NORTH AMERICAN PLESIOSAURS
TRINACROMERUM

S. W. WILLISTON
The University of Chicago

In previous papers[1] I have discussed the known characters of *Elasmosaurus*, *Cimoliasaurus*, *Brachauchenius* and *Polycotylus*, and *Trinacromerum*, as derived from the species *T.* (*Dolichorhynchops*) *osborni.* The brief and somewhat erroneous description of the type of *Trinacromerum* by its author has hitherto prevented its recognition with much certainty. Its relationships with *Dolichorhynchops* I recognized at the time that I proposed that genus, and suggested the possible identity, but it was not until I had the opportunity of examining the type specimen of *Trinacromerum*, which was kindly granted by the president of Colorado College, where the specimen is now preserved, that I became assured of the synonymy, an acknowledgment of which was made in the third volume of Chamberlin and Salisbury's *Geology*, and, later, in the second of the papers cited below. Furthermore, I am now nearly as well assured of the synonymy of *Trinacromerum* with *Polycotylus*, but am yet hesitant to abandon the name *Trinacromerum* until the skull of the type species of *Polycotylus*, (*P. latipennis* Cope) shall be better known and have been more thoroughly studied. The only differences that I can so far discover are the deeper concavity of the vertebral centra, the number of epipodials and the manner of attachment of chevrons—of doubtful value. The name *Trinacromerum*, therefore, is used provisionally until such time as more positive evidence is forthcoming.

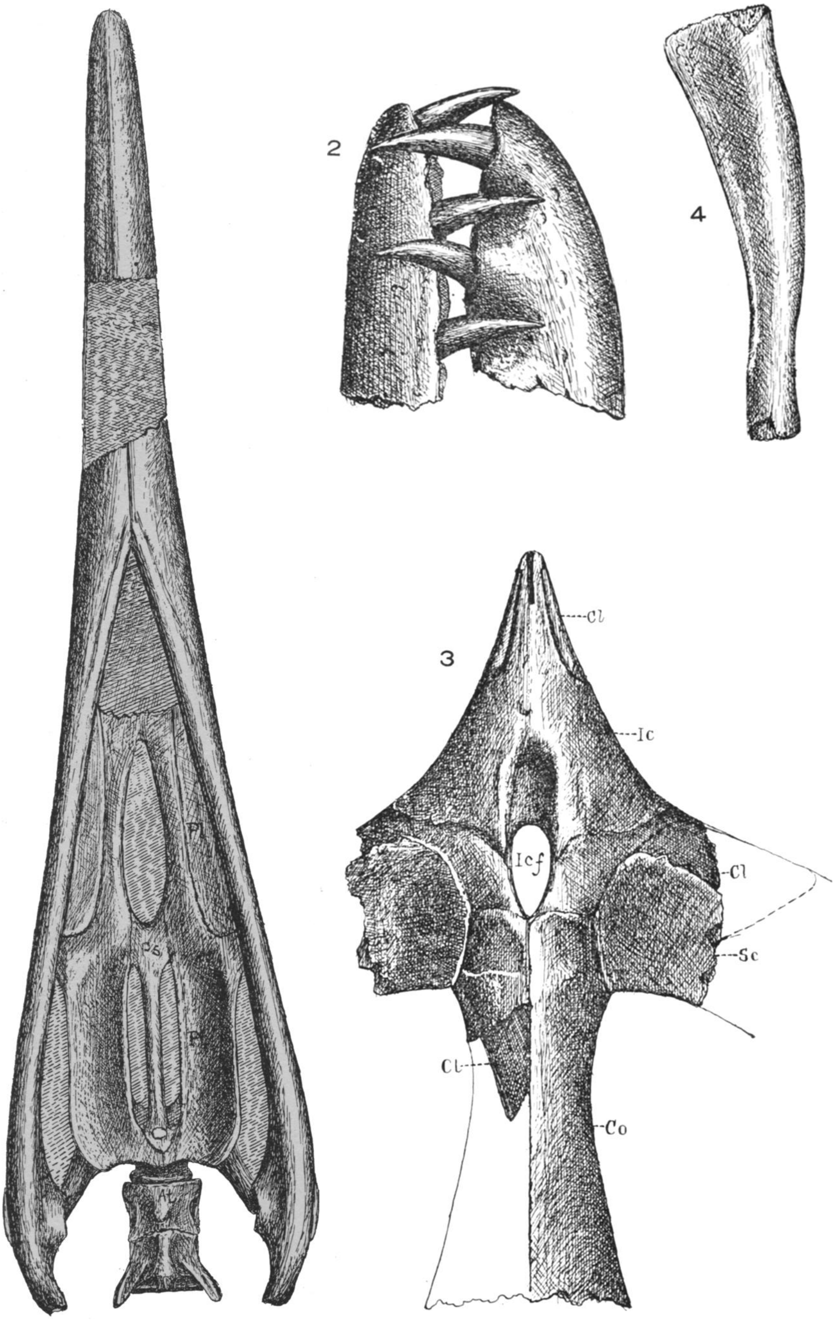
Very recently, through the courtesy of Professor Sclater, I have had the opportunity of further study of certain important parts of the type specimen of *Trinacromerum bentonianum*, kindly sent me for that purpose. I am thus enabled to give a number of figures and a more complete description of this important species.

[1] *Publication No. 73* of the Field Columbian Museum, 1903; *American Journal of Science*, XXI, 221, 1906; *Proc. U. S. Nat. Mus.*, XXXII, 477, 1907.

Trinacromerum bentonianum Cragin

Skull.—In his original description Cragin speaks of three skulls referred by him to his typical species. One of his skulls, however, proves to be a part of the pectoral girdle of his original type, an error resulting from the confusion of the interclavicular foramen with the pineal foramen, an error not so great as it would seem, since such a foramen in the pectoral girdle was unknown previously among plesiosaurs. A close comparison of the two skulls, both from the same horizon and adjacent localities, leaves no doubt of their identity, both generically and specifically. Skull "No. 2," the better specimen, shows the underside nearly complete, with the hyoids and jaws in place, a small part of the facial portion only, wanting. The upper part of the skull is so badly compressed and mutilated that but little decisive can be made out from it, but the palatal structure, perhaps the most important of the plesiosaur cranial anatomy, has been determined from this specimen almost perfectly, the relations of the vomers only being doubtful (figs. 1, 2).

The slender parasphenoid separates two long and narrow openings between the pterygoids, which openings may properly be called the parasphenoidal vacuities for the present. On either side, the long, broad, gently concave plate of the pterygoid fills up nearly all the free space between the vacuity and the mandible, and thence extends forward as a slender process on either side of the real interpterygoidal vacuity to articulate externally with the palatine, and anteriorly, doubtless as in *T. osborni*, with the vomer. The true interpterygoidal vacuity is an elongated ovate opening, obtuse posteriorly, acute in front, bounded by thickened, rounded margins; posteriorly it is bordered by the slightly expanded anterior end of the parasphenoid, which is here concave in outline and thick, the pterygoid suture extending forward on each side from the front end of each parasphenoidal vacuity. In the type specimen of *T. osborni* the anterior end of this bone was somewhat mutilated, and I was not quite certain that it was not produced forward to fill up this vacuity as in other known plesiosaurs. This, however, is not the case. This extraordinary opening is therefore unique for this genus and *Polycotylus* among plesiosaurs, and indeed among all known reptiles, if it be merely a vacuity. And I venture the opinion that it may be compared with a similar opening



FIGS. 1–4.—*Trinacromerum bentonianum* Cragin. 1, skull from below, one-sixth natural size; 2, extremity of beak, one-half natural size; 3, pectoral girdle in part one-sixth natural size; 4, left hyoid from below. At, atlas; Cl, clavicle, Co, coracoid; Ic, interclavicle; Icf, interclavicular foramen; Pl, palatine; Ps, parasphenoid; Pt, pterygoid; Sc, scapula.

in the skull of *Nyctosaurus* and *Pteranodon*, the American Cretaceous pterodactyls. This would suggest that the supposed elongated basisphenoid of *Nyctosaurus* is really the parasphenoid, against which view we have the improbability of the survival of so large a parasphenoid in this type of reptiles, as well as the mode of attachment of the pterygoids on either side.

The junction of the transpalatine is seen in the specimen on the left side, but the shape and relations of the bone are obscured by the mandible, though certainly there is no posterior palatine foramen; doubtless the relations of the bone are quite as I have figured them in *T. osborni*.

The relations of the pterygoids posteriorly cannot certainly be made

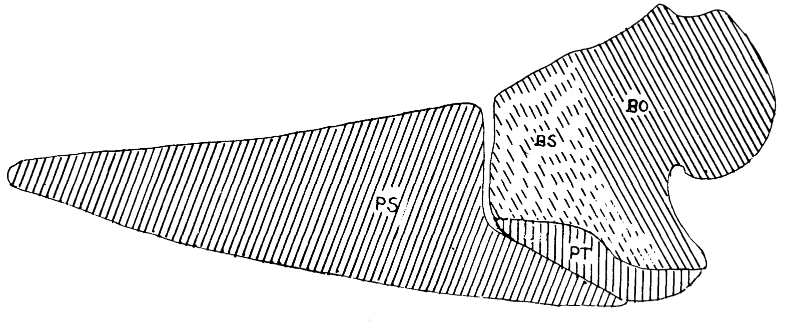


FIG. 5.—*T. bentonianum*. Section through basioccipital and parasphenoid, one-half natural size. BO basioccipital; BS, basisphenoid; PS, parasphenoid; PT, pterygoid.

out in skull "No. 2" nor were they in the type of *T. osborni*. Very fortunately, however, the posterior part of skull "No. 1," the type specimen of the genus, gives nearly all the information that could be desired. In this specimen there is a longitudinal break or split through the occipital condyle, nearly in the middle line, to the interpterygoidal vacuity. I give this section in fig. 5. The distinction between the basioccipital and basisphenoid is not clear, but it must be as in *T. osborni* or nearly so, as has been indicated by the broken lines of the figure. In front of the basisphenoid the conical and thickened parasphenoid, or "presphenoid" narrows into a median, long, and vertically broad bone to the hind end of the interpterygoidal vacuity, which it bounds. Posteriorly it extends, by a squamous underlap, nearly to the hind margin of the basioccipital, the united pterygoids clearly intercalated between them. Between the pterygoids and parasphenoid, and hollowed from the latter there appear to be two parallel canals, terminating on the free surface below. Along the middle of the rounded under surface of the parasphenoid there is seen a slender groove, as though the remains of a suture, a remarkable thing if it be really a suture. The parasphenoidal vacuities are bounded outwardly by the everted margins of the pterygoids, internally by the parasphenoid. The openings, however, do not quite reach to the hind end of the external boundaries, the pterygoids forming a floor to the grooves on the posterior fourth, as seen from below. So extraordinary a development of the parasphenoid in this group of reptiles as is shown in these specimens is of more than passing interest. If it be the true vomer of the mammals, one cannot understand the cause of its retention in so highly developed a condition unless the plesiosaurs sprang from reptiles that had not yet lost it. The Nothosauria are markedly different in the complete union of the pterygoids on the median line, to the exclusion, not only of the parasphenoid but the basisphenoid also; a condition, which, associated with the typical reptilian phalangeal formula, excludes the group I believe absolutely from direct and perhaps indirect genetic relationships with the plesiosaurs. Furthermore, the persistent retention of the parasphenoidal vacuities, so definitely bounded in all plesiosaurs, is puzzling, unless the explanation is that suggested by me in my earlier paper—that they are the real nareal openings.

The crushed condition of the upper part of the skull is such that little definite can be made out, though the resemblance to the same parts in *T. osborni* is evident. On the left side the jugal arch has been but little disturbed, showing the jugo-postorbito-squamosal sutures as in *T. osborni*. There is no indication whatever, and the parts are here intact, of a quadratojugal bone, the supposed suture of *T. osborni* being in no wise apparent. I believe that at last it may be definitely said that the quadratojugal bone is *absent in all plesiosaurs*, as a distinct element.

Unfortunately the jumbled condition of the frontal and prefrontal elements in these skulls has obliterated all sutures. An examination, however, of the various plesiosaur skulls in the British Museum and at Cambridge, confirms me, in the determination of the elements in *Brachauchenius* and *Trinacromerum*. That this was not the frontal structure in all plesiosaurs is also quite certain. As I have stated before, the suture between the frontal bone and the element directly in front of it had never been positively determined. A suture has been given for the skull of *Plesiosaurus macrocephalus*, nearly transverse in position and immediately in front of the pineal opening, but this is incorrect. However, an isolated specimen of the frontal region of a species of *Plesiosaurus* in the British Museum, for the privilege of examining which I am indebted to Dr. Woodward, shows clearly a fronto-parietal suture, beginning some distance in front of the pineal opening, in the middle line, and extending obliquely outward and forward, clearly distinguishing a median frontal bone; and the one at either side of this true frontal is as clearly the prefrontal. In the later plesiosaurs, or some of them, I believe that the prolongation of this parietal projection forward to the backwardly produced premaxilla has separated the real frontals; and this interpretation is confirmed by the examination of the bones of this region in *T. anonymum* described farther on.

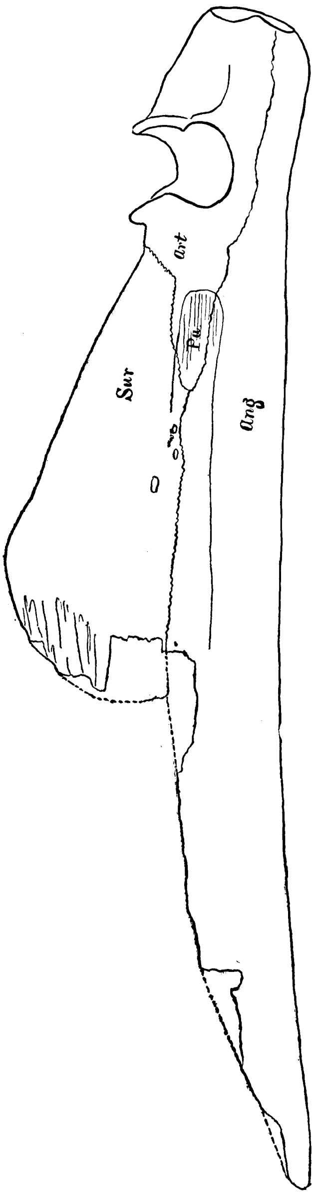


FIG. 6.—*Polycotylus latipinnis* Cope. Posterior part of right mandible, two-sevenths natural size. Art, articular; Ang, angular; Pa, prearticular; Sur, surangular.

Mandible.—The structure of the mandible is, for the first time, completely made out in a specimen (No. 1125) in the Yale Museum. Although the specimen belongs to the closely allied, possibly identical genus *Polycotylus*, it may be described here. The suture between the articular and surangular, never before determined, is here clearly shown, running obliquely downward and forward from just in front of the cotylus to connect with the angular-surangular suture beneath the proximal end of the prearticular (fig. 6). In the earlier of the cited papers I recognized the differentiation of this element in front of the articular, clearly homologous with the 'splenial' of the turtles, and gave to it the name prearticular. Baur, who had previously recognized this new element in the reptilian mandible unfortunately took for the type of structure that of the turtles, and changed the names of the other elements to conform thereto, giving to the splenial, as the name was originally applied, the name presplenial. This confusion was pointed out in a later publication by me, but without mentioning the fact that I had previously proposed the term prearticular for the newly discovered element.[1] Kingsley later, in reviewing the mandibular structure proposed for the same element the term dermarticular. In this separation of the prearticular from the articular the plesiosaurs show certain relationships with the turtles, but not important ones, since a like condition will probably be found in most of the early reptiles. The great elongation of the coronary, and its union in a median symphysis is the most striking characteristic of the plesiosaur mandible.

Hyoids.—Under each skull are preserved in perfect condition, and in undisturbed positions the hyoids. They lie below the concave lateral pterygoid plates, the anterior end reaching nearly as far forward as the hind end of the interpterygoidal opening. The bones of skull No. 2 (fig. 4) are a little less slender than those of skull No. 1. The posterior end is rounded, rod-like, and the mesial border is the thinner and more concave one. The hyoids have hitherto been unknown, so far as I am aware, in the plesiosaurs.

Vertebrae.—The atlas and axis are united with each other and with the occipital condyle in the type specimen. They resemble very closely the same bones in *T. osborni*. The axial rib is firmly attached.

[1] *Field Mus. Publ.*, No. 73, p. 30.

On the underside of the atlantal intercentrum, beyond the middle antero-posteriorly, there is an obtuse hypopophysis with the sides concave. The axial intercentrum has an obtuse keel, thicker posteriorly; this bone, also, is proportionally a little longer than in *T. osborni*. Ten or twelve other cervical vertebrae are preserved, but are, for the most part, without processes. They all have a conspicuously large vascular foramen on each side of a prominent ridge. A pair of smaller foramina for the centrum veins is seen in the floor of the neural canal. The ribs are single-headed, their sutures well indicated,

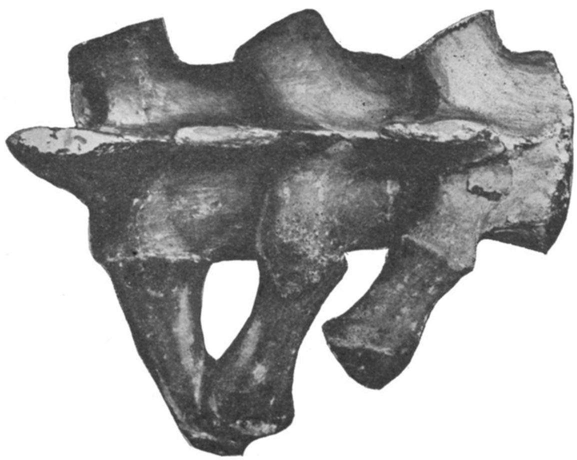


FIG. 7.— *T. bentonianum*. Sacrum, from above, one-fourth natural size.

though they, as also the neural arches, are firmly attached to the centrum.

Length of atlanto-axis	80 mm
Diameter of axis posteriorly	54
Lengths of vertebrae, as preserved	37, 37, 48, 50, 50, 50, 50
Transverse diameters of same	53, 75, 75, 75, 83, 86

There are fifteen dorsal vertebrae preserved in the type specimen, none of which is complete, though the preserved parts indicate well their structure. Two united anterior thoracic vertebrae have each a length of 63^{mm} and a width of 85^{mm}. The transverse processes, arising low down, are stout, and the zygapophyses are large and stout. The underside of the centrum is gently concave, and has the usual two vascular foramina, but they are small, and the ridge between them is obsolete. Posteriorly the centra become more nearly circular in outline, and the articular surfaces are nearly flat, the under border also nearly straight. The transverse processes here are more slender and are directed more obliquely upward. The zygapophyses are smaller and weaker.

Lengths	63, 63, 66, 70, 72, 72, 72, 72
Widths	85, 85, 97, 97, 97, 97, 97, 97
Heights of centra	86, 86, ? 97, 97, 97

Sacrum.—The structure of the sacrum is so well shown in the figures (figs. 7, 8) that a detailed description is unnecessary. The specimen is of especial interest as for the first time giving a complete knowledge of this part of the vertebral column in the plesiosaurs. Three vertebrae, it is seen, take part in the structure of the sacrum. A fourth in front, probably, as in *Pantosaurus*, has its sacral rib arising from the centrum in part and participating in the support of the ilium, but if so it was not preserved with the remainder of this skeleton. The two posterior vertebrae are co-ossified, the front one not. The anterior sacral rib was connected with the ilium by ligamentous union, a rugosity for which is usually observed at a little distance from the extremity of the ilium.

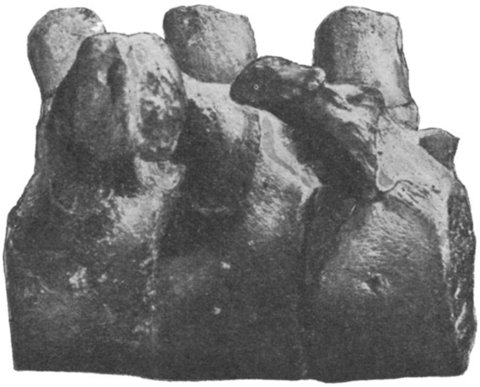


FIG. 8.—T. *bentonianum*. Sacrum from right side, one-fourth natural size.

The opinion has been expressed at various times that the plesiosaurs are related to the turtles because of the position of the ilia, directed as they are downward and forward. But I see no necessity for such an explanation of the resemblances here. The hind limbs in the turtles, as in the plesiosaurs, are used chiefly as propelling organs. The strain upon the ilium at the acetabulum would be antero-posterior, inclining the ilium forward. While the union with ilium was a strong one, as is shown by the large size of the sacral ribs, it was clearly a yielding, ligamentous one.

Pectoral girdle (Fig. 3).—The pectoral girdle lacks most of the scapulae, save their clavicular ends, the outer angles of the clavicles, and a portion of the coracoids. Otherwise it is in a remarkably undistorted and natural condition.

Scapula.—In the type specimen the extremity of the ventral process is preserved in relation with the clavicles and interclavicle. It is a flat, thin plate, underlapping the clavicle, meeting suturally the clavo-coracoid process for a short distance, with its distal mesial border slightly thickened, angularly, for cartilage. The outer part of the plate is missing on both sides; it doubtless covered the clavicle to the free border.

Interclavicle.—The interclavicle is a large, triangular bone, with a deep posterior emargination, and is strongly convex on its lower surface from side to side. As seen from below, there is an elongate process, with a small, narrow, slit-like emargination in the middle in front. The visible border widens gradually for a considerable distance, and then turns outward sinuously to the hind angle. The real border is underlapped in front by the clavicles, as is indicated by the interclavicle of *T. anonymum* (*Field Mus. Publ.*, No. 73, p. 44, f. 9), continuing in front of the anterior end of the clavicles as a seeming continuation of their borders. The posterior border is thin and squamous, directed outwardly nearly transversely on each side of the interclavicular foramen. It sends a pointed process back on each side a third of the distance of the foramen, apparently, though scarcely forming a part of the border of that opening. In the middle there is a deep emargination forming a fossa continuing the foramen anteriorly, its roof filled in by a thin bone suturally underlapping the interclavicle.

Clavicles.—The clavicles are elongate, triangular bones, in position and shape resembling those of *T. osborni*. The outer angle of each is lost in the specimen. On either side of the interclavicle they are visible in front. The posterior outer border is also concave, beginning in the angular depression lodged in the depression of the underside of the clavo-coracoid processes. Just in front of these processes is the large interclavicular foramen, ovate in shape, rounded in front and acute behind. The front border of the foramen is evidently formed by the clavicles, but no median suture is visible.

Coracoids.—The right coracoid has the proximal part of the scapula in position. The two coracoids formed a deep trough, with the anterior processes directed somewhat ventrad. The intergelenoid bar is very much thickened, with a deep concavity transversely above. The left bone shows, on the posterior side near the thickening, the margin of a foramen, as has been observed in species of *Polycotylus* and in *T. osborni*. It may be the real coracoid foramen. The glenoid fossa looks directly outward in the articulated position. The clavo-coracoid processes are elongate and flattened, the thickened inner border beveled obliquely for symphysial union. The sutural surface for the interclavicle extends on the visceral surface about two-fifths of the distance to the base of the process. The anterior ends are slightly thickened for cartilaginous attachment.

The united bones of the girdle are, as stated, in this specimen quite normal in position and shape, and, so far as they are preserved are in the relations of life. The under margin of the interclavicle turns upward at an angle of about ten degrees from the plane of the coracoids, and the girdle is very convex transversely on the under side. A much wider knowledge of the structure of the pectoral girdle in the older reptiles since the publication of my first paper convinces me of the correctness of the determination of the elements. The clavicles and interclavicle are assuredly the same elements, and not unlike those of the older reptiles. The ventral process is, furthermore, I am confident, not the united procoracoid, but merely a prolongation of the scapula, corresponding to the 'acromion' of such reptiles as *Dicynodon*, etc. What has become of the procoracoid we cannot positively say, but I believe that, as Seeley has suggested, it is represented by the portion of the coracoid in front of the foramina described. If this supposition be true, the immense size of the coracoid is chiefly due to the development of the procoracoid. And it is not unreasonable to suppose that such a development might have occurred; the two bones always meet normally in the middle, and do yet in the Monotremata, and the same propelling function of the fore limbs would tend to develop strongly these parts, as it has the pubes of the pelvic girdle. Furthermore, in the Elasmosauridae, the posterior parts of the coracoids are broadly separated, their early, normal condition. The interclavicular foramen is a relatively late development, reaching its highest extreme in this genus and *Polycotylus*. Such a foramen, imperfectly understood, occurs in *Muraenosaurus*, and in a species described by me from the lower Cretaceous of Kansas provisionally, but incorrectly referred to *Plesiosaurus*.[1] What its function was it is difficult to say, if it had any, and its well-formed and thickened borders suggest that it did have some function.

Length of interclavicle	224 mm
Expanse of interclavicle	166
Width of foramen	33
Length of foramen	90
Length of clavicles	410

Pelvis.—The pelvis, though incomplete, has no distortion or malformation. The larger part of each ischium is present, the two united in the median line, and the left one has the ilium attached. The right ilium is quite perfect. Its upper extremity is flattened from within outward, and has a roughened surface on the inner side near the end for ligamentous attachment to the first of the sacral ribs. Below, the shaft is thicker, at its middle forming nearly a circle in cross-section. The lower extremity is thickened, club-shaped, with a large, flat, articular surface, broadly oval in shape, the anterior broad part looking more directly downward for the acetabulum; the posterior, more obliquely placed, smaller and subtriangular in shape, for articulation with the ischium. The anterior border of the bone is concave, with a slight convexity above, and a strong convexity at the lower end. The posterior border is convex except at the lower part, where there is a concavity.

Length of ilium	323 mm
Diameters of shaft at middle	37, 53
Greatest diameter of lower extremity	82
Antero-posterior diameter of lower extremity	100

Ischia.—The ischia are shaped very much as in *T. osborni*, that is, elongate and narrow, a characteristic of the group. Both ischia are present, attached to each other, and, as already stated, to the pubes.

[1] *Loc. cit.*, p. 44, Fig. 11.

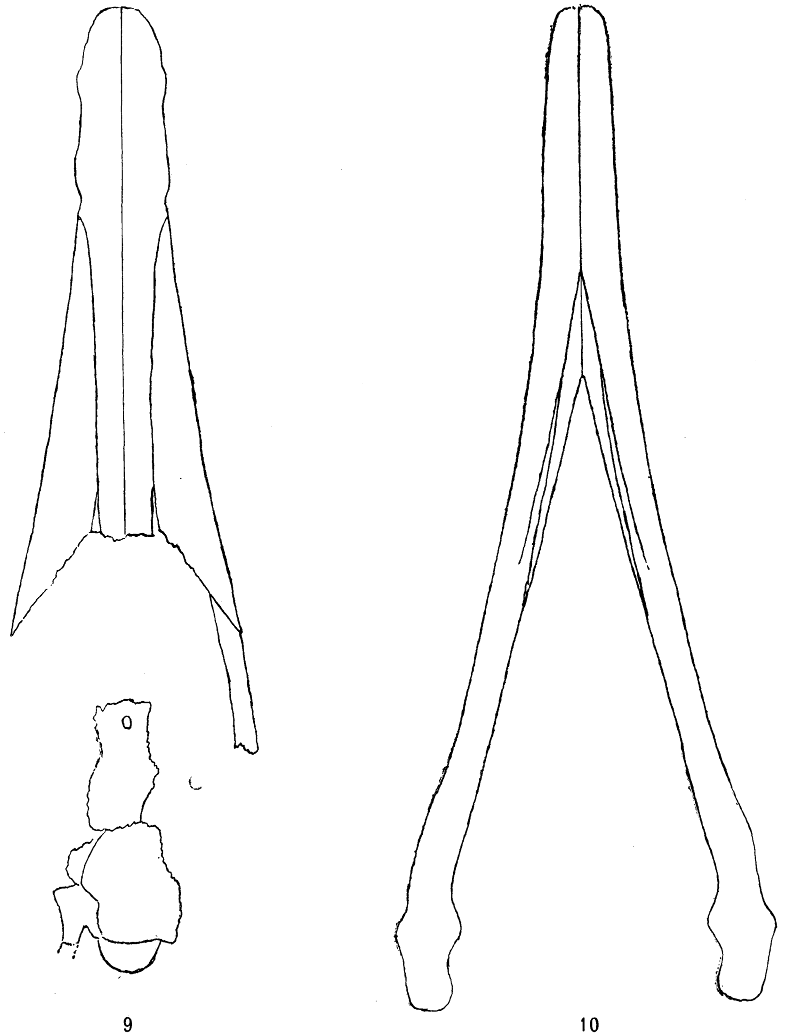
The left ischium also is united with its ilium. The bones are somewhat concave longitudinally above, and considerably so from side to side. The blade is thin. In front view, when articulated, the interacetabular thickening lies nearly horizontal, with the acetabular thickening lying above the transverse plate so that the acetabulum looks upward and outward. Back of the thickening, the downward curvature of the thinned part leaves an obtuse keel in the middle.

Pubes.—The pubes are incomplete, but their outline cannot differ materially from that of *T. osborni.* The right pubis is firmly attached to the ischium in its natural position. The sutural border is but little more than half the length of the acetabular border; thence to the symphysial angle the curve is smoothly and deeply concave, the immediate border for the most part somewhat thinned, though the bone is thickened a little in front of it. The external border, thinner, is not evenly concave as in *T. osborni*, but is sinuous, with a convexity in the middle of the concavity. The anterior external angle is somewhat thickened and rounded. Of the thin anterior border a part has been lost. The symphysial border is squarely truncated, showing a horizontal union. The upper surface of the bone is strongly concave, the external angle turned upward at about thirty degrees from the horizontal part. As is indicated in the pelvis of *T. osborni*, the whole bone turns downward distinctly from the plane of the ischium.

Width of pubes, from side to side, as articulated	682 mm
Antero-posterior extent of pubis, approximated	403
Width of neck of pubis	157
Length of symphysis	255
Length of ischium	600
Expanse of ischia	630

Paddles.—Parts of three paddles are preserved, one of them nearly complete, though, unfortunately there is no complete propodial among the material.

The proximal articular surface of the humerus forms nearly a hemisphere, the pitted cartilaginous surface limited sharply by a distinct rim. The tuberosity stands out prominently on the dorsal side, its top only has a distinctly limited cartilaginous surface connected with that of the head. The shaft below the head is somewhat oval. The distal extremity of one propodial has the epi-, meso-, and metapodials and the first row of the phalanges attached, except that the epipodial supernumeraries are absent. Another, similarly united proximal series of the smaller bones has the first epipodial supernumerary in place, and there is possibly a place for a second one,



9 10

FIG. 9.—*Trinacromerum anonymum* Williston. Outline of anterior part of skull, from above; a little less than one-sixth natural size.

FIG. 10.—*T. anonymum*. Outline of mandibles from below; a little less than one-sixth natural size.

as in *Polycotylus*. The generic name is derived from the belief that there were but three bones in the epipodial row. Beyond these connected series of bones there is another, and still a third includes the extreme tip of the paddle. In the first digit there are actually preserved ten phalanges, in the second twelve, and in the third fourteen—this last is the longest. The second digit could not have had less than fifteen and the third twenty. The three distal phalanges of the first digit seem to have been imperfectly ossified, and are closely related to, if not co-ossified with, the second digit. So, also, the distal four phalanges of the fifth digit are united, and are closely applied to the fourth digit, as are also the terminal three or four of the second with the third. The terminal phalanges of the third and fourth digits are flattened at the end, almost ungulate. The paddles are remarkably long and slender.

Trinacromerum anonymum Williston

A specimen in the Yale Museum (No. 1129), collected in 1873 by the late Mr. Joseph Savage from the Benton Cretaceous of Kansas "three miles south of the Solomon," is clearly identical with the species which I figured and partially described under the provisional name *Trinacromerum anonymum*, the type specimen collected by the late Professor Mudge from nearly the same locality and doubtless the same horizon in the Upper Benton. The species differs from the type species in its much smaller size, less slender skull, the different shape of the interclavicle and of the propodial bone. The Yale specimen must originally have been an excellent one, comprising the skull and vertebral column and portions of the paddles, but like so many of the specimens of those early days it suffered in its collection. The skull (figs. 9, 10), so far as it is preserved, bears a strong resemblance to *T. osborni*, but the attenuated portion of the face is shorter and the symphysis of the mandibles much shorter. The undersurface of the parietals with their attachments is clearly shown, and a little in front the opening into the deep median sinus or canal leading to the pineal foramen 50^{mm} in advance is clearly seen. Two tongue-like projections lie close together, projecting apparently as far forward as the end of the projection, the under surface with longitudinal striae like those of the upper surface. On each side there is a broad deep fissure for the attachment of the so-called prefrontal or "frontal," but there is not the slightest indication of a suture either above or

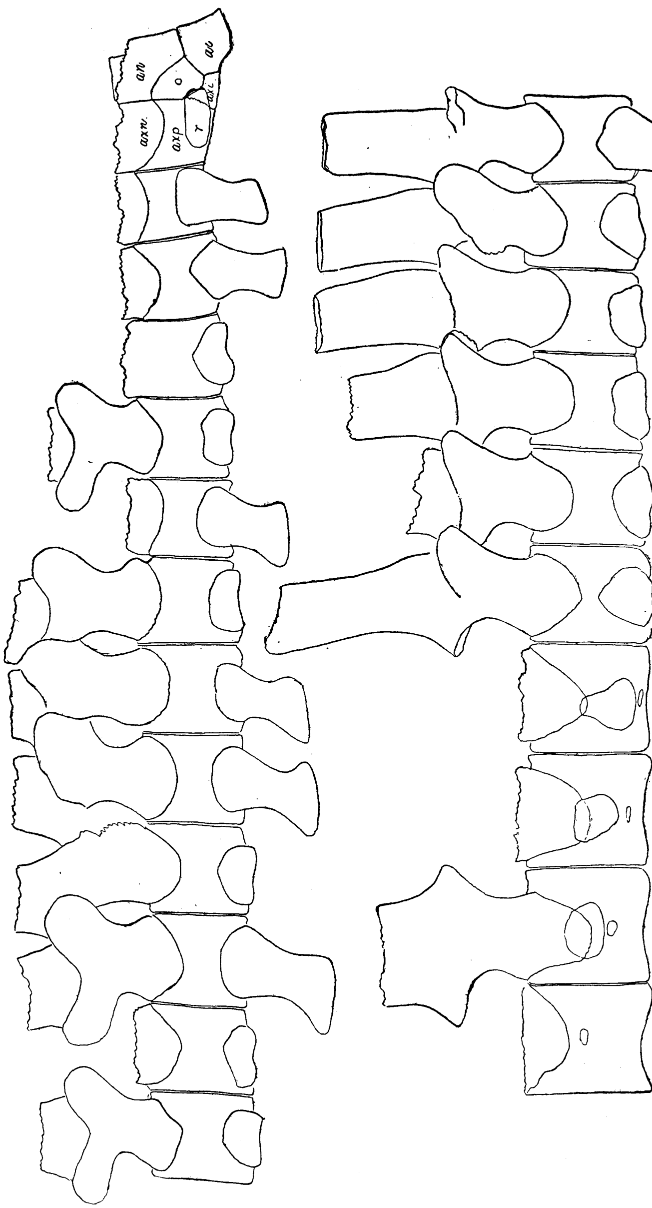


FIG. 11—*T. anonymum.* Cervical vertebrae, three-eighths natural size. ai, atlantal intercentrum; axi, axial intercentrum; axp, axial pleurocentrum; o, odontoid (atlantal pleurocentrum); r, place of rib attachment.

below, separating this anterior projection, which goes forward to meet the premaxilla, from the true parietal.

The supraoccipitals are shaped nearly as *T. osborni*, though they may meet for a short distance above.

Twenty-three cervicals in a continuous series are present, their processes for the most part lost. As this is the first absolutely positive

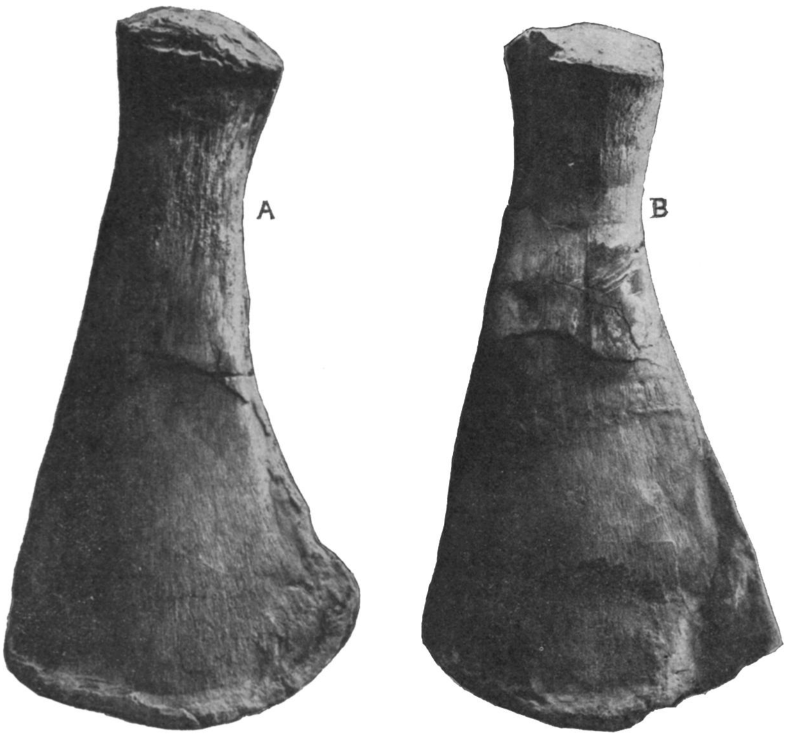


FIG. 12.—*T. anonymum.* A, left humerus; B, left femur, No. 1129 Yale Museum.

determination of the number of cervical vertebrae in this genus, I give careful outline figures of the series (fig. 11). The centrum of the third vertebra measures 23^{mm} in length, 32 in height, and 40 in width. The tenth vertebra has for its corresponding measurements 32, 34, 42; the twentieth, 32, 40, 58. The zygapophyses are heavy and large, placed nearly at right angles with each other, and are nearly plane. The twenty-fourth has the diapophyses wholly on the arch, and is, hence, a true dorsal vertebra, leaving twenty as the number of true cervicals, and three pectorals. The characteristic structure of the cervical and dorsal vertebrae of *Polycotylus latipinnis* is shown in fig. 13.

Twenty-three presacral centra follow. They are all depressed from pressure. The largest measures 42^{mm} in length and the series $1,300^{mm}$. The length of the neck is 700^{mm}, that of the skull 700^{mm}, giving a total length of the animal in life as about eleven feet, or a little greater than that of the type specimen of *T. Osborni*.

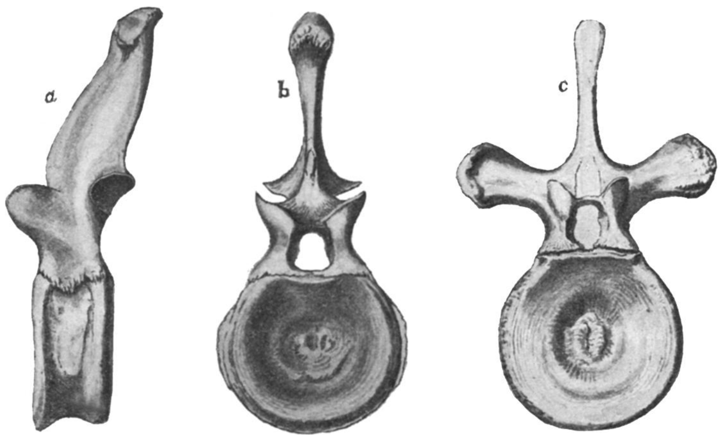


FIG. 13.—*Polycotylus latipinnis*. a, twenty-sixth (last) cervical vertebra from the side; b, the same vertebra, from in front; c, dorsal vertebra (forty-fourth of series) from in front. All one-fourth natural size.

Trinacromerum latimanus, n. sp.

Among the collections of the University of Chicago from the Hailey Shales of the Upper Benton of Wyoming, are parts of two individuals which I refer to an undescribed species of *Trinacromerum* chiefly because of the absence of the second supernumerary epipodial in the limbs and the character of the vertebrae. One of these specimens has the posterior part of the skull, a number of vertebrae and portions of the limbs; the other, which may be taken as the type, is an isolated humerus in perfect condition, collected by Mr. Roy Moodie (fig. 15). From the humeri of *T. bentonianum* and *T. anonymum* it differs conspicuously in its greater expansion distally. From the humerus of *Polycotylus latipinnis*, which I here figure for the first time (fig. 14), it differs in the absence of the fourth epipodial, the greater concavity of the ulnar border, the convexity of the distal radial border, etc.

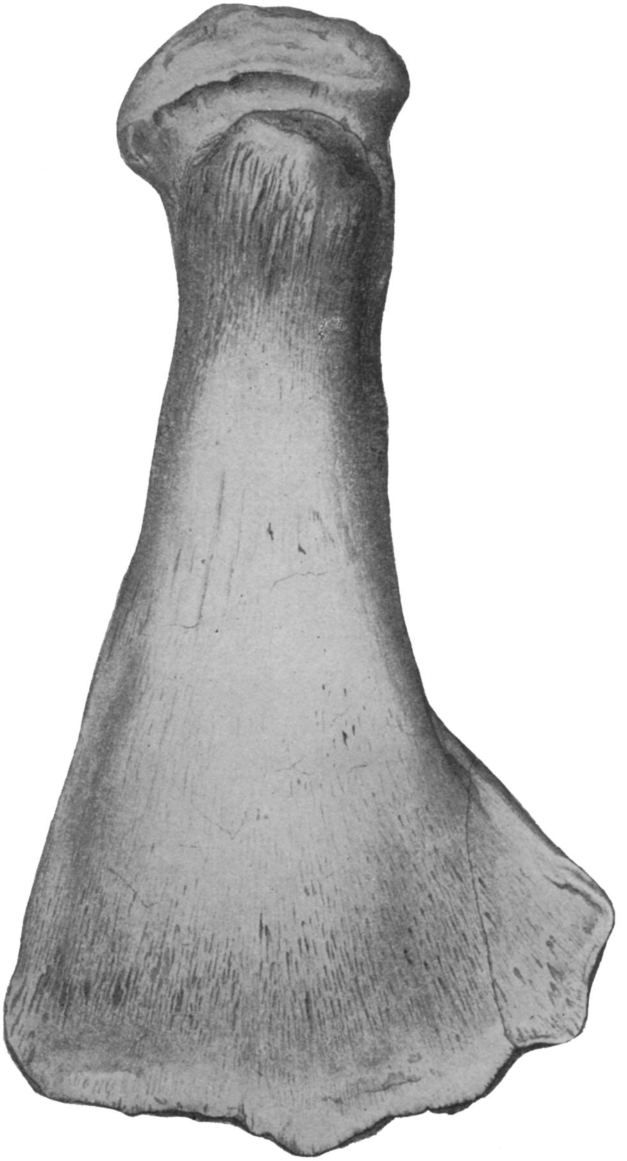


FIG. 14.—*P. latipinnis.* Left humerus, dorsal side, three-sevenths natural size.

Length	351 mm
Least diameter of shaft	87
Greatest width	250

The next paper of this series will be devoted to a discussion of the Jurassic species.

FIG. 15.—*Trinacromerum latimanus.* Left humerus, dorsal side, three-sevenths natural size.

Family POLYCOTYLIDAE Cope

Skull with long facial rostrum and thin, high parietal crest. Supraoccipital bones separated. Palate with large interpterygoidal vacuity, the pterygoids articulating with vomers, and meeting in the middle line posteriorly; no palatine foramina. Neck but little longer than head, the vertebrae all short; ribs single headed. Coracoids meeting throughout in symphysis, with long clavicular processes articulating with clavicles and scapulae, the interclavicle present; a large interclavicular foramen; ischia elongate. Three or four epipodial bones, all broader than long. Colorado Cretaceous, North America.

Polycotylus

Cope, *Proc. Amer. Phil. Soc.*, XI, 117, 1869; Williston, *Amer. Journ. Sci.*, XXI, 233, March, 1906.

P.) *latipinnis* Cope, *loc. cit.; Ext. Batrachia*, etc., 36, pl. 1, ff. 1–12; *An. Rep.*, U. S. Geol. Surv., 1871, 388; *ibid.*, 1872, 320, 335; *Bull.*, U. S. Geol. Surv. Terr., 27, 1874; *Cretac. Vert.*, 45, 72, 255, pls. I, VII, ff. 7, 7*a;* Leidy, *Ext. Vert. Fauna*, 279; Williston, *Field Mus. Publ.*, No. 73, p. 67, pl. XXI; *Amer. Journ. Sci.*, 2, 234, pl. III, Niobrara Cretaceous, Kansas.

P.) *dolichopus* Williston, *Amer. Journ. Sci.*, XXI, 235, pl. III, f. 2; Niobrara Cretaceous, Kansas and Wyoming.

Trinacromerum

Cragin, *Amer. Geologist*, December, 1888, p. 404; September, 1891, p. 171; Williston, *Amer. Journ. Sci.*, XXI, 236; *Dolichorhynchops* Williston, *Kans. Univ. Sci. Bull.*, No. 9, p. 141, September, 1902; *Field Mus. Publ.*, etc.

T.) *bentonianum* Cragin, *loc. cit.* Fencepost horizon of Benton Cretaceous Downs, Kansas.

T.) *osborni* Williston, *loc. cit.; Amer. Journ. Sci.*, XXI, 234; *Field Mus. Publ.*, No. 73, pp. 1–51, pls. I–XVII (*Dolichorhynchops*). Niobrara Cretaceous, Kansas.

T.) *anonymum* Williston, *loc. cit.*, p. 45, pl. XVIII. Upper Benton Cretaceous, Kansas.

T.) *latimanus* Williston, *antea*.—Hailey Shales, Upper Benton, Wyoming.

Piratosaurus

Leidy, *Cretac. Rept. N. Amer.*, p. 29, 1865.

P.) *plicatus* Leidy, *loc. cit.*, pl. XIX, f. 8. Cretaceous, Manitoba.

As has been suggested, this genus is perhaps identical with *Polycotylus* or *Trinacromerum*, in which case the name must take priority. If so, the determination cannot be made with certainty until such time as more complete specimens from the type, locality, and horizon have been studied.

The above species are all that are known belonging to the group. It is possible that other forms from the Fort Pierre may eventually be found, perhaps some have been described under other names. I may add here that the type of *Nothosaurops occiduus* Leidy is unquestionably a *Champsosaurus* Cope, as was suggested by Zittel, and that name should take precedence.

LIST OF DESCRIBED NORTH AMERICAN PLESIOSAURS

JURASSIC (BAPTANODON BEDS)

Plesiosaurus shirleyensis Knight.—Wyoming.
Pantosaurus striatus Marsh.—Wyoming.
Megalneusaurus rex Knight.—Wyoming.
Cimoliasaurus laramiensis Knight.—Wyoming.

LOWER CRETACEOUS (COMANCHE)

Plesiosaurus mudgei Cragin.—Kansas.
Plesiosaurus gouldi Williston.—Kansas.

BENTON CRETACEOUS

Trinacromerum bentonianum Cragin.—Upper, Kansas.
Trinacromerum anonymum Williston.—Upper, Kansas.
Trinacromerum latimanus Williston.—Upper, Wyoming.
Brachauchenius lucasii Williston.—Middle or Lower, Kansas, Texas.
Elasmosaurus, n. sp. Williston.—Middle, Kansas.

NIOBRARA CRETACEOUS

Elasmosaurus snowii Williston.—Middle, Kansas.
Elasmosaurus serpentinus Cope.—Nebraska, Wyoming.
Elasmosaurus marshii Williston.—Middle, Kansas.
Elasmosaurus ischiadicus Williston.—Upper, Kansas.
Elasmosaurus nobilis Williston.—Basal, Kansas.
Elasmosaurus sternbergi Williston.—Middle, Kansas.
Polycotylus latipinnis Cope.—Kansas.
Polycotylus dolichopus Williston.—Kansas, Wyoming.

FORT PIERRE CRETACEOUS

Plesiosaurus gulo Cope.—Kansas.
Elasmosaurus platyurus Cope.—Basal, Kansas.
Elasmosaurus intermedius Cope.—South Dakota.
Uronautes cetiformis Cope.—Montana.
Ophrosaurus pauciporus Cope.—Fox Hills, New Mexico.
Piptomerus megaloporus Cope.—Fox Hills, New Mexico.
Piptomerus microporus Cope.—Fox Hills, New Mexico.
Piptomerus hexagonus Cope.—Fox Hills, New Mexico.
Embaphias circulosus Cope.—South Dakota.

CRETACEOUS OF NEW JERSEY AND THE SOUTH

Plesiosaurus brevifemur Cope.—Greensand No. 5, New Jersey.
Cimoliasaurus magnus Leidy.—Greensand No. 5, New Jersey.
Discosaurus planior Leidy.—Mississippi, New Jersey.
Brimosaurus grandis Leidy.—Arkansas.
Elasmosaurus orientalis Cope.—New Jersey.
Taphrosaurus lockwoodi Cope.—No. 1, New Jersey.

OF DOUBTFUL RELATIONS AND HORIZON

Oligosimus primaevus Leidy.—Green River, Wyoming.
Piratosaurus plicatus Leidy.—Cretaceous.