56.81,9C:14.71

Article XXXVIII.—*CORYTHOSAURUS CASUARIUS:* SKELETON, MUSCULATURE AND EPIDERMIS.

SECOND PAPER.

BY BARNUM BROWN.

PLATES XIII–XXII.

This genus and species was founded on a skeleton of a new crested dinosaur in 1914, and a detailed description of the skull was given at that time (Bull. Amer. Mus. Nat. Hist., Vol. XXXIII, Art. XXXV, pp. 559–565, Oct. 8, 1914).

The skeleton, No. 5240, is now prepared and mounted and a more extended knowledge of the anatomy can be presented but detailed description and figures of individual bones must be derived later from another specimen.

The missing parts of the front limbs in the type specimen found in 1912 have been restored from a second nearly complete skeleton of the same size and species, No. 5338, found in 1914, a few miles below Steveville.

The impression of the epidermis covering the greater part of the body has been skillfully worked out in detail by Mr. Otto Falkenbach and although faint in places, where covered by masses of vegetable material, the general pattern is fairly well determined, likewise the outline of neck, body and tail.

It is evident from attendant circumstances of deposition that the carcass had drifted on a beach. The bedding plane under the body was unusually irregular; a complete skeleton of a young Baënid turtle, No. 5241, and several water-worn Trachodont bones were lying under the tail; *Unio* shells were abundant all round, and over the body three distinct masses of sandstone were deposited in folds, the cross-bedded planes showing water currents from different directions.

It was lying on the left side and the skin impression on the left side is continuous but the mass of vegetal material on which it was lying did not allow a clean-cut definition of the pattern. Better defined areas appear in sections on the right or upper side where the silts were homogeneous but patches of the skin were torn off in places, consequently it was deemed advisable to preserve the skin on both sides wherever possible and expose only those bones not covered.

All blocks are united as found, and the specimen is erected from the

horizontal to a vertical position, assuming a pose it may well have taken in swimming.

The second skeleton, No. 5338, establishes the proportion of the front limb in this genus, in which the radius is much longer than the humerus. It also determines the type of *Trachodon marginatus*, a front leg described by Lambe, to have been correctly referred at first to the genus *Trachodon*. This species was later taken as the genotype of *Stephanosaurus*.

Corythosaurus casuarius may now be defined as follows:

Corythosaurus casuarius.

Generic and specific characters. Skull comparatively short with a high helmet-like crest formed by nasals, prefrontals and frontals. Nasals not separated in front by premaxillaries. Beak narrow, expanded part in front of nares elongate. Narial opening small. Vertebral formula C. 15, D.19, S. 8, Cls. 61+. Dorsal spines of medium height. Anterior caudal spines high. Chevrons long. Scapula long, blade of medium width. Radius considerably longer than humerus. Metacarpals comparatively short. Ilium decurved anteriorly. Ischium long with foot-like terminal expansion. Pubis with anterior blade short and broadly expanded at end. Femur longer than tibia. Phalanges of pes short. Integument over sides and tail composed of polygonal tuberculate scales without pattern but graded in size in different parts of the body; belly with longitudinal rows of large conical limpet-like scales separated by uniformly large polygonal tubercles.

This definition compared with that of *Hypacrosaurus* (Bull. Amer. Mus. Nat. Hist., Vol. XXXII, Art. XX, p. 396, 1913) shows a general similarity of structure. The two genera are closely related, and *Corythosaurus* may have been the ancestor of *Hypacrosaurus*. They are distinguished at present by the development of the vertebræ and differences of proportion in the fore and the hind limbs. *Hypacrosaurus* is typically an Edmonton genus. It has also been reported from the Two Medicine Formation of Montana, strata that are determined as of Judith River (Belly River) age (Gilmore, Smithsonian Miscellaneous Collections, Vol. LXIII, No. 3, Publication 2262, p. 10, 1914), but which I believe may be of Edmonton age.

Skeleton.

The skull of *Corythosaurus casuarius* has already been described (loc. cit.).

The vertebral column is composed of 103 consecutive vertebræ and several are missing from the end of the tail, possibly twenty. It is divided as follows: cervicals 15, dorsals 19, sacrals 8, caudals 61+. In front of the

caudals the matrix and integument obscure the centra so that it is impossible to give a detailed description of the vertebræ in this part of the body. The presacral vertebræ are apparently developed as in *Trachodon* and *Saurolophus*, with normal centra and spines, whereas in *Hypacrosaurus* the centra of the dorsals are reduced and the spines are extremely high and massive.

The ribs appear to be more slender than those of *Trachodon* or *Saurolophus*. Each presacral vertebra carries a rib, those on the last dorsals very small and delicate. The longest is the seventh dorsal and they decrease in length anteriorly and posteriorly from this point.

The spines of the anterior caudals are high and broad antero-posteriorly while the chevrons are extremely long, the first chevron being between the fifth and sixth caudals. Fifteen of the anterior caudals bear transverse processes.

The greater part of the fore-limb has been painted in from No. 5338, which has been worked out on one side only so that a detailed description must be deferred till this specimen is available. As a whole the fore-limb agrees with that of *Hypacrosaurus* in the greatly lengthened forearm as compared with *Trachodon*. The blade of the scapula is not so broad and is curved more than in *Hypacrosaurus*, and the radius is three inches longer than the humerus, whereas in *Hypacrosaurus* the radius is almost five inches longer than the humerus.

The pelvis resembles that of *Hypacrosaurus* with less deep but strongly decurved ilium; short pubis with broadly expanded blade and long post-pubis; ischium elongate and massive, terminating in an expanded foot-like end less massive than in *Hypacrosaurus*. The femur is considerably longer than the tibia and fibula, with the fourth trochanter low-down below the middle of the shaft. Pes with Mt. III not so markedly enlarged as in *Hypacrosaurus*. Phalanges short.

Tendons and Musculature.

The tendon bones in this specimen are unique, giving for the first time definite knowledge of their placement and furnishing a partial key to the musculature of unarmored predentate dinosaurs.

Tendon bones are present in the dorsal, sacral and caudal regions and do not extend below the transverse processes of the vertebræ. None are present in the cervical region.

Each tendon at its origin is flattened with fimbricated terminal points, the central rod is oval and at place of insertion tapers to a rounded point.

They are developed chiefly overlying the posterior dorsals, sacrals and anterior caudals, diminishing posteriorly and do not appear to have been present toward the distal end of the tail. They are disposed in two layers (Figs. 6–9), an outer and an inner series. In each series they are parallel one to another and both series are diagonal to the axis of the vertebral column.

Outer series. This series is best preserved and those tendons lying back of the sacrum can be traced accurately on both sides of the skeleton. Each tendon originates at the base of a spine, passes backward and upward across eleven spines and is attached to the anterior face of the twelfth spine at a point about two inches from the top.

Inner series. In this underlying series each tendon originates on the posterior outer face of the spine at a point two inches from the top, passes backward and downward apparently across seven spines and was attached at the base of the eighth. This series is not so well preserved as the outer one but is clearly demonstrated on the left side.

The tendon bones are clearly the calcified terminal parts of large deep-seated muscles that moved the vertebral segments in series. The contracted part of such muscles is well defined by these calcified sections but their origin was doubtless fleshy masses that extended in most cases beyond the part that has been preserved.

Another series of muscles is seen on the right side of the specimen (Fig. 10), where they are represented by raised parallel equidistant folds as large as the tendon bones but not calcified. They apparently originated on the ischium, cross the chevrons diagonally and are attached to the sides of the centra. This set is doubtless the *ischio-caudals.*

A fourth set of muscles, crossing the *ischio-caudals* at right angles (Fig. 10) is indicated just above the end of the ischium. These are fairly prominent at the border of the skin but rapidly become indistinct anteriorly. They are in the region of the cloaca and may represent the sphincter muscles.

In Trachodonts the footed ischia of the Saurolophinæ are developed much stronger than the rod-like ischia of the Trachodontinæ, comparatively greater than in the alligator, a comparison which leads to the conclusion that the tail was a more powerful organ in this subfamily, and I believe the crested Trachodonts were to a greater extent natatorial in habits.

In equally large carnivorous dinosaurs that habitually walked on the hind feet the tail is equally large but of different function, a balancing organ. In such forms the ischia are the least developed part of the pelvic bones.

In *Trachodon* the caudal tendons are arranged in two series similar to those of *Corythosaurus,* and the dorsal musculature was probably similar

in both genera, but it cannot be determined from the present specimen. In a *Trachodon* skeleton, No. 5058, the tendons of the dorsal region are shorter and more complex than those of the caudal section. Anterior to the middle of the sacrum there are three series of tendons; 1st an outer series, a continuation of those along the tail; 2nd an inner series, probably a continuation of the inner series along the tail; 3rd a deep-seated series lying next to the vertebræ and parallel to the outer series. In each of these dorsal series the broad fimbriated end of the tendon is uppermost.

Epidermis.

Where a considerable part of a connected skeleton of any member of the Trachodontidæ is found it is exceptional not to find all or a part of the skin impression surrounding the bones, a fact that shows that the carcasses were rapidly covered before they were decayed. Usually there is direct associated evidence of water, shells, etc., that indicates an aquatic habitat for this family.

In all members of the family the skin is tuberculate and the tubercles or scales are never imbricated or overlapping as in lizards. No bony dermal plates are present.

In each genus the pattern of the skin is as characteristic as among modern reptiles, especially in the abdominal and pelvic regions, but species characters are not so clear. In two species of the genus *Trachodon*, *T. annectens* and *T. mirabilis*, the epidermis is alike so far as known.

In *Corythosaurus casuarius* the tubercles are rather uniformly large without differentiated pattern over the sides, back and tail. The abdomen, in the pelvic region, is characterized by rows of large raised oval limpet-like tubercles.

The preserved outline of the body in the type specimen shows that the neck was rather slender, somewhat deeper than wide; the body was narrow and deep; and the tail was extremely thin and deep back to the fifteenth caudal where the transverse processes disappear. Beyond this point the tail was a compressed oval in cross-section with the greatest diameter vertical and a slightly greater bulk is indicated on the lower side.

A median fold of skin extended along the back in the dorsal, sacral and caudal regions and presumably above the neck and skull. Over the anterior caudals and sacrals this fold rises five inches above the spines but in no place is it complete.

In the dorsal region rather sharp ridges or folds extended over the body at right angles to the vertebral column, shown in this specimen on the right side (Fig. 11), where the reverse impression of the left side is preserved.

This folded character of the skin is shown also in the mummy specimen of *Trachodon annectens,* American Museum Coll. No. 5060. In this specimen there are irregular ridges or folds extending from the vertebræ down across the body, especially in the shoulder region. These ridges appear to have been present in life as loose folds of skin similar to that of living iguanas.

Over the spines of the dorsals, sacrals and anterior caudals there are distinct vertical furrows which correspond to but are not in accord with the vertebral segments.

The epidermal markings over the entire body may be classified as of two kinds — polygonal tubercles and large conical tubercles.

Over the sides, back and tail the tubercles are rather uniformly large, although not so large as in *Trachodon,* polygonal in form and not differentiated in pattern. On the anterior dorsal region and on the inner side of the thigh overlying the fourth trochanter of the femur (Fig. 12) they are smaller than elsewhere. On the fleshy portion of the tail, back of the caudals that bear transverse processes, and on the median dorsal fold above the vertebræ the tubercles are uniform and slightly larger than those on other parts of the body.

The abdominal skin (Fig. 13) underlying the pelvis is characteristic of this genus. In this area the epidermis is marked by longitudinal rows of large raised limpet-like cones, four and one half centimeters in length and three centimeters in width. They extend in rows parallel to each other and the large conical tubercles are separated by uniformly large polygonal tubercles, in size and form similar to those covering the tail.

On the bottom of the hind feet (Fig. 14) there were distinct fleshy pads, apparently segmented as lobes under the metatarsals and at least the proximal phalanges. The palmar surface of these pads was covered by large low tubercles, in arrangement and form like those on the tail but apparently not raised above the surface of the epidermis.

Measurements of Corythosaurus casuarius.

	cm.
Length of vertebral column and skull, measured over top of spines from the mouth to the 61st caudal	935.
Height of centrum and spine of first caudal	47.5
Length of longest chevron (6th) from anterior end	38.5
Scapula, greatest length	89.
" " width	20.
Ilium, length	103.5
" height, anterior peduncle	20.5
Pubis, length of pubis and postpubis	100.
" greatest depth of anterior blade	27.

	cm.
Pubis, length of anterior blade from acetabulum to anterior end	49.
" narrowest depth of blade in front of peduncle	10.
Ischium, greatest length	103.
" length of terminal foot	22.
" least vertical diameter, middle of shaft	6.
Femur, greatest length	108.
" length of condyle anteroposteriorly	26.
" least diameter of shaft below distal end of 4th trochanter	13.
" position of 4th trochanter from central point to the top of femur	58.
Tibia, length of tibia and astragalus	100.
Fibula, length	95.
Pes Mt. II, length	31.
Mt. III, "	38.
Mt. IV, "	32.
Digit II, first phalanx	14.
" " second "	4.5
" " third "	8.5
Digit III, first phalanx	13.5
" " second "	4.
" " third "	2.5
" " fourth "	9.
Digit IV, first phalanx	11.
" " second "	2.5
" " third "	2.
" " fourth "	1.7
" " fifth "	9.5

EXPLANATIONS OF PLATES XIII–XXII.

PLATE XIII.

Fig. 1. Combined three-section photograph of *Corythosaurus casuarius* type, left side, about $\frac{1}{30}$ natural size. Skeleton mounted as found partly covered by skin impression. Missing parts of front limb and lower part of abdomen painted in.

Fig. 2. Outline drawing of the bones of the skeleton, left side. About $\frac{1}{30}$ natural size.

PLATE XIV.

Fig. 3. Right side of specimen. Front limb and outline of abdomen painted in. Section of abdomen cut through showing reverse epidermal impression of left side. About $\frac{1}{30}$ natural size.

Fig. 4. Outline drawing of the bones of the skeleton, right side. About $\frac{1}{30}$ natural size.

PLATE XV.

Fig. 5. Detail photograph of anterior section of skeleton, left side.
Fig. 6. Detail photograph of mid-section of skeleton, left side.

PLATE XVI.

Fig. 8. Detail photograph from section of skeleton, right side.
Fig. 9. Detail photograph of anterior section of skeleton, right side.

PLATE XVII.

Fig. 7. Detail photograph of distal end of tail. A, left side; B, right side.
Fig. 10. Detail photograph of anterior section of tail, right side, showing ischio-caudal and cloacle sphincter muscles.

PLATE XVIII.

Fig. 11. Detail photograph of reverse impression of abdominal section of the left side.

PLATE XIX.

Fig. 12. Detail photograph of skin overlying fourth trochanter, inner side of left femur, shown on the right side.
Fig. 13. Detail photograph of rows of large conical plates and smaller intervening tubercles underlying ischium, right side of skeleton.

PLATE XX.

Fig. 14. Detail photograph of pads and skin of left foot, left side of skeleton.

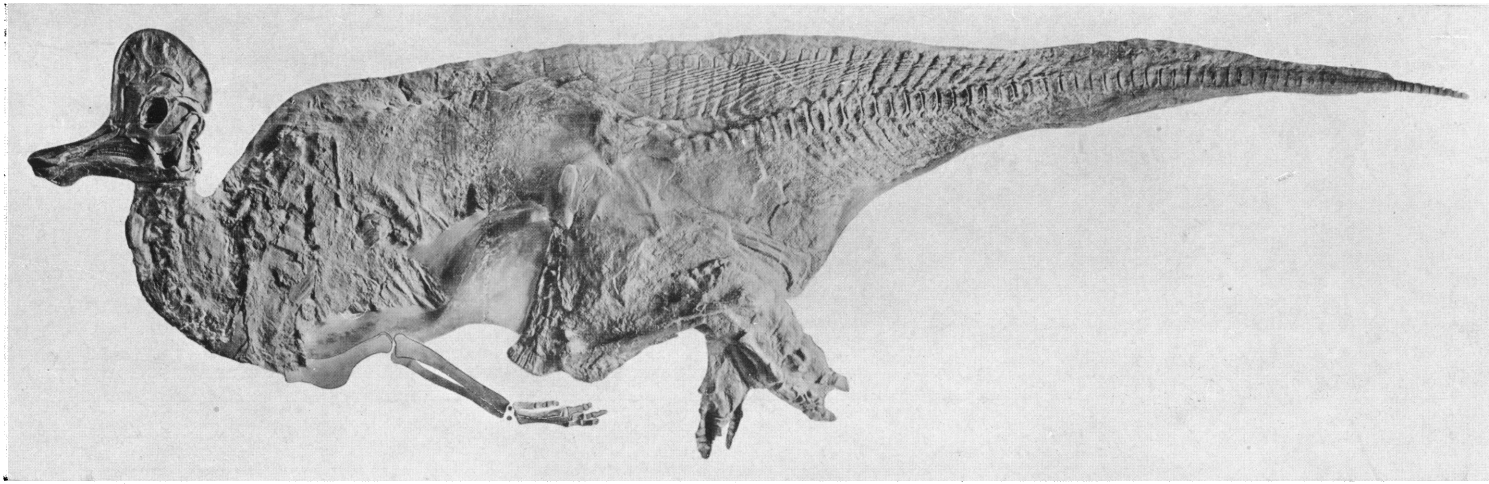
PLATE XXI.

Fig. 15. Restoration of *Corythosaurus casuarius*. Drawn by Richard Deckert.

PLATE XXII.

Fig. 16. Belly River marsh scene, showing typical foliage and Trachodonts. (1) *Corythosaurus*, (2) *Trachodon*, (3) *Kritosaurus*.

1



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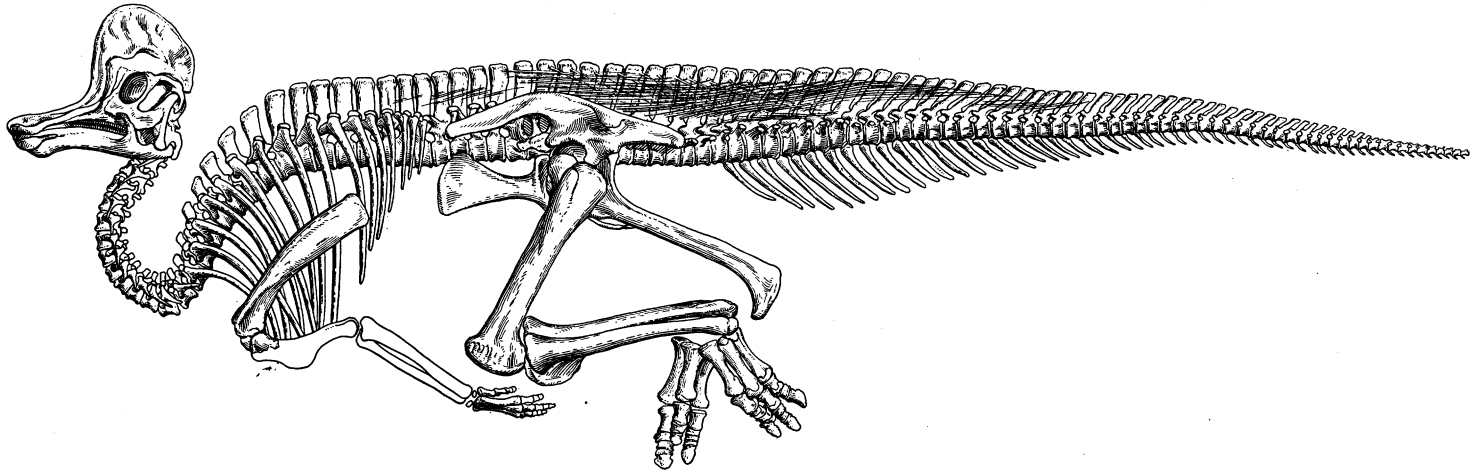

FIGS. 1 AND 2.—CORYTHOSAURUS CASUARIUS. Brown.

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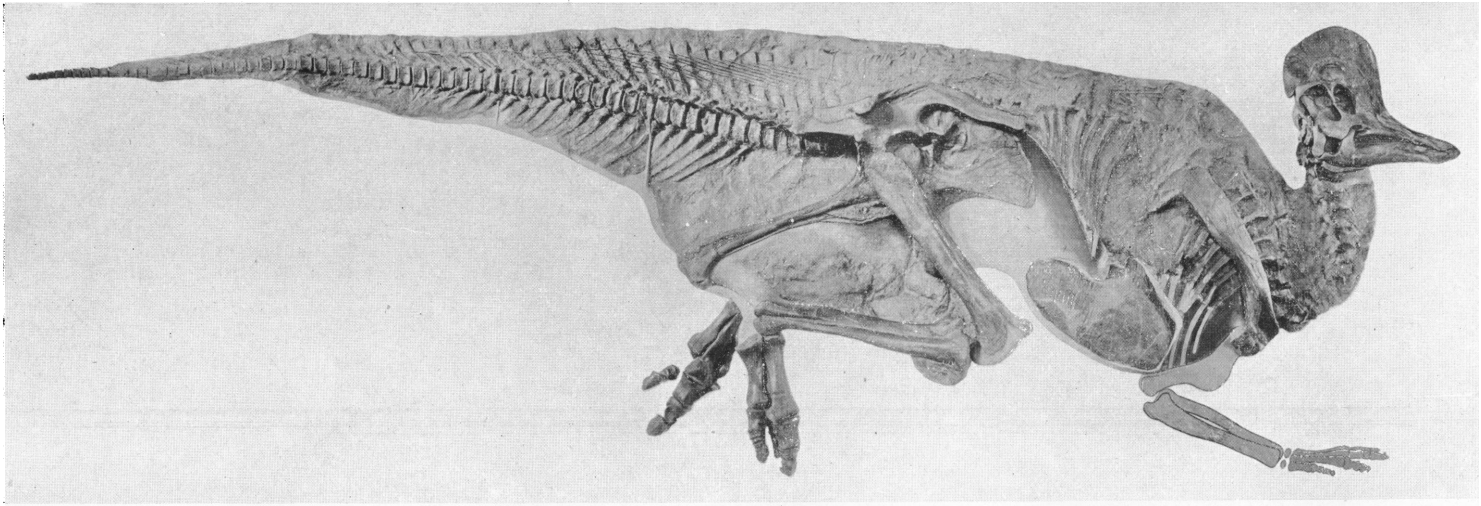

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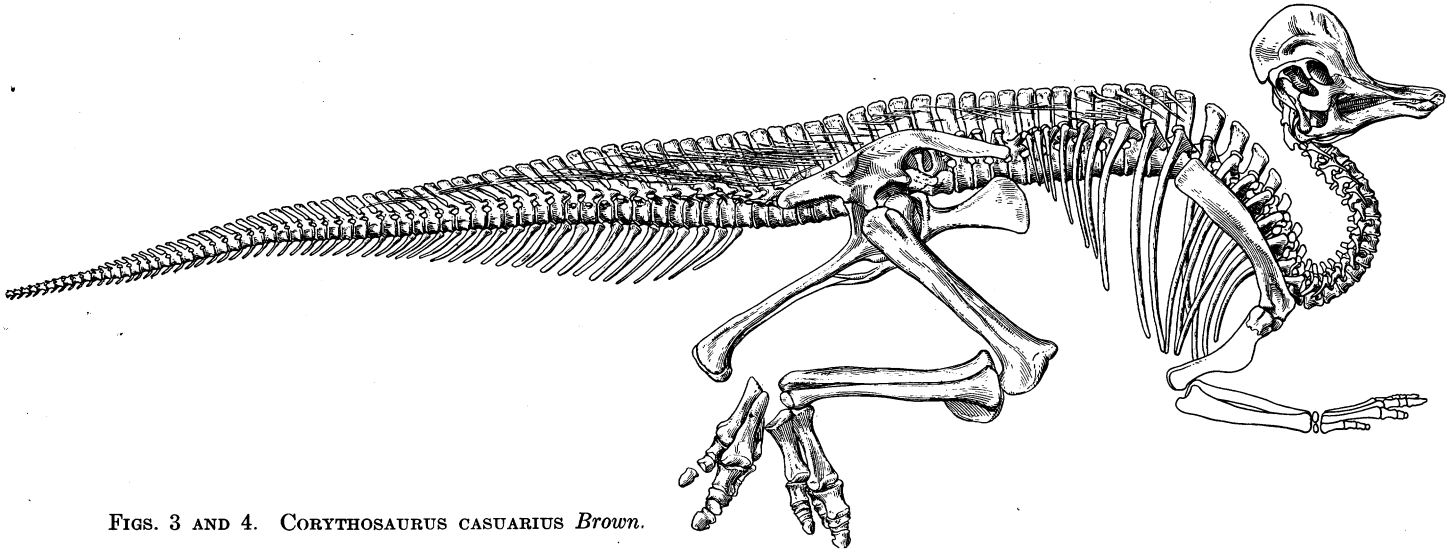
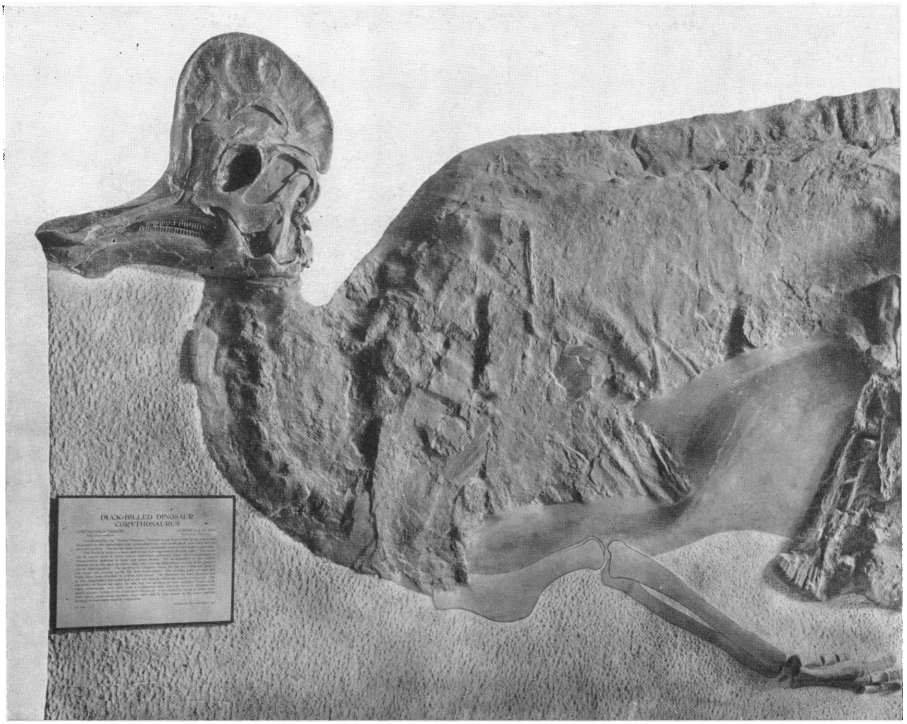


FIGS. 3 AND 4. CORYTHOSAURUS CASUARIUS *Brown*.



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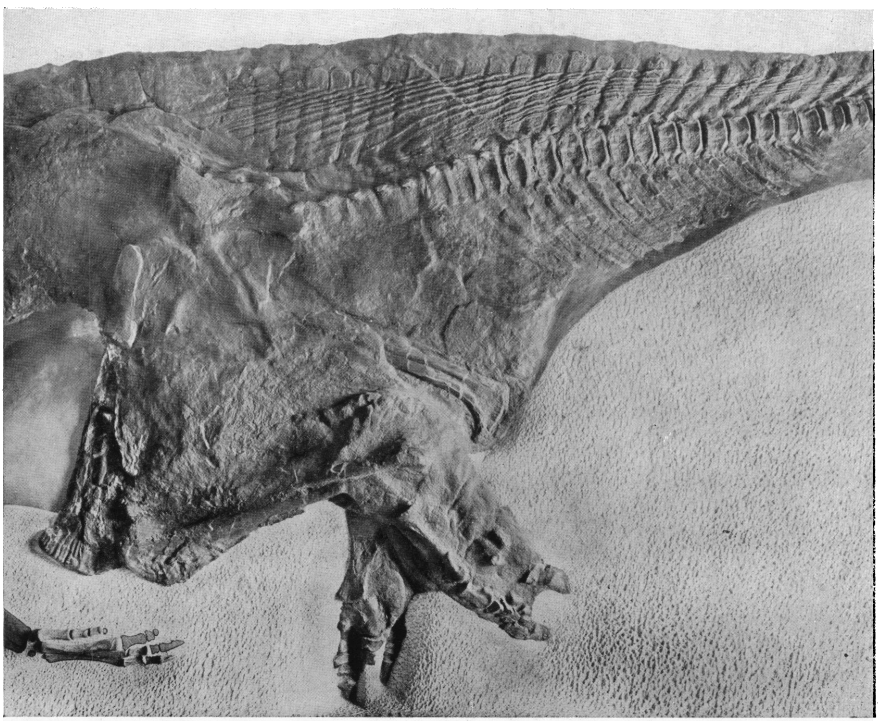

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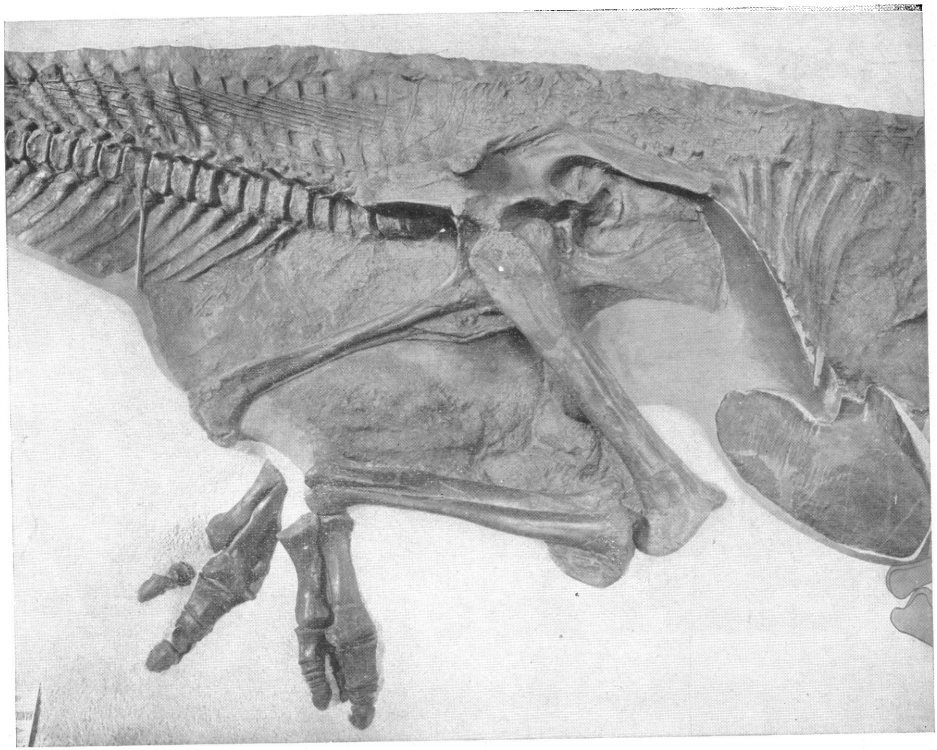
FIGS. 5 AND 6. CORYTHOSAURUS CASUARIUS *Brown*.



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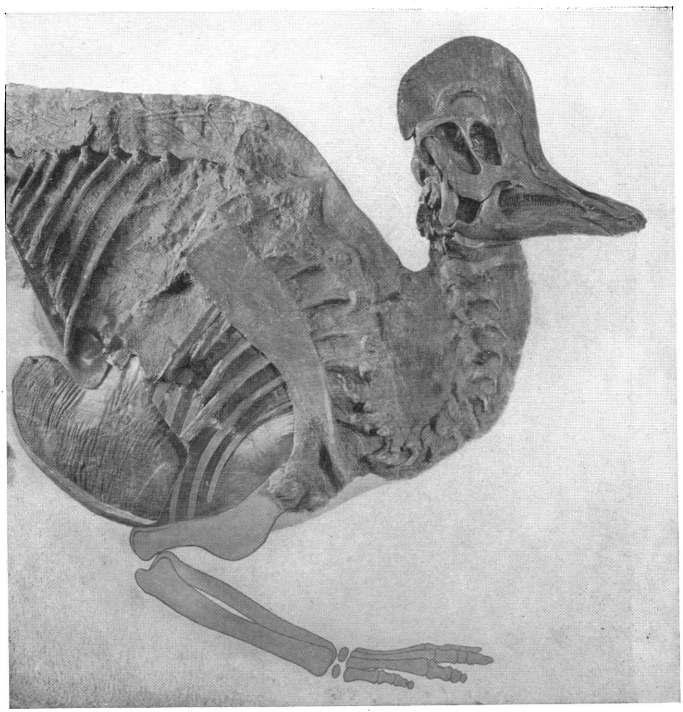

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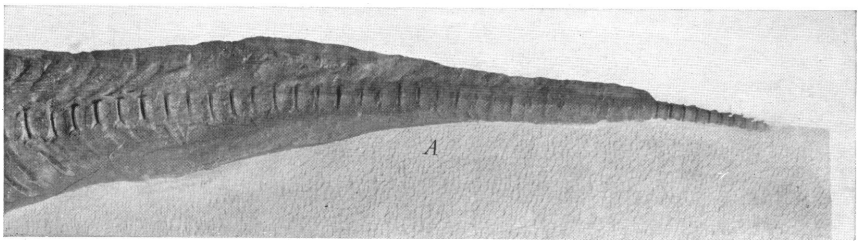
FIGS. 8 AND 9. CORYTHOSAURUS CASUARIUS *Brown.*



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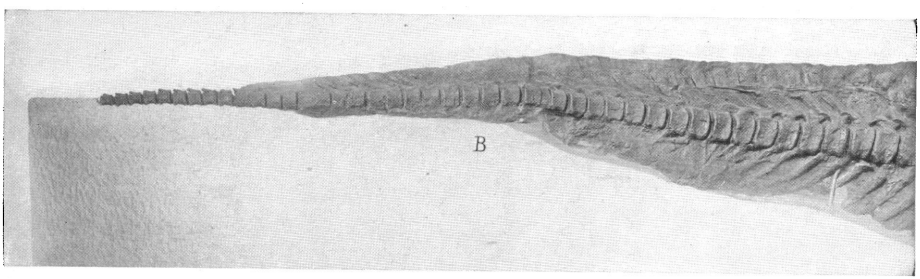

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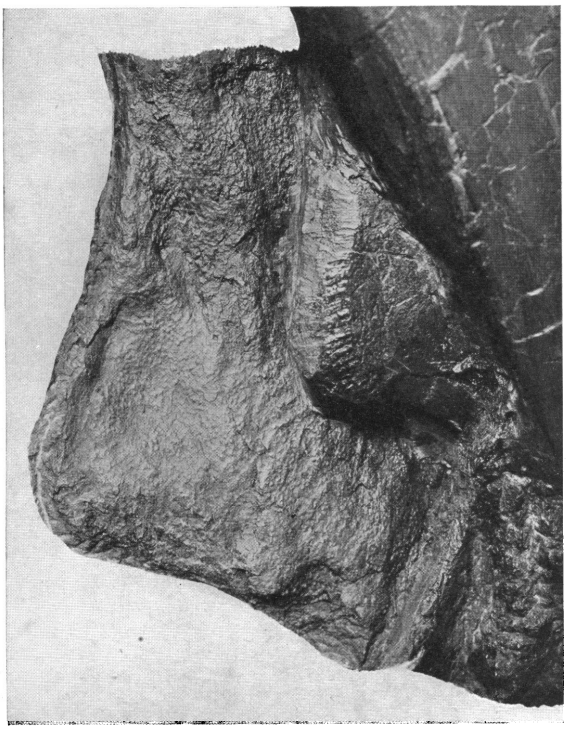
FIGS. 7 AND 10. CORYTHOSAURUS CASUARIUS *Brown*.

FIG. 11. CORYTHOSAURUS CASUARIUS *Brown*.



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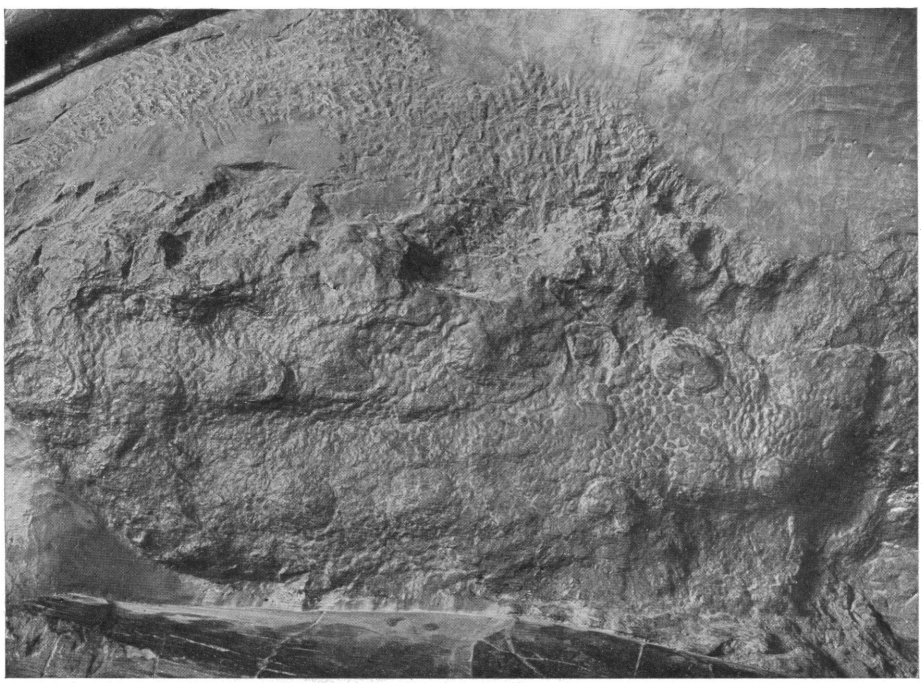

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FIGS. 12 AND 13. CORYTHOSAURUS CASUARIUS *Brown*.

FIG. 14. CORYTHOSAURUS CASUARIUS *Brown*.

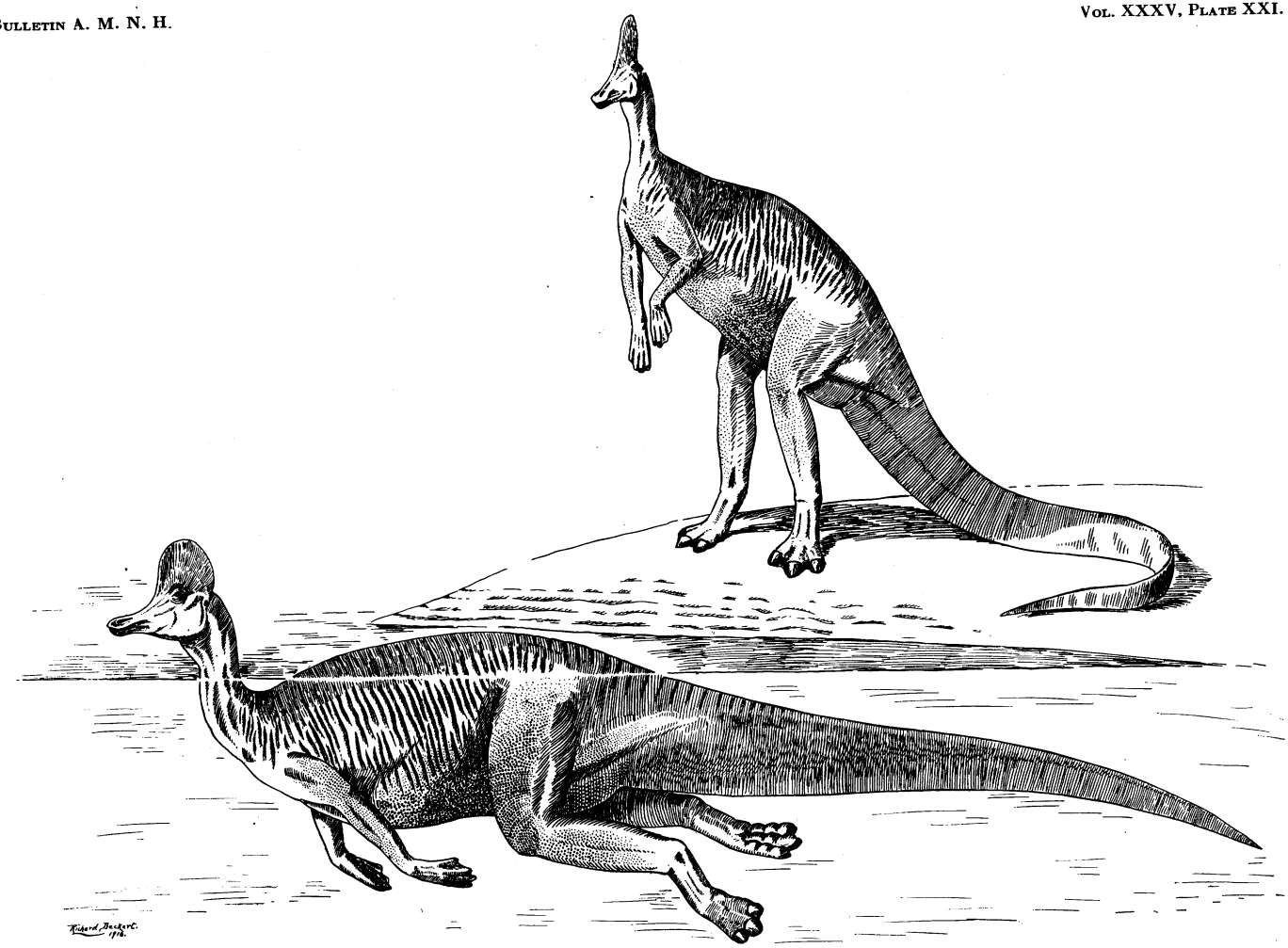
Richard Bickart
1918.

FIG. 16. RESTORATION OF CORYTHOSAURUS CASUARIUS *Brown*.