skull and jaws of *Aulacocephalodon peavoti*. *A*, Lateral aspect of skull; *B*, Medial aspect of right lower jaw; *C*, Lateral aspect of right lower jaw. *ART*, articular; *BS*, basisphenoid; *D*, dentary; *JU*, jugal; *MX*, maxillary; *P ART*, prearticular; *PMX*, premaxillary; *PO*, postorbital; *PP*, preparietal; *PRO*, proötic; *SANG*, surangular; *SQ*, squamosal. × about $\frac{1}{4}$.

anterior ends of the lower jaws are very heavy and meet in a strong symphysis. The posterior portions are light and the articulation with the skull is not particularly strong.

VERTEBRAL COLUMN

The twenty-six presacral vertebrae present in the specimen appear to form a complete series. Because they are somewhat distorted it is impossible to determine the exact number of cervical vertebrae, the vertebrarterial canal having been obliterated. Likewise it is impossible to be certain of the exact number of thoracic and lumbar vertebrae.

The atlas-axis complex is well preserved. The atlas consists of a crescent-shaped intercentrum, which is closely applied to the lower half of the odontoid, and of two separate dorsal portions. The dorsal segments are wing-shaped structures, pointed medially but expanding anteriorly and posteriorly so that, viewed in superior aspect, the outline is wedge-shaped, the base of the wedge occupying a lateral position. From the anterior half of the base of the wedge arises the pointed transverse process. This may also include the first rib. The anterior border of the process is curved ventrally to form a well-developed flange.

The centrum of the first vertebra is fused firmly to that of the axis. The odontoid process so formed is moderately convex. The centrum of the axis is elongate and concave laterally. The neural arch rises above it to enclose a restricted neural canal. The neural spine is quite high and is expanded anteroposteriorly. The anterior border of the spine curves markedly forward. The transverse processes, arising from the anterior half of the neural arch, take origin immediately above the centrum and curve sharply ventrad.

Because of the distortion of the vertebrae, the description of the remainder of the presacral region can be only very general. Throughout this region the centra are rather cylindrical and only slightly concave on their sides. There is a uniform increase in size from anterior to posterior. The most massive centrum is that of the last presacral vertebra, this being almost double the size of the centrum immediately following the axis.

The neural spines are all about the same height. There is, how-

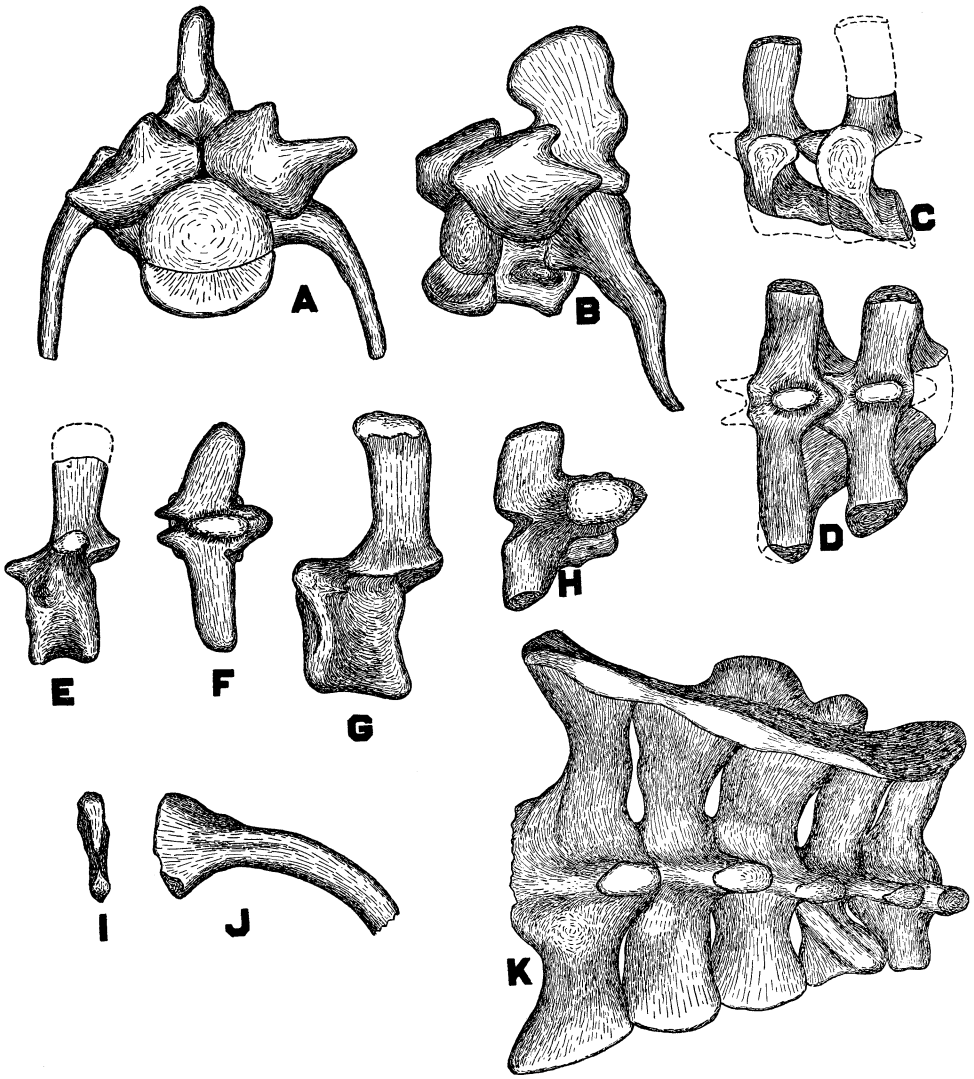

FIG. 3.—Vertebrae and ribs of *Aulacocephalodon peavoti*. *A*, Atlas and axis, anterior aspect. *B*, Atlas and axis, lateral aspect, left. *C*, Vertebrae 6 and 7, lateral aspect, left. *D*, Vertebrae 6 and 7, dorsal aspect. *E*, Vertebra 15, lateral aspect, left. *F*, Vertebra 15, dorsal aspect. *G*, Vertebra 21, lateral aspect. left. *H*, Vertebrae 21, dorsal aspect. *I*, Rib 7?, head in proximal aspect. *J*, Rib 7?, anterior aspect. *K*, Sacrum, dorsal aspect. $\times\frac{1}{4}$.

ever, an increase in massiveness posteriorly. The increase is the result of an anteroposterior expansion of the spines. The spines tend to become bulbous toward their summits. The spines in the cervical region appear to be directed slightly to the posterior, those in the thoracic region to stand more or less vertically, and those in the general lumbar region to be directed slightly to the anterior.

An interesting migration of the transverse processes is to be noted. At the anterior end of the column the transverse processes arise from the base of the neural arch and from about the center of that structure. Posteriorly the processes raise somewhat higher on the arches. At the same time their origins move progressively forward, until, in the lumbar region, the transverse processes spring from the sides of the anterior zygapophyses.

The sacrum includes five vertebrae all closely opposed to one another, although apparently not ankylosed. There is a gradual decrease in size from the first sacral to the fifth. The neural spine of the first sacral curves somewhat anteriorly while those of the remaining four are directed posteriorly. The transverse processes are very short.

Except for five centra the caudal region has been entirely restored. The centra preserved are short anteroposteriorly and roughly circular in transverse section. Apparently the transverse processes arise at the points of junction of the centra and the neural arches.

RIBS

The ribs are dichocephalous throughout the presacral region. Posteriorly, however, the capitulum rises until, in the last presacral, it is very close to the tuberculum. All the tubercular heads attach to the ventral sides of the transverse processes. Anteriorly the capitular facets are centrally located. Posteriorly they are shifted in position so that a single facet becomes two demifacets, the anterior demifacet being situated on the posterior border of the preceding centrum.

The presacral ribs taper gradually toward their ventral extremities. The cross sections are oval proximally and slightly elliptical distally. The arch of the ribs indicates a fairly spacious body cavity. The longest ribs are those of the middle of the section.

The sacral ribs are all firmly fused to the transverse processes. The first sacral is the most massive of the series, the other four becoming successively shorter and less massive. The middle portion of each rib is somewhat constricted, the internal portion flaring broadly to its articulation with the transverse process and the external portion flaring broadly to its articulation with the ilium. The first sacral rib, oval in section, descends sharply to the anterior.

PECTORAL GIRDLE

The preserved portion of the shoulder girdle consists of a nearly complete right scapula, a left scapula from which only the anterodorsal corner is missing, the left post-coracoid, and the anterior portion of the interclavicle. In the accompanying figure and the restoration the precoracoids, the clavicles, the cleithrum, and a sternum have been added.

The scapula is a bladelike structure expanded along its superior border and tapering to its greatest constriction just above the glenoid. The posterior border is markedly concave, the anterior border almost straight. The scapula is arched externally in a dorsoventral plane to accommodate itself to the expansion of the thoracic cavity. The axillary ridge causes the posterior border to be somewhat thickened. The ridge appears slightly below the superior border and proceeds to the glenoid buttress with which it merges. The scapular border of the glenoid is directly somewhat posteriorly. A strong glenoid buttress is present. A well-developed acromion process appears slightly below the center of the scapula on the anterior border.

The postcoracoid exhibits a strong ridge running from the glenoid to the posterior corner. Otherwise the element is thin and platelike. The glenoidal surface is produced posteriorly, is slightly concave, and is directed dorsally and laterally more than it is posteriorly. The anteroventral position of the coracoid, as well as the precoracoid, seems to be missing.

The interclavicle is greatly expanded along its anterior border and sends out winglike flanges for its contacts with the clavicles. Posteriorly the interclavicle constricts sharply to a stout, slightly curved projection, which presumably underlay the sternum.

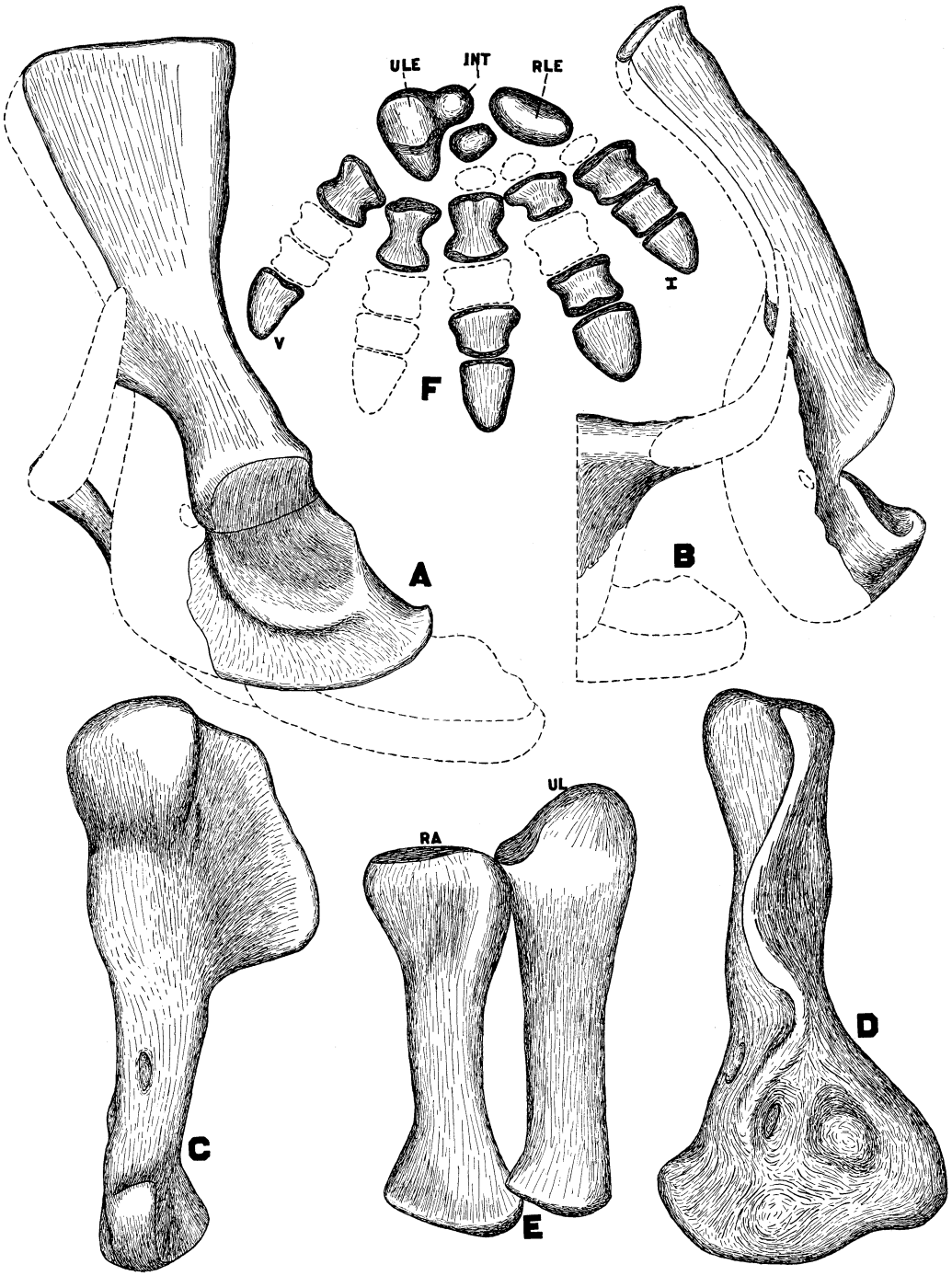

FIG. 4.—Pectoral girdle and forelimb of *Aulacocephalodon peavoti*. *A*, Left side of pectoral girdle, lateral aspect. *B*, Left side of pectoral girdle, anterior aspect. *C*, Left humerus, posterior aspect. *D*, Left humerus, ventral aspect. *E*, Left radius and ulna, anterior aspect. *F*, Forefoot, right. *INT*, intermedium; *RA*, radius. *RLE*, radiale; *UL*, ulna; *ULE*, ulnare. $\times\frac{1}{4}$.

FORELIMB

The forelimb as preserved includes both humeri, the radii and ulnae of both sides, and a considerable portion of the right wrist and hand.

The humerus is a very powerful element. A large, nearly round head gives origin from its anterodorsal border to a greatly expanded deltopectoral crest. At the point of subsidence of the crest a short but stout shaft appears. The shaft soon expands distally to form the massive trochlea and somewhat less massive capitulum. The epicondyles are but slightly developed. A conspicuous entepicondylar foramen is present. There is no indication of an ectepicondylar foramen. The plane of the distal condyles lies at an angle of about 30° to that of the medial border.

The radius and ulna are short but massive bones. Proximally each one is subcircular in cross section. The shafts are considerably flattened in the lateral plane. The distal end of the radius flares both medially and laterally while that of the ulna is expanded only medially. The ulna bears a massive, rounded olecranon process.

The pisiform and the distal carpals are missing from the wrist. The radiale is an elongated, egg-shaped element. The ulnare is flattened on its dorsal and ventral surfaces. Viewed from above, the ulnare is nearly circular in outline. Apparently fused to the medial border of the ulnare is the small, spherical intermedium, and fused to its distal border, a small, pointed second centrale. The first centrale is small in size and ovoid in form.

All the metacarpals are present, and all conform to a single general pattern. The proximal and distal borders are expanded and somewhat convex. The waist is conspicuously constricted.

The first phalanx of the first digit is a short element and is somewhat flattened dorsoventrally. The ungual phalanx is short and bluntly pointed. The first phalanges of the second and third digits are missing, the second phalanges quite short, and the ungual phalanges bluntly pointed. The fourth digit is missing and only the medially curved, moderately pointed ungual phalanx is preserved of the fifth digit. The phalangeal formula appears to be 2–3–3–3–3.

PELVIC GIRDLE

The right side of the pelvic girdle has been preserved intact except for the medial portions of the pubis and ischium. The left side of the girdle is absent.

The ilium consists of an anteroposteriorly expanded dorsal flange rising above the stout ventral shaft. The superior border, curved throughout most of its length, passes sharply downward anteriorly and less markedly so posteriorly. The anterior process is longer than the posterior. The anterior half of the external surface of the crest is somewhat concave; the posterior half, slightly convex. Anteriorly the crest flares laterally.

The greatest anteroposterior constriction of the ilium is slightly below the crest. Ventrally from that point the element expands considerably to contribute to a capacious acetabulum. A strong acetabular buttress is developed on the anterior half of the ilium.

The acetabular portion of the pubis is quite thick. Anteriorly it bends sharply toward the median line. Posteriorly it slopes ventrally to its contact with the ischium. Only the external margin of the puboischiadic foramen is preserved.

The ischium, markedly concave along its vertically directed posteroexternal border, curves sharply toward the median line. The element lies principally in a nearly vertical plane.

The dorsal half of the acetabulum is developed from the ilium. About two-thirds of the ventral half are contributed by the ischium. The iliac portion faces both ventrally and externally, the ischial and pubic portion, only externally.

HINDLIMB

The femur, tibia, a portion of the fibula, and the proximal tarsals are preserved on the right side. Of the elements of the left leg, only the fibula is preserved.

The femur is a powerful, slightly flattened element. The head is poorly differentiated from the greatly expanded greater trochanter, which does not subside into the shaft for fully half the length of the bone. The expanded distal end is composed of poorly distinguished condyles.

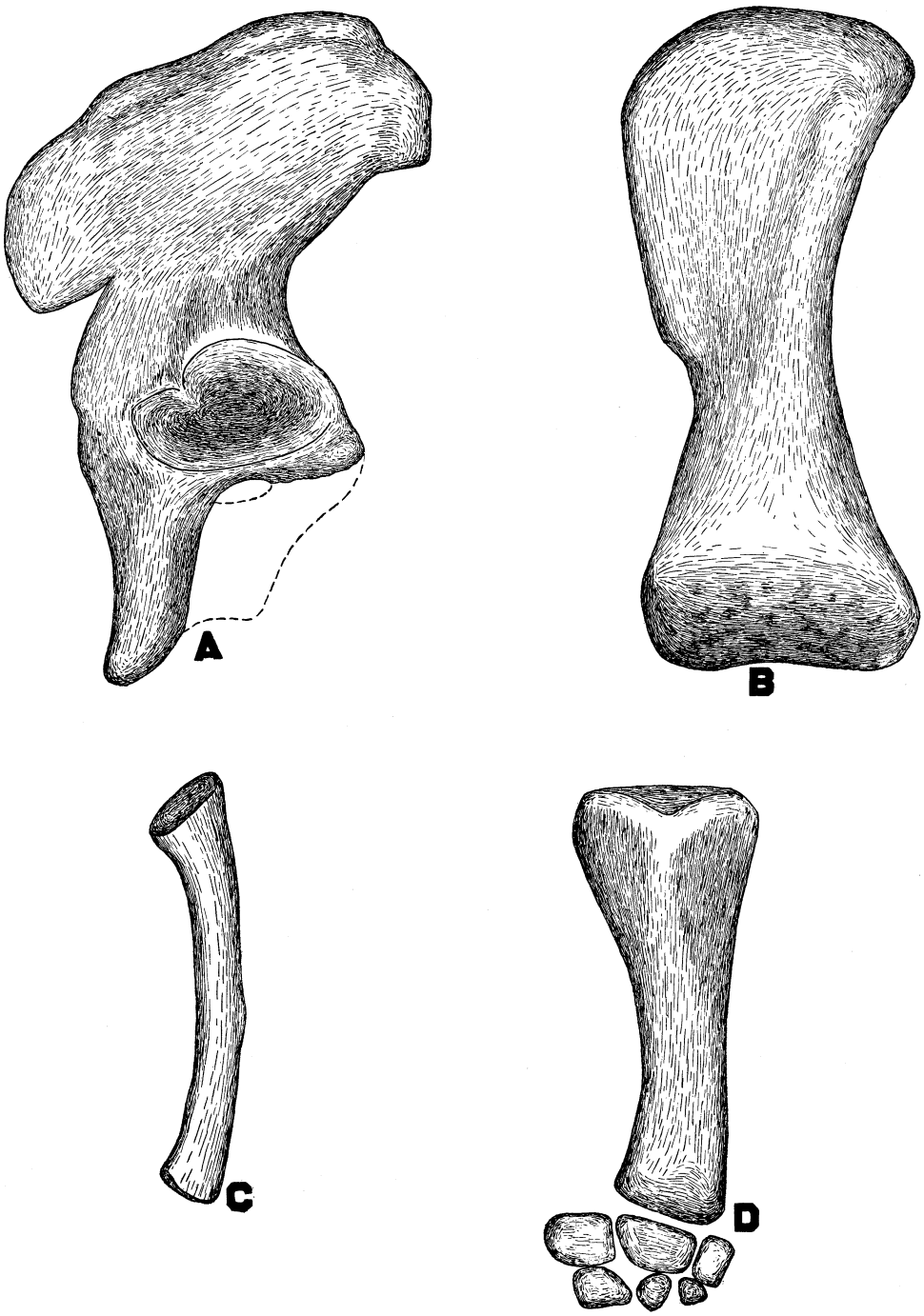

FIG. 5.—Pelvic girdle and hindlimb of *Aulacocephalodon peavoti*. *A*, right side of pelvis, lateral aspect. *B*, right femur, anterior aspect; *C*, Left fibula, anterior aspect; *D*, Right tibia and proximal tarsals, anterior aspect. $\times\frac{1}{4}$.

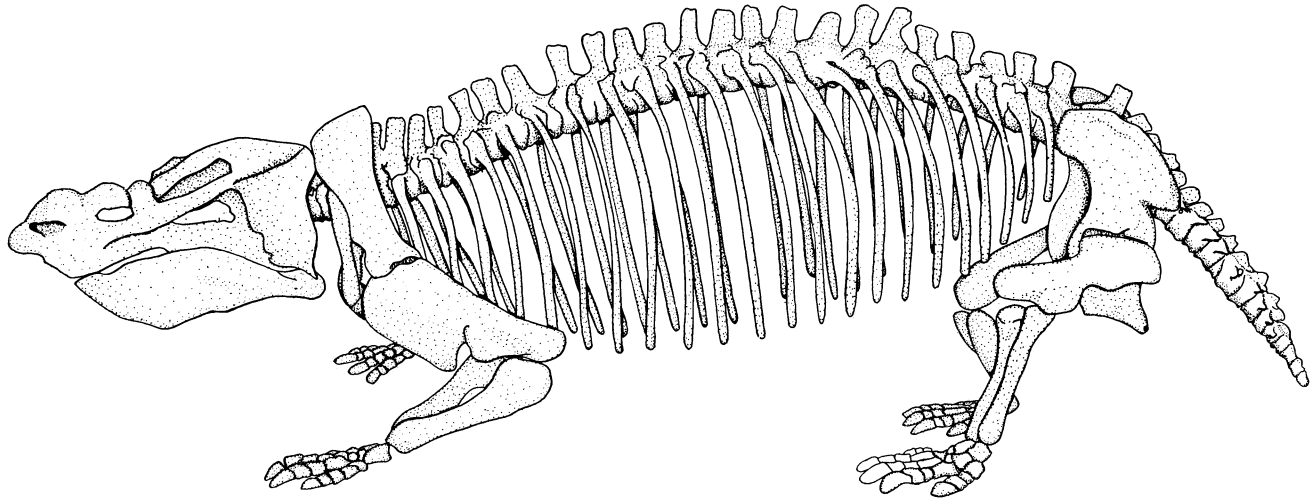

FIG. 6.—Restoration of *Aulacocephalodon peavoti* Broomi

The stout tibia presents an expanded proximal articular surface to the femur. Distally it tapers to a somewhat flattened shaft. The internal border is markedy concave, the external border nearly straight. The fibula is a slender bone roughly circular in cross section. The proximal end is but slightly expanded, the distal end even less so. The element is strongly concave along its internal border.

The ankle and hind foot are missing in the specimen except for some of the proximal tarsals. The elements preserved may be identified as a small, square intermedium; a five-sided, fairly large tibiale; two small centrales; and two other elements which might be the fibulare and a somewhat smaller navicular.

NOTES ON THE RESTORATION

The accompanying restoration of *Aulacocephalodon peavoti* is redrawn from photographs of the mounted specimen and shows the attitude of the skeleton as mounted. Distortion of the bones imposed certain limitations on the positions in which they could be placed in the mounted skeleton and a few portions are not precisely in the positions which they probably assumed during the life of the animal. Most striking in this regard is the shoulder girdle, which probably is too far forward, mainly a result of the forward projection of the scapula. The forelimb perhaps actually was somewhat more under the animal, although the nature of the articulation of the girdle and humerus, and the humerus and radius and ulna, indicates that the limb did project laterally. The ribs were distorted from their original form so that the ventral extremities project more directly downward than probably was the case in the living animal. In the lumbar region in particular the distal ends of the transverse processes are crushed so that they lie above the normal position. The tail is largely restored, and its length and position are somewhat conjectural. The arch of the vertebral column is that suggested by the articulations of the vertebrae, but crushing may have altered the original condition somewhat so that the arch is too pronounced.