

Article XIV.—A MOUNTED SKELETON OF *NAOSAURUS*,
A PELYCOSAUR FROM THE PERMIAN OF TEXAS.

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PLATES IX AND X.

The more or less complete skeletons of the Permian Pelycosauria *Naosaurus* and *Dimetrodon* constitute some of the finest and most interesting portions of the Cope Permian collection presented to the American Museum by Mr. Morris K. Jesup. The present article is devoted to a preliminary description of a composite skeleton of a Permian Pelycosaurian mounted with great skill by Mr. Adam Hermann under the writer's direction with the coöperation of Dr. W. D. Matthew.

The assemblage in this imposing mount, which has a total length of 8 ft. 6½ inches or 2.62 m., represents a large number of individuals arbitrarily associated with the chief specimen (Amer. Mus. No. 4015), collected by Mr. Sternberg in 1896 on Hog Creek, Baylor County, Texas. This chief specimen includes all the vertebræ and ribs except those parts which are obviously restored in plaster; clavicles, and epiclavicles; a portion of the scapula not used was doubtfully associated. The association of the other parts collected by Messrs. Boll (1880) and Cummings (1882) is highly conjectural. Dr. E. C. Case, the chief authority on this group writes his belief that the skull of *Dimetrodon* cannot be used as a basis for the restoration of the skull of *Naosaurus*.

The reader will, therefore, thoroughly understand that the assemblage is largely composite. It serves, nevertheless, to give us for the first time an adequate conception of the unique and imposing characters of these great extinct forms.

Detailed List of Parts Assembled.—It is important at once to record the catalogue numbers and the localities of the specimens used in this assemblage:

No. 4015. Sternberg, 1896, Hog Creek, Baylor Co., Texas.

All vertebræ and ribs (except as restored in plaster); *clavicles* and *cleithrum*.
Part of scapula not used; doubtfully associated.

No. 4081. Ball, 1880. North Fork of Little Wichita River, Texas.

Skull and jaws except as restored in plaster. (The right jaw, a large part of right side of skull, and smaller part of left side, are bone. All teeth are restored.)

No. 4057. Cummins, 1882. Elm Creek, Texas.

Fore and hind limbs, in part, as follows: right radius and ulna, ulnare,

radiale, carpale II, metacarpals I-IV, phal. II; left femur, right and left tibiæ, right astragalus. Scapulæ, parts of humeri, pelvis, and many vertebral centra not used. A part of a single spine preserved, and the length of the tail indicates this as *Dimetrodon* rather than *Naosaurus*. The length and character of limbs and feet is not sufficiently different to prevent its being used in the *Naosaurus* skeleton.

No. 4145. Sternberg, 1895. Coffee Creek, Baylor Co., Texas.

Scapulæ, humeri, left radius and ulna. Femur not used. This specimen agrees pretty closely with No. 4057 in parts comparable, but is somewhat more robust.

No. 4163. Sternberg, 1902. Coffee Creek. Composite number, bone bed.

Nearly all phalanges, parts of several metapodials and distal tarsals.

The Pelycosaur material in this lot was sorted out and is mostly of appropriate size.

No. 4103. Indian Creek, Texas.

Interclavicle. Scapula, not used. Somewhat too large for No. 4057, but may not be too large for No. 4015, which is more robust than No. 4057.

No. 4132. Right femur.

Unnumbered specimens. Calcaneum, two carpals, a few phalanges.

The above numbers are from the American Museum catalogue as determined by Messrs. Matthew, Case, and Gregory. Dr. W. D. Matthew furnishes the following additional notes:

Limbs and feet.—The limb and foot material in the Museum collection does not include anything that can be *certainly* regarded as belonging to *Naosaurus*; all the best limb and foot material is in association with *Dimetrodon*, but since *Naosaurus* is about as abundant as *Dimetrodon* it is fair to infer that about half of the unassociated limb and foot material belongs with *Naosaurus*. It is probable that *Naosaurus* was a somewhat more robust animal, but otherwise much like *Dimetrodon*. The limbs and feet used in this assemblage may fairly represent *Naosaurus* but more probably belong to a large species of *Dimetrodon*.

Vertebræ.—The central specimen (Amer. Mus. No. 4015) includes the greater number of vertebræ. The characters here shown are confirmed by two other remarkably complete vertebral series with spines. The chief characters of the atlas and axis are well ascertained from Amer. Mus. Nos. 4034, 4040, referred by Dr. Case to *Dimetrodon gigas* and *D. incisivus* respectively (Fig. 1). The length of the tail is inferred to be exceptionally short in *Naosaurus*, chiefly because of the absence of any large or long caudals in association with any of these giant Pelycosauria. In *Dimetrodon* it was apparently somewhat longer than in *Naosaurus*.

Skull.—As above noted, the association of the skull is highly conjectural; its size and robustness as compared with that of *Dimetrodon* constitute the principal ground for this association.

We are struck by the enormous and powerful head, which was supported

by ligaments attached to the stout neural spines of the anterior cervicals and dorsals, the elongate back, from which radiate like the rays of a fan the greatly elongated neural spines, the transverse bars of which suggested the name *Naosaurus* or 'ship lizard' to Professor Cope. Anteriorly the spines almost overhang the back of the head, posteriorly they are sharply retroverted into a horizontal plane. The fore limbs are supported by a very powerful shoulder girdle. The hind limbs are relatively large and more powerful. The horizontal position of the humerus and femur and the sharp angulation of the ankle joint are conditioned by the peculiar position of the articular facets. The pose is taken from a careful study of some of the existing lizards.

Details of Structure.

1. The skull is modeled from comparative study of several Pelycosaur skulls in the American Museum with the assistance of one loaned by Professor S. W. Williston from the University of Chicago. It is probably substantially correct. The position of the lower canines is determined by deep,

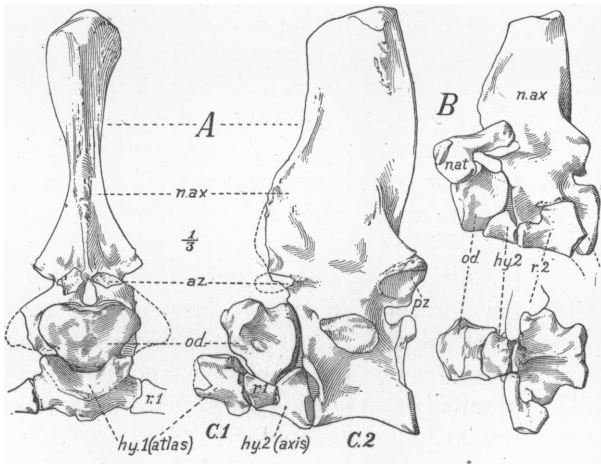


Fig. 1. Axis and atlas complex of the Pelycosauria. A, No. 4034 Cope Collection, American Museum. Anterior and lateral aspects. B, No. 4040, Cope Collection, American Museum. Lateral and inferior aspects. The dorsal border of *n. at.* was probably broadly convex.

lateral grooves on the outer sides of the premaxillaries. The face is strongly convex, the orbits are large, the temporal fenestræ are contracted by the powerful bones of the temporal region.

2. *Cervicals*.—The structure of the atlas and axis is very primitive, as determined from American Museum Nos. 4034 *Dimetrodon gigas* (fide Case) 4040 *D. incisivus* (fide Case), and represented in Fig. 2, A, B.

In the smaller specimen (No. 4040, Fig. 2B) the odontoid or atlanteal pleurocentrum reaches the ventral line of the vertebræ, and the facet for the hypocentrum is almost on the same transverse plane with the facet for the skull. The spine of the atlas is relatively low. In the larger specimen (No. 4034, Fig. 2 A) the odontoid is excluded from the ventral line by hypocentra 1 and 2, and the facet for hypocentrum 1 is very oblique.

In No. 4040 the odontoid supports the distinct halves of the neural arch of the atlas (*N. at.* Fig. 2 B), as in *Chamipsosaurus* and other primitive Diapsida. Each half of this neural arch¹ has a large facet for the odontoid. It also articulated postero-dorsally with the prezygapophysis of the axis, and probably also distally with the atlanteal hypocentrum (*hy 1*) which in No. 4034 (*D. gigas*) shows a distinct articular depression on its dorso-lateral border. In No. 4034 (Fig. 2 A) the first rib certainly articulated with the postero-lateral border of hypocentrum 1, and possibly may also have articulated dorsally with the postero-inferior portion of the atlanteal neural arch, as observed by Dr. Case in his specimen No. 131. The second rib articulates by the tubercle with hypocentrum 2 (of the axis) and by its capitulum with the diapophysis of the axis.

The neck was apparently abbreviate, each vertebra behind the atlas being provided with large, free two-headed ribs.

3. The vertebræ excepting the sacrals and ? anterior caudals were provided with free hypocentra. The centra are perforated by the notochordal tube. The vertebral centra (pleurocentra) are relatively small and reduced, especially in the anterior dorsal region where as supporting structures they are more or less functionally replaced by the enormously enlarged neural spines.

4. The neural spines of the anterior dorsals are directed upward and partly expand at the extremities to support the stout ligaments attached to the occipital surface of the skull. As we pass backward the spines become more slender and assume a vertical, an oblique, and finally a curved retroverted position horizontally overhanging the sacrum and anterior portion of the tail. The vertebral formula is approximately:

Rib-bearing cervicals	?5
Rib-bearing dorsals	19.
Sacrals	3.
Caudals	25.

5. The post-atlanteal ribs articulate by the capitulum with the hypocentrum or are intercentral in position; the tuberculum of each is pleurocentral being attached to the sides of the succeeding vertebra.

¹ Owing to the crushed condition of the specimen, the shape of the neural arch is incorrectly represented in the drawing. Its dorsal border should be convex.

6. The short, stout shoulder girdle includes a very large plate-like scapula. The suture between the coracoid and procoracoid cannot be made out.

The clavicular arch includes: (1) epiclavicles, (2) clavicles, (3) the elongated interclavicle or episternum. The close articulation of clavicles and interclavicle is clearly observed.

7. *The manus*.¹—The reconstruction of the manus and pes (hypothetically arranged in Fig. 3), is due to Dr. Matthew. The carpus apparently comprises the following parts: radiale, intermedium, ulnare, 2 centralia, 5 distinct carpalia. The phalangeal formula is that of the typical Diapsida, namely, 2, 3, 4, 5, 4. A primitive feature characteristic of other Diapsida, such as *Sphenodon* and *Stereosternum* is an intracarpal foramen (*for.*) indicated by a curve in the mesial aspect of the ulnare. An analogous intratarsal foramen in the pes is indicated by a curve in the mesial aspect of the fibulare.

8. *The pes*.—The first character of this hypothetical restoration is the sharp or right angle in the ankle joint. Thus the fibula articulates with the internal face of the fibulare, the tibia with the internal face of the supposed tibiale + intermedium. The bone corresponding to the navicular is provisionally interpreted as centrale 1 (as indicated by Broom's figure of the pes of *Procolophon*). There is a space for another small centrale tarsi (possibly for two centralia) although in the restoration centrale 3 is indicated as coalesced with tarsale 4. The phalangeal and digital formula are hypothetically represented as in the manus.

In both manus and pes the terminal phalanges are of the locomotor rather than of the prehensile type, that is, they were provided with flattened rather than with sharply recurved claws.

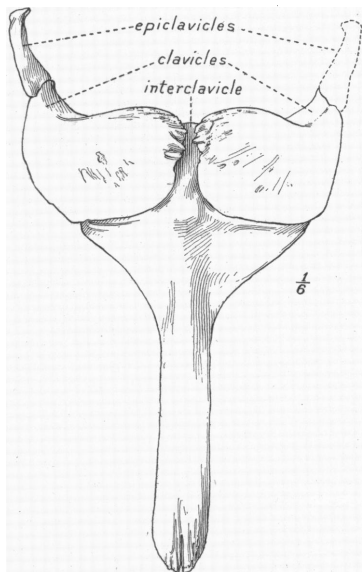


Fig. 2. Clavicular arch. The breast plates attributed to *Naosaurus*. Cope Collection, No. 4103, American Museum.

¹ Owing to the fact that the manus is reconstructed from several specimens the intermedium is probably too small in the drawing and does not extend sufficiently upward between the radius and ulna. Centrale 2 is also probably incorrect in form (Matthew).

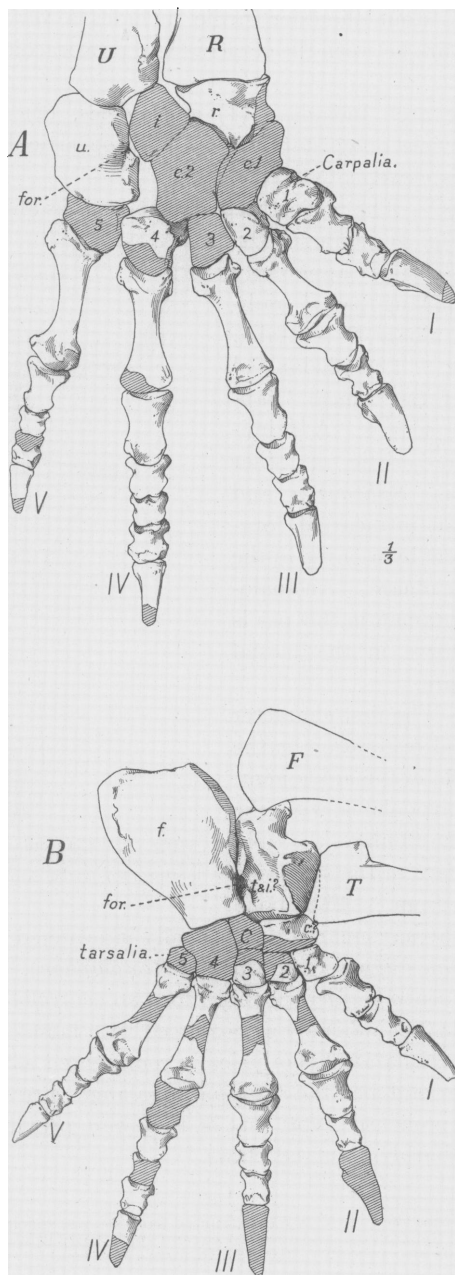
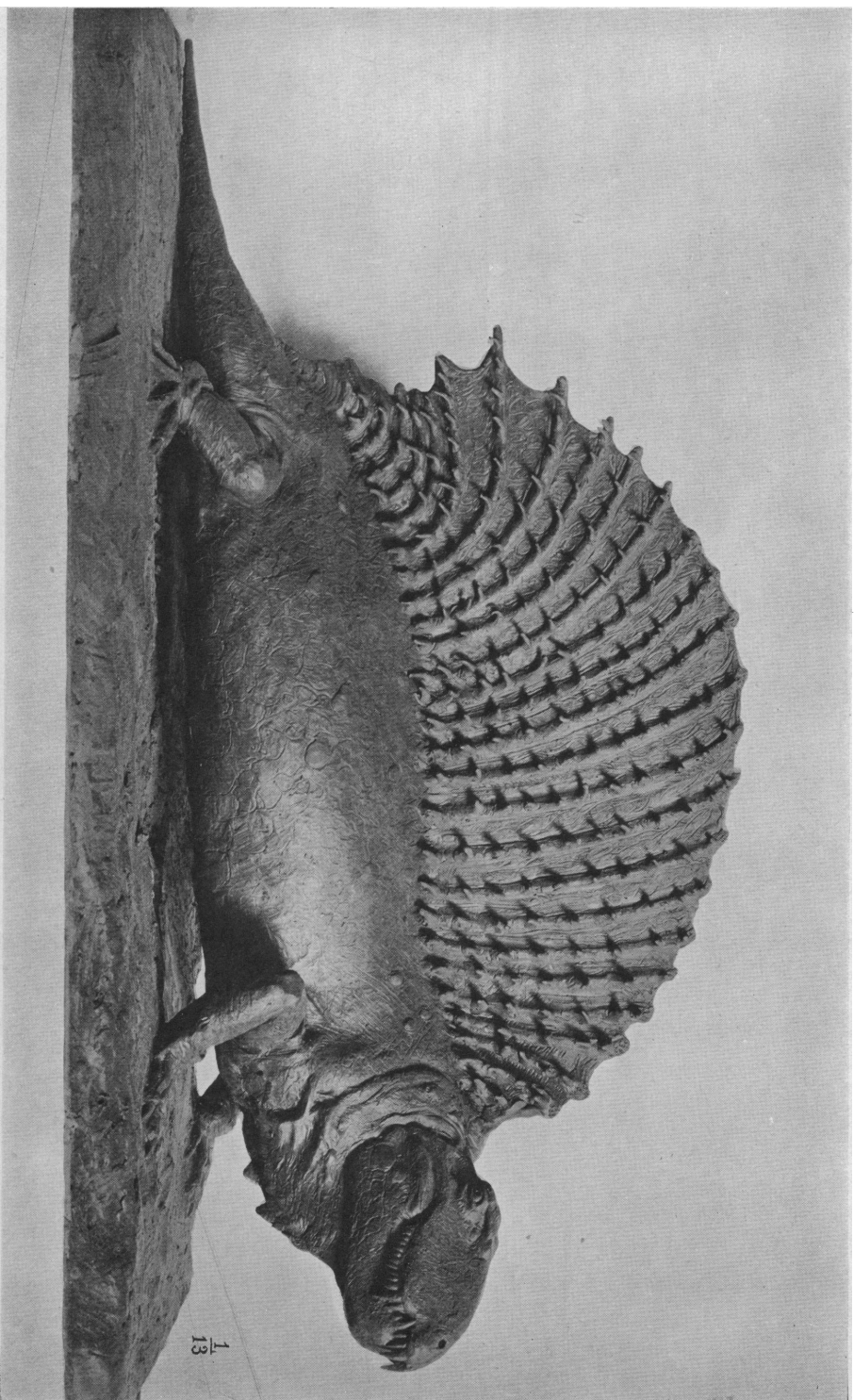
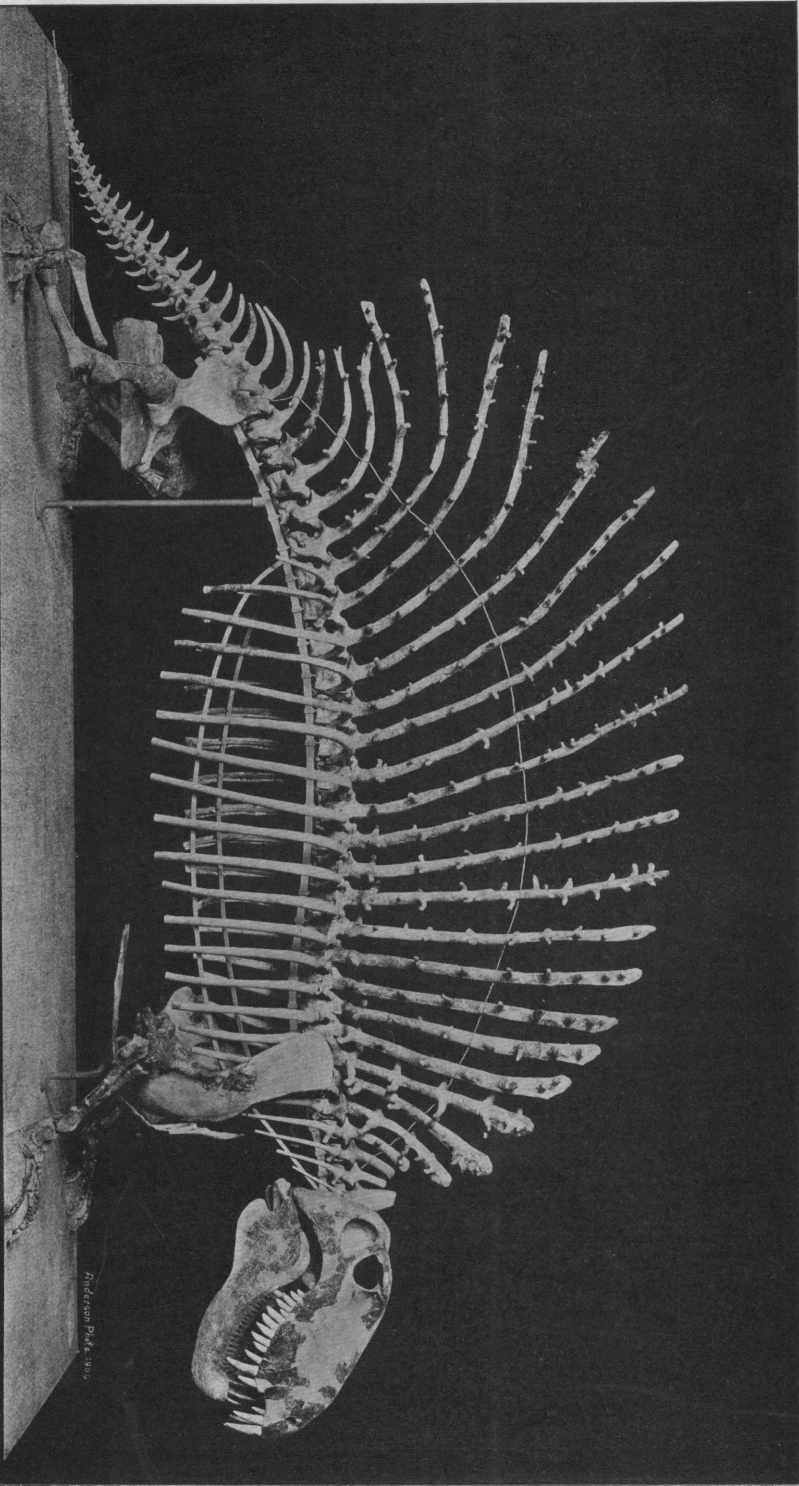


Fig. 3. A, manus, B, pes, of a large Pelycosaur. Composition, from a number of different individuals.



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Model of *Naosaurus claviger*, by Charles R. Knight, based upon the mounted skeleton shown in Plate X.



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Composite skeleton of a large Pelycosaurian Lizard, from the Permian of Texas. (Composed of assembled parts chiefly belonging to the genera *Nasaurus* and *Dimetrodon*.)