VIII. NEW TITANOTHERES FROM THE UINTA EOCENE IN UTAH

By O. A. Peterson*

Professor O. C. Marsh in 1875 was the first to describe a horned titanothere from the Uinta Eocene, although he was not aware of that fact. The type of *Diplacodon elatum*, in the Peabody Museum of Natural History in New Haven, consists of a crushed palate with the cheek-teeth well represented. From this specimen Marsh was able to observe that the cheek-dentition was advanced towards the stage attained by the Oligocene titanotheres, but unable, due to the incompleteness of his material, to detect in his Eocene genus *Diplacodon* the extraordinary anatomical feature of heavy fronto-nasal horn-cores which are so characteristic of all known titanotheres of the White River Oligocene formation. In his original description Marsh appears to be of the opinion that *Diplacodon* has no horns.[1] In 1890 Osborn described a portion of a titanothere skeleton found by the Princeton field party in the Uinta sediments which he referred to *Diplacodon elatum* Marsh.[2] In this publication Osborn expressed his belief that the skull of *Diplacodon* "will show the initial development of the great horns of *Titanotherium*." To the Princeton University in general and to Mr. J. B. Hatcher in particular goes the credit of the first surprising discovery of the true horned Oligocene-type titanotheres in the Uinta Eocene. In the American Naturalist, Vol. XXIX, 1895, p. 1084, December issue, Hatcher described *Diplacodon emarginatum* and proposed for this new species his generic name *Protitanotherium*, "should future discoveries show that there are hornless forms with the same dental characters as *Diplacodon*." In Osborn's exhaustive study upon the titanotheres on pages 176 and 374 of Vol. I, *op. cit.* he ac-

*The critical illness and untimely death of the author prevented him from reading the proof of this paper.

[1]Amer. Jour. Sci. Vol. IX, 1875, pp. 246-247.

[2]Trans. Amer. Philos. Soc., Vol. XVI, 1890, p. 514. On pp. 150, 653 of Vol. I of Osborn's *Titanotheres of Ancient Wyoming, Dakota and Nebraska*, U. S. Geol. Surv., Monograph 55, it appears that he regards these early Princeton specimens as "of uncertain generic and specific references."

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cepts and amplifies Hatcher's description of *Protitanotherium*. In 1913 Peterson described a horned titanothere (*Eotitanotherium osborni*) from the base of horizon C, or the upper part of horizon B, of the Uinta Eocene sediments of Utah. The principal generic distinction of *Eotitanotherium* was based on the premolar dentition, which is of an unusually advanced stage for a titanothere in the upper part of horizon B of the Uinta sediments. Osborn on p. 196, Vol. I, of the *Titanotheres of Ancient Wyoming, Dakota and Nebraska*, regards the genus *Eotitanotherium* as doubtfully separated from *Diplacodon* Marsh. On pp. 434-435 of the same volume, Osborn, after closely comparing *Eotitanotherium* with *Diplacodon*, places the two latter genera in his subfamily *Diplacodontinæ*, and has this to say: "On the other hand, the type of *E. osborni* appears to represent a distinct species or even a different genus from *D. elatus*, for although it comes from a lower geological level (Uinta B_2) its premolars are decidedly more progressive in characters, p^3, p^4 having the tetartocones larger and more separated from the deuterocones, the external and internal cingula reduced, and the whole appearance of the crown more molariform than in *D. elatus*." As no additional material of this genus has yet been discovered in the same geological horizon in which *Eotitanotherium* was found, this question of whether or not we are to regard *Diplacodon* and *Eotitanotherium* as congeneric may well rest in abeyance.

In the abundant material of horned titanotheres in the Carnegie Museum from higher levels in horizen C of the Uinta sediments, we discover now that the genus *Diplacodon* is very well represented. Recent comparative and minute study of the type specimen in the Peabody Museum, New Haven, leaves no room for doubt that we have in this higher horizon an advanced species of the genus *Diplacodon* which may be named:

Diplacodon progressum sp. nov.

PLATES XXVI-XXVII

Holotype: Skull with lower jaws associated, C. M. No. 11879A; eleven dorsal vertebræ, the lumbar series, sacrum and pelvis all found articulated; several ribs, 1 humerus, the right and left femora, one tibia and parts of fore and hind feet, C. M. No. 11879, were found close to and are associated with the holotype.

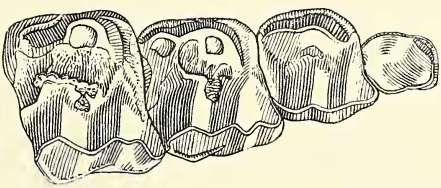
Paratype: Skull very nearly complete. C. M. No. 11881.

Geological Horizon: Uinta Eocene; upper series of horizon C.

Locality: "Skull Pass" Quarry on Green River, seven miles above Ouray, Uinta Co., Utah.

Generic Characters.—Osborn in his *Titanotheres of Ancient Wyoming, Dakota and Nebraska* Vol. I, p. 439, has defined the genus *Diplacodon* as follows: "Skull mesaticephalic to dolicocephalic; zygomatic arches slender. Superior premolars with flattened ectolophs and double convexities; p^{2-4} progressive, quadritubercular—that is, with tetartocone; molars of elongate or dolicocephalic type—that is, laterally compressed." To Osborn's definition may now be added: Nasals well developed and curved downward at the tips; fronto-nasal horn-cores well developed in the males, with elongate oval bases; top of skull saddle-shaped with high and broad occiput as is the case in the lower White River oligocene titanotheres.

Specific Characters.—So far as comparison may be made between the present new species and the holotype of *D. elatum* it is quite clear that the facial region is shorter in *D. progressum*, because the premolar series is relatively shorter. Furthermore the premolar series in the new species is farther advanced in molarization than in *D. elatum*, the individual teeth being more perfectly quadrate in *D. progressum*, P^2 being especially advanced from that in the species from the earlier horizon.



Upper premolars of *Diplacodon progressum*.
C. M. No. 11879A (Two-thirds natural size)

If we may be permitted to make a few comparisons between *Eotitanotherium osborni* and the new species here proposed; or, it may be better to say, if it should develop that *Eotitanotherium* is, after all, congeneric with *Diplacodon*, we have a number of important anatomical differences between the two forms, of which the following may be mentioned: In *D. progressum* the nasals, though similar to those in *E. osborni*, are shorter and heavier, and the alveolar border of the premaxillary is noticeably shorter.

The lower jaws of the holotype are shortened by a fore-and-aft crushing in the region of the symphysis so that the part bearing the premolars appears unusually short. The individual premolar teeth are, however, relatively short and broad when compared with those in *E. osborni*. M_3 in *D. progressum* is also shorter than the corresponding tooth in *E. osborni*.

MEASUREMENTS

Skull	Holotype No. 11879A	Paratype No. 11881
Tip of nasals to occiput, median line	555 mm.	525*mm.
Tip of nasals to anterior base of horn-cores	108*mm.	108*mm.
Transverse diameter across the tips of the horn-cores	290 mm.	292 mm.
Transverse diameter at greatest expanse of the zygomatic arches	405 mm.	
Transverse diameter at occipital plate	240 mm.	235 mm.
Incisor teeth to occipital condyles	580 mm.	581 mm.
I^1 to and including M^3	298 mm.	298*mm.
Diastema between canine and P^1	22 mm.	22 mm.
Length of cheek dentition	227 mm.	225 mm.
Length of premolar series	83 mm.	85 mm.
Length of molar series	147 mm.	142 mm.
Length of P^1	16 mm.	16 mm.
Transverse diameter of P^1	12 mm.	12*mm.
Antero-posterior diameter of P^2, external measurement	20 mm.	21 mm.
Median measurement P^2	20 mm.	21 mm.
Internal measurement P^2	19 mm.	18 mm.
Transverse diameter of P^2, median body of the tooth	23 mm.	23 mm.
Antero-posterior diameter of P^3	23 mm.	24 mm.
Transverse diamter of P^3	27 mm.	29 mm.
Antero-posterior diameter ot P^4	26 mm.	27 mm.
Transverse diameter of P^4	33 mm.	35 mm.
Antero-posterior diameter of M^1	38 mm.	36 mm.
Transverse diameter of M^1	41 mm.	44 mm.
Antero-posterior diameter of M^2, external measurement	58 mm.	50 mm.
Antero-posterior diameter of M^2, median measurement	51 mm.	47 mm.
Transverse diameter of M^2	52 mm.	52 mm.
Antero-posterior diameter of M^3, external measurement	64 mm.	63 mm.
Antero-posterior diameter of M^3, median measurement	58 mm.	53 mm.
Transverse diameter of M^3	54 mm.	54 mm.

Lower Jaws	Holotype No. 11879A
Total length of the jaw fragment	410 mm.
Inferior border of angle to top of coronoid process	265 mm.
Inferior border of angle to top of articulating condyle	217 mm.
Depth of ramus at M_3, internal measurement	87 mm.

*Approximate measurements.

Depth of ramus at P_4, internal measurement	72 mm.
Length of P_3	23 mm.
Greatest transverse diameter of anterior crescent P_3	13 mm.
Greatest transverse diameter of posterior crescent P_3	16 mm.
Antero-posterior diameter of P_4	25 mm.
Greatest transverse diameter of anterior crescent P_4	16 mm.
Greatest transverse diameter of posterior crescent P_4	18 mm.
Antero-posterior diameter of M_1	37 mm.
Greatest transverse diameter of anterior crescent M_1	21 mm.
Greatest transverse diameter of posterior crescent M_1	24 mm.
Antero-posterior diameter of M_2	47 mm.
Greatest transverse diameter of anterior crescent M_2	26 mm.
Greatest transverse diameter of posterior crescent M_2	29 mm.
Antero-posterior diameter of M_3	69 mm.
Greatest transverse diameter of anterior crescent M_3	28 mm.
Greatest transverse diameter of posterior crescent M_3	26 mm.
Greatest transverse diameter of heel M_3	18 mm.

When the great mass of titanothere material from the "Skull Pass Quarry" on Green River, Utah, is taken out and extracted from the matrix in the laboratory, a full report upon the osteology of *Diplacodon progressum* will be published, together with that of other forms which may occur in the quarry.

THE SUBFAMILY TELMATHERIINÆ OSBORN.
STHENODECTES GREGORY.

After a very careful comparison with the holotype of *Sthenodectes* in the Carnegie Museum and also with the published results of studies on the Eocene titanotheres by Osborn and Gregory[3] it is very evident that a skull and the lower jaws found articulated in horizon A of the Uinta Eocene sediment by Mr. J. LeRoy Kay, of the Carnegie Museum Field Party, 1927, is to be referred to that genus. The specimen answers most closely to the generic characters given in Osborn's work on the titanotheres (*op. cit.*, p. 353) except for the presence of the "fronto-nasal horn swellings" in the specimen before us which may here be regarded as characteristic of the male.

That the genera *Telmatherium* and *Sthenodectes* are very closely related, is especially evident when the form of *Sthenodectes* found in the lower Uinta is compared with *Telmatherium vallidens* and *T. cultridens* of the Bridger sediments. However, the relatively shorter facial region and the macrodont incisor series of *Sthenodectes*, together with other less noticeable characters of the dentition, are here regarded as of such anatomical importance that it seems prudent to continue to treat the two lines represented by the genera *Sthenodectes* and *Telmatherium* as distinct.

Sthenodectes priscus sp. nov.

PLATES XXVIII

Holotype: Skull and lower jaws. C. M. No. 11437.

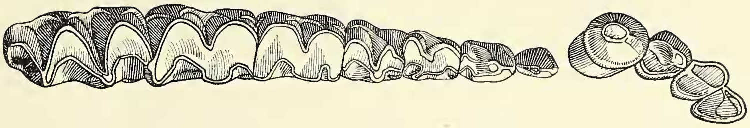
Horizon: Uinta Eocene; horizon A.[4]

Locality: Willow Creek, Uinta County, Utah.

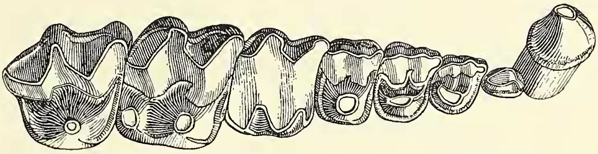
Specific Characters: Upper canine of rounder cross-section at the base of the crown and with posterior cingulum less developed than in *S. incisivus*; cheek-dentition less hypsodont and cingula less developed than in *S. incisivus*. A short diastema present back of the upper canine, but absent in *S. incisivus*.

[3]"Titanotheres of Ancient Wyoming, Dakota and Nebraska"; U. S. Geol. Surv. Monograph 55, Vol. I, 1929; Science, Vol. XXXV, 1912, p. 546.

[4]The first twenty feet of heavily bedded sandstone above the Green River Shale, recorded on p. 301 and Pls. X and XI in the paper by Peterson and Kay, on the "Upper Uinta Formation of Northeastern Utah" (Ann. Carn. Mus., Vol. XX, 1931) is the exact geological horizon from which this holotype came.



Lower teeth of *Sthenodectes priscus* Peterson
C. M. No. 11437 (One-third natural size)



Upper teeth of *Sthenodectes priscus* Peterson.
C. M. No. 11437 (One-third natural size)

The skull of the holotype of *Sthenodectes* is not distorted by crushing but, unfortunately, the greater part of the zygomatic arches, the premaxillaries, and the tips of the nasals are absent. The basicranial region was also apparently partly destroyed before the final interment of the specimen. The lower jaws are more completely preserved and were found articulated with the cranium.

Like those of *S. incisivus*, the nasals are evidently short, tapering rapidly in front, with the naso-maxillary notch on a line with the interval between the canine and P^1, and the nasals are much broader posteriorly at the point where they are received by the frontals. The dorsal face of the nasals is convex from side to side along the posterior median line and concave along the lateral borders. The fronto-nasal "horn swellings" are prominent, and this, as before stated, may well be a sexual character. The frontals are broad anteriorly, with heavier superior borders of the orbits than in *S. incisivus*, but, as in the latter, the post-orbital processes are heavy. The temporal line is light and it converges gradually to conform with the narrow parietals and thence backwards to the high and thin sagittal crest. As is the case in *S. incisivus*, the upper contour of the skull is saddle-shape with the highest anterior point at the fronto-nasal "horn-swellings." The face in front of the orbit is somewhat less concave than in *S. incisivus* which difference may, in part at least, be due to a crushing of the holotype of the latter species. The "lacrimal pit," which Douglass originally described in *S. incisivus*,[5] is not present in the specimen here

[5]Ann. Carn. Mus., Vol. VI, 1909, p. 305.

described, which apparently strengthens Osborn and Gregory's supposition that these vacuities were formed by a crushing of the holotype of *S. incisivus*.[6] The large infraorbital foramen is close to the orbits (18 mm.). In agreement with the species described by Douglass, there is no infraorbital shelf or protuberance of the malar, but a large postorbital process is present. The orbit is of well proportioned size and of a sub-diamond shape with the posterior acute angle bounded by the large postorbital processes of the frontal and malar bones. The palatine plates of the maxillaries are evenly concave from side to side, nearly rectilinear fore-and-aft, and the anterior border of the postnarial opening is opposite the posterior part of M^2. As stated above, the base of the skull is mutilated and of no service for description.

In the holotype of *S. priscus* the upper incisors are lost. The canine is large, and, as is the case in *S. incisivus*, the crown is long, but less angular postero- and antero-laterally and more nearly round in cross-section. P^1 is longer than broad, having on the front part of the crown a simple cone and back of this a large base. The whole of the crown is surrounded by a prominent cingulum except on the external anterior angle.[7] The length and breadth of the premolars in the species here proposed agree fairly well with the corresponding dimensions in *S. incisivus*, as does, also, the detailed structure, except the more sharply rounded convexities on the external wall of the protocone, and the greater hypsodont feature and heavier cingula in *S. incisivus*. The dentition in *S. priscus* has received greater wear than that in *S. incisivus*, but this is fully considered in connection with the study of the relative hypsodont character.

The upper molars agree in most characters with those of *S. incisivus*: that is, by their diameters; by their detailed structure, including the absence of the hypocone on M^3; and by the poorly developed cingula on the internal faces. The brachydont condition of the premolars already mentioned is observed in the molars in approximately an equal degree when compared with the somewhat more hypsodont molars in *S. incisivus*.

[6]"Titanotheres of Ancient Wyoming, Dakota and Nebraska"; U. S. Geol. Surv. Monograph 55, Vol. I, 1929, p. 354; Science, Vol. XXXV, 1912, p. 546.

[7]According to the illustration by Riggs, Field Mus. Geol. Ser., Vol. IV, 1912, Pl. XII, the specimen of *Sthenodectes* in the Field Museum in Chicago, has P^1 somewhat more rounded and the main cusp carried farther back on the crown, but the tooth appears to be surrounded by a basal cingulum.

Lower Jaw.—The side view of the lower jaw of *Sthenodectes incisivus*, as figured on Plate XII, in Riggs' paper, *op. cit.*, appears distinctly short and deep when compared with that of the specimen under description. Furthermore the measurement given of the lower canine on p. 39 in Riggs' publication indicates that the tooth in the new species here proposed is more nearly equal in transverse and antero-posterior diameters. On p. 354 of Osborn's *Titanotheres of Ancient Wyoming, Dakota and Nebraska*, Vol. I, the isolated lower jaws described by Riggs as *Sthenodectes incisivus* are included as material of that species. If the lower jaws in the Field Museum are to be regarded as of *S. incisivus*, it appears that the differences noted in the characters of both skull and jaws indicate the appearance of specializations of considerable importance from *S. priscus* of horizon A to *S. incisivus* of horizon B of the Uinta Eocene.

The presence of massive lower incisors in the holotype of *S. priscus* constitutes one of the main reasons for regarding the specimen as belonging to the genus *Sthenodectes*. They are much worn anteriorly, except I_3 of the left side. This tooth shows that the lower incisors of *S. incisivus* will prove to be much like those of the upper series when found associated; that is, with an anterior prominent tubercle and a large posterior base surrounded by a heavy cingulum thus differing from the incisors in *Telmatherium* which are more "acutely convergent or V-shaped." In the specimen under description the incisors gradually increase in size from the median to the lateral. The antero-posterior diameter of the crowns is greater than the transverse.

The size and shape of the lower canine is much like that of the upper. The crown is rounded in cross-section, long and recurved with the basal cingulum of nearly an equal development to that in the upper canine; less developed than in the upper canine in the holotype of *S. incisivus*; and perhaps also less than in the canine of the lower jaw described as *S. incisivus* by Riggs (*op.cit.*, fig. 3, Pl. XII).

Premolars.—P_1 is very little worn and has a rather high and pointed crown, the main cusp of which occupies the greater portion. In front of the apex the prominent crest terminates in a slight swelling at the base, while posteriorly the crest is extended a little farther down on the crown. There is little or no indication of a posterior basal cusp. On the antero-external angle there is a cingulum slightly indicated, while postero-externally and medially there is very slight evidence of it. There are shallow anterior and posterior fossæ on the internal face.

P_2 has a very high and large protoconid, the postero-external (= hypodonid) tubercle being relatively quite small and concave internally, while the anterior base presents a slight style. Judging from the illustration of *S. incisivus* by Riggs, that species appears to have P_2 further advanced. P_3 has a similar large, though somewhat less elevated, protoconid than on P_2 and the tooth is farther along on its way to molarization. The anterior base and especially the postero-external cusp is developed to a greater extent, giving the tooth a broader aspect. The internal crest, from the protoconid to the postero-internal angle, is of sufficient development to effect an enclosed fossa of considerable size in that region of the crown. As is the case with the preceding teeth (P_2 and P_3) the anterior portion of the crown of P_4 is higher than the posterior region. This tooth is, however, quite molariform, the postero-external angle of the crown being well developed and it has received considerable wear. The antero-internal angle is filled out to a greater degree than that in P_3 and the postero-internal fossa is similarly enclosed, but of larger size. The cingula of the premolars are confined to the antero and postero-external angles; the posterior one is carried forward slightly beyond the external fossa.

Lower molars.—The lower molars are well worn and correspond in every way to those of the upper series. The detailed structure of this series is quite similar to those illustrated by Riggs. The cingula on the internal faces of the molars are confined to the anterior portion, while externally, expecially in M_2 and M_3, there is a more extensive development.

MEASUREMENTS.

SKULL.

Basilar length, condyle to and including the canine	415 mm.
Length from antorbital border to posterior border of infraorbital foramen	18 mm.
Transverse diameter of frontals at the orbits	185 mm.
Transverse diameter of occipital plate	150 mm.
Length of molar-premolar series	198 mm.
Greatest antero-posterior diameter of canine at base	26 mm.
Greatest transverse diameter of canine	26 mm.
Length of premolar series	58 mm.
Length of molar series	124 mm.
Antero-posterior diameter of P^1	16 mm.
Transverse diameter of P^1	11 mm.
Antero-posterior diameter of P^2	19 mm.
Transverse diameter of P^2	23 mm.
Antero-posterior diameter of P^3	23 mm.

Transverse diameter of P^3	30 mm.
Antero-posterior diameter of P^4	23 mm.
Transverse diameter of P^4	34 mm.
Antero-posterior diameter of M^1	34 mm.
Transverse diameter of M^1	42 mm.
Antero-posterior diameter of M^2	43 mm.
Transverse diameter of M^2	51 mm.
Antero-posterior diameter of M^3	48 mm.
Transverse diameter of M^3	49 mm.

LOWER JAW.

Greatest length of ramus, angle to and including incisors	430 mm.
Depth of ramus at P_1	60 mm.
Depth of ramus at M_1	68 mm.
Depth of ramus at M_3	82 mm.
Length of molar-premolar series	217 mm.
Length of premolar series	83 mm.
Length of molar series	132 mm.
Antero-posterior diameter of I_1 at the base of crown	19 mm.
Transverse diameter of I_1	13 mm.
Antero-posterior diameter of I_3	21 mm.
Transverse diameter of I_3	17 mm.
Antero-posterior diameter of canine at the base of crown	24 mm.
Transverse diameter of canine	22 mm.
Antero-posterior diameter of P_1	17 mm.
Transverse diameter of P_1	10 mm.
Antero-posterior diameter of P_2	21 mm.
Transverse diameter of P_2	15 mm.
Antero-posterior diameter of P_3	21 mm.
Transverse diameter of P_3	18 mm.
Antero-posterior diameter of P_4	25 mm.
Transverse diameter of P_4	21 mm.
Antero-posterior diameter of M_1	33 mm.
Transverse diameter of M_1	25 mm.
Antero-posterior diameter of M_2	41 mm.
Transverse diameter of M_2	30 mm.
Antero-posterior diameter of M_3	58 mm.
Transverse diameter of M_3	29 mm.