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OSTEOLOGY OF DOLICHORHINUS LONGICEPS DOUGLASS, WITH A REVIEW OF THE SPECIES OF DOLICHORHINUS IN THE ORDER OF THEIR PUBLICATION.

By O. A. Peterson.

(Plates XLIV–LVII)

In the year 1913 Mr. Earl Douglass of the Staff of the Carnegie Museum made a fortunate discovery of remains of the genus *Dolichorhinus* in the Upper Eocene near the head of a small stream running from the west through Wagonhound Canyon to the White River in northeastern Utah. The outcrop of bones (See figs. 1 and 2) occurred in the face of a cliff, twenty feet from the base and

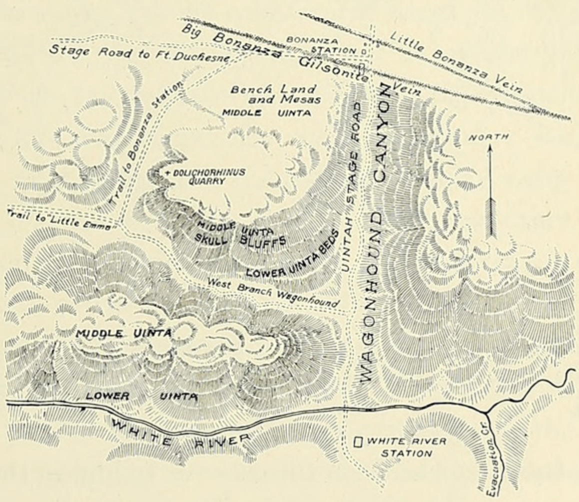

Fig. 1. Sketch-map showing the location of the quarry where Mr. Douglass obtained much of his material representing *Dolichorhinus*. Scale: 2 cm. = 1 mile.

fifteen feet from the top. The bone-bearing stratum was located in the lower portion of the Middle Uinta (Horizon B). In order to secure the material Mr. Douglass blasted off the top of the cliff until the layer of bones was reached. Then by means of excavations, such as are ordinarily employed in like cases, the material was taken out in the form of large and small blocks of sandstone in which the bones remained imbedded. One of these blocks contained very nearly the entire skeleton of a specimen of *Dolichorhinus longiceps* Douglass, which is now exhibited in the Gallery of Fossil Mammals in the Carnegie Museum. The sandstone is very hard and refractory, and much credit is due to Mr. S. Agostini for the patient and skilful manner in which he labored to extricate the bones from

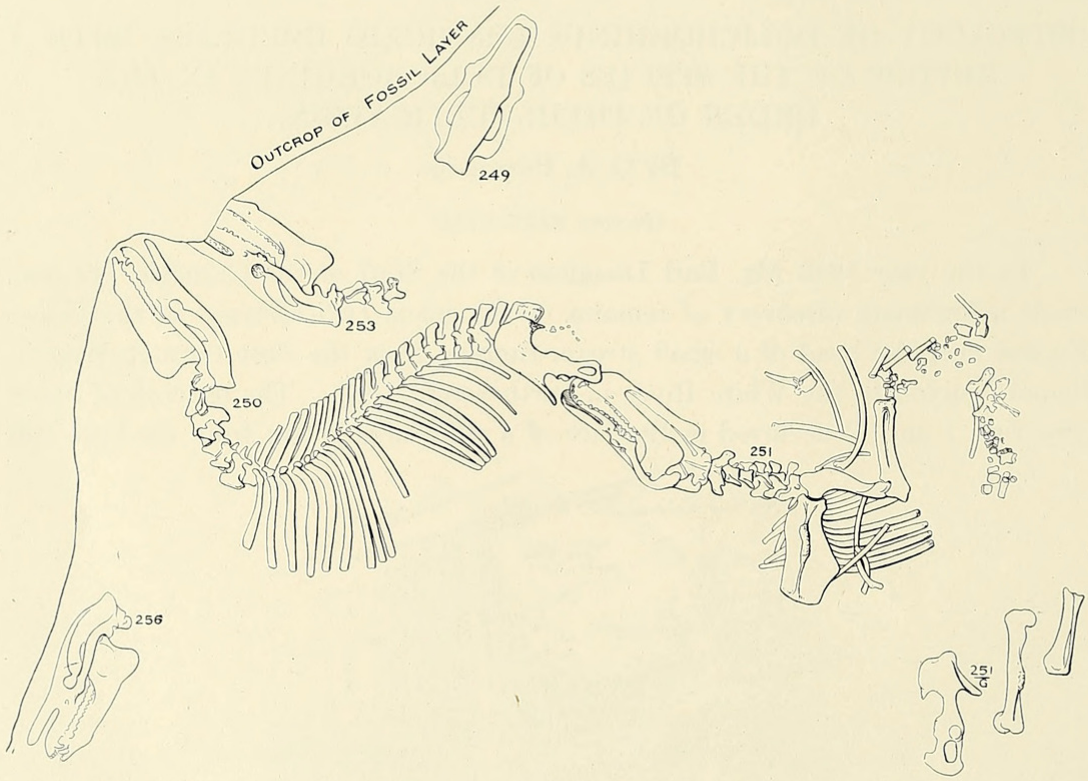

Fig. 2. Showing the position of different specimens of *Dolichorhinus* in the quarry. The numbers are those given in Mr. Douglass' field-notes. No. 250 is No. 11,072, and 251 is No. 11,071, C. M. Cat. Vert. Fossils.

their tough matrix, after they had been turned over to him in the laboratory. The restoration in the Gallery of Fossil Mammals in the Carnegie Museum (See Plate LV) was prepared by Mr. Agostini. To the Field Museum and to the American Museum of Natural History we are indebted for a number of original illustrations, for which special acknowledgement is given in their titles. Mr. Sidney Prentice is the author of the plates given in this memoir and of most of the text-figures. Finally I wish to make special acknowledgement to Dr. W. J. Holland for his helpful suggestions and for his kind assistance in revising this paper and preparing it for the press.

The upper Eocene on the eastern borders of the Uinta Basin has yielded much material representing the titanotheres, which is now installed in various museums of this country. The recent collections made by the Carnegie Museum contain the best preserved specimens brought from this field up to the present time. The author believes that a systematic description of the osteology of *Dolichorhinus*, so far as it is decipherable from this material, will be of considerable service to students.

Seven species have up to the present time been assigned to the genus *Dolichorhinus*. When more and better material is secured the number of proposed species will very probably be reduced. At present, however, we would not gain much by attempting to reduce some of these species to the rank of synonyms, as some of them are so very imperfectly represented by the material at command; and we accordingly recognize them provisionally as they stand in the literature of the subject. This course is pursued in face of the fact that there does not appear to have been complete accord in regard to some proposed species in the genus *Dolichorhinus*. Osborn (Bull. A. M. N. H., Vol. XXIV, 1908, p. 611) regards *D. cornutus* Osborn as being identical with *D. hyognathus* Scott and Osborn, the latter having priority. On the other hand Riggs (Field Museum Nat. Hist., Geol. Ser., Vol. IV, 1912, pp. 31–32) regards it as undesirable to unite the two, being inclined to accept *D. cornutus* Osborn as a valid species, until more material representing the skulls and mandibles shall be found. Riggs discovered that there is a disparity in the length of the molar-premolar series in the types of the two species, *D. hyognathus* and *D. cornutus*, as well as other differences in proportion. Further remarks on this subject will be found on pp. 410, and 430-4.

During the study of the remains of *Dolichorhinus* in the Carnegie Museum the writer was led more and more to doubt that any species of the genus has only two incisors in the lower jaw, as stated by Professor Osborn (Bull. A. M. N. H., Vol. VII, 1895, p. 93). Finally a note was forwarded to the American Museum of Natural History, requesting a re-examination of the lower jaws of their specimen, No. 1,857, which had been studied and published upon by Dr. Osborn, as well as other individuals of *Dolichorhinus* in the collections of that institution. I am indebted to the courtesy of Dr. William K. Gregory for the following letter:

American Museum of Natural History,
77th Street & Central Park West,
New York, N. Y.
November 15, 1920.

Dear Mr. Peterson:

In answer to your inquiry regarding jaw No. 1857: I have examined the specimen and find that it is a very old animal of *Dolichorhinus cornutus* (*hyognathus*). Although there are only two incisors in place on each side there are traces of the alveoli of the third incisors, so that the statement is probably an error. I have never seen any *Dolichorhinus* jaws, or for that matter any Uinta titanotheres, with less than three incisors on each side.

Very sincerely yours,
William K. Gregory.

This note seems to dispose of the difficulty arising from the statement inadvertently made by Dr. Osborn. This fact and the unusual position of the posterior nares enable me to present a statement of the generic characters of the genus *Dolichorhinus*, based upon that already given by Riggs (Field Mus. Nat. Hist., Geol. Ser., Vol. IV, 1912, p. 31) which I adopt, enclosing my emendations in brackets.

GENERIC CHARACTERS OF DOLICHORHINUS.

"Middle Eocene titanotheres, progressively dolichocephalic, nasals elongate and laterally infolded, cranial region strongly convex, incipient horn-cores above the orbits, a shelf-like infra-orbital process, occiput broad and low, condyles broad. Dentition complete [$I.^{3}_{3}$, $C.^{1}_{1}$, P^{4}_{4}, M^{3}_{3}] premolars relatively progressive, first pair of upper incisors separated by median diastema, posterior nares [far back] of last molar."

SKULL AND LOWER JAWS. (Plates XLIV–XLVI.

In the collection of the Carnegie Museum specimens Nos. 11,071 and 11,072, which are more or less complete, have crania associated with lower jaws. These two specimens, with other material obtained from the same and other localities in the same general region, furnish the basis of the descriptions given in the following pages. The jaws articulated with the crania in these specimens definitely establish the fact that *Dolichorhinus longiceps*[1] and *D. hyognathus* are closely related.

The crania, especially those of Nos. 11,071 and 11,072, which are here provisionally referred to *D. longiceps* Douglass, have the same contour as *D. cornutus*

[1] *Dolichorhinus longiceps* Douglass may be the female of *D. cornutus* Osborn.

Osborn and in general agree with Osborn's descriptions and illustrations. The smaller horn-cores of *Dolichorhinus longiceps* as well as the earlier geological formation in which the type was found are made the subject of discussion in the general description hereafter given and in the review of the species towards the end of this paper (See pp. 437–39).

Two crania, Nos. 11,080 and 11,081, likewise provisionally referred to *Dolichorhinus longiceps*, are of especial interest, as they are well preserved in the palatine and pterygoid regions. In these skulls there are found no posterior nares in the region of the median pterygoid fossa, where these openings are usually found in most mammalia, especially in the Perissodactyla. In the posterior region of the palate there is, however, a depression, which apparently marks the original position of this orifice, and where also the postnares are located in the Oligocene titanotheres. The depression referred to is covered with a bony structure and four or five centimeters further back is a second depression. In skull No. 11,081 the anterior margin of this depression is pierced, especially on the left side, while in skull No. 11,080 this depression is not pierced. The piercing of this film of bone was undoubtedly done by some insect larva, possibly by *Dermestes*, shortly after the death of the animal, and might be mistaken for the orifices of the postnarial openings. Back of this second depression there are oblong or ovate inflated areas of this same thin kind of bone, which measure about seven or eight centimeters in length. These last mentioned inflations and depressions are separated by a thin vertical plate, the vomer. This vomerine plate extends backward to, and forms a contact with, the basisphenoid. At the point of contact the latter bone has a sudden upward turn, which imparts a curious angle to the basicranial axis. On either side of the vomer between the pterygoid processes back of the swollen area described there are again deep depressions, which I judge to be the functional posterior nares. In the region of the anterior margin of this depression the thin bony structure is partly destroyed, so that the margin of this orifice is not complete. I feel, however, quite certain that in better preserved specimens the complete anterior margins of the posterior nares will be found at this point. The nasopalatine passages of this genus are thus seen to be of great length and of a most unusual character, heretofore not clearly known[2] (See Plate XLV, fig. 3, and Plate XLVI, fig. 2).

In this connection it is of interest to turn to the genus *Sphenocœlus* from the lower portion of Horizon B of the Eocene beds of the Uinta Basin, described by

[2] From Mr. Riggs' general description of the material in the Field Museum of Natural History (Field Museum Publications, No. 159, Geol. Ser., Vol. IV, 1912, p. 33) it is clear that he found some evidence of these thin bony plates bridging over the postnares.

Osborn (Bull. A. M. N. H., Vol. VII, 1895, p. 98). On comparing Osborn's illustration (*l. c.*, p. 99, fig. 12) with the palate of *Dolichorhinus* just described (See Plate XLVI, fig. 2) there is a most remarkable similarity of characters disclosed. Not only do the foramina and the different processes, including the zygomatic process of the squamosal, agree in general, but, most interesting of all, is the pair of pits in the floor of the skull upon either side of the narrow vomerine extension of the presphenoid, described by Osborn (*l. c.*, pp. 98–99). In the light of what is revealed by the crania of *Dolichorhinus*, I now believe that these pits in *Sphenocœlus* mark the position of the postnares. We would thus have another genus possessing these long and curious infundibula of the backward extension of the narial passages. We may even be justified in provisionally including *Sphenocœlus* in the dolichorhinine series of the Uinta titanotheres under the name *Sphenocœlinæ*, distinguished by a long narrow cranium, and a short sagittal crest with diverging sagittal ridges.

A comparison of the lower jaws of our specimens, Nos. 11,071 and 11,072, with the illustrations and descriptions of *Dolichorhinus hyognathus* by Mr. Charles Earle[3] reveals differences of at least specific value. As in *D. hyognathus* from the Washakie, the jaw of *D. longiceps* is elongated and shallow, but it is noticeable that in *D. hyognathus* the jaw decreases more rapidly from the vertical ramus forward, so that the diameter at M_3 is very nearly twice that at P_2, as was observed by Earle (*l. c.*, p. 349). In the species from the Uinta, on the other hand, the ramus is more uniform in depth from M_3 forward to P_2. The extraordinary length of the symphysis is perhaps the most striking feature in *D. hyognathus*, a character well emphasized by Earle (*l. c.*) and also remarked by Scott and Osborn (See their original description, Trans. Am. Phil. Soc., Vol. XVI, p. 513) and by Osborn (Bull. A. M. N. H., Vol. VII, p. 93), who states that the symphysis of the lower jaw (Specimen No. 1,857, A. M. N. H.) which he referred to *D. cornutus*: "presents somewhat more angulation of the chin than in *T. hyognathum*." If the symphysis of the jaw in the type of *D. hyognathus* (Scott and Osborn) is in a natural condition, we shall also have to admit a proportionally longer postcanine region in its skull than we find in any of the forms of the genus known from the Uinta beds. On comparing the lower border of the ramus of *D. longiceps* with the illustration in Mr. Earle's paper (*l. c.*, Plate XI, fig. 10) it is interesting to find that in this figure there is a failure to represent the downward thrust, which is so prominent immediately anterior to the angle along the inferior border of the ramus in *D. longiceps*. From this illustration in Mr. Earle's article, it may also

[3] Journal Acad. Nat. Sci. of Philadelphia, Vol. IX, 1884–95, p. 348, Pl. XI, figs. 10 and 11.

be inferred that the vertical ramus of *D. hyognathus* has proportionally a greater antero-posterior diameter than is the case in the jaw of *D. longiceps*.

In the lower jaws of C. M. No. 11,071 the symphysis is of about the same length as in the type of *D. hyognathus*. This is, however, entirely due to pathological conditions, the animal during life having received injury in the region of the chin, which caused a backward exostosis. With this exception there is little or no noteworthy difference from the lower jaws belonging to C. M. No. 11,072 above mentioned.

HYOID ARCH.

The hyoid arch of *Dolichorhinus* is chiefly known through the studies of Mr. O. A. Peterson (Ann. Car. Mus., Vol. IV, 1914, pp. 130–131). In the skull forming a part of the skeleton of C. M. No. 11,071 the greater part of the hyoid arch was found practically in position, as shown on Plate XLIV, figs. 1 and 4. This material supplements that described by Peterson (*l. c.*) and gives us further knowledge as to this portion of the anatomy. The stylohyoid only differs from that already described by Peterson in having the proximal end less expanded vertically, and thus corresponding more nearly to the same element in the living tapir, *e. g. Tapirus terrestris*. The bone as a whole is, however, slenderer in proportion than in the tapir, as has already been pointed out by the writer. The ceratohyal in the present specimen is complete. It is rib-like, with the outer surface convex from side to side and the inner surface plane. The contact with the basihyal is expanded, especially transversely, to meet the large contact-surface on the basihyal. Immediately above this contact-surface and for two-thirds of the length of the bone the shaft is uniform in its antero-posterior diameter. It curves first upward and forward from the base, then upward and slightly backward. The upper one-third is reduced in size and the contact with the epihyal is attenuated. The latter bone is not at present known to the writer to be represented in any material of *Dolichorhinus* which has been thus far collected. The basihyal does not appear to be completely represented in the specimen under consideration, inasmuch as the anterior truncated appendix, shown in the basihyal earlier described by Peterson (*l. c.*) is not so well developed in C. M. No. 11,071. This region appears to have received some abrasion, but to what extent cannot be stated. The thyrohyal is represented by the proximal end and a portion of the shaft. This bone is a round process, largest at the contact with the basihyal, and tapered toward the free end. The bone, when found complete, will no doubt bear a close similarity to that in the horse.

VERTEBRAL COLUMN.

Specimen No. 11,072, C. M., Cat. Vert. Foss., consists of the complete skull and lower jaws, the entire vertebral column with the pelvis, the ribs, and the anterior portion of the sternum, all in position as originally found in the quarry (See Plates XLVII and LV). A portion of the scapula and the humerus were also found in front of the ribs and below the cervicals. The rest of the limb and foot-bones were dislocated, but found in close proximity to the skeleton. This individual is slightly larger than No. 11,071, in this respect more nearly agreeing with the type of *D. cornutus* (Osborn). Osborn has given fifteen dorsals in his restoration of *Dolichorhinus* "*hyognathus*,"[4] while Riggs states the correct number of dorsal vertebræ to be seventeen.[5] The view maintained by Riggs is confirmed by specimen No. 11,072, in which there are present and articulated in position seven cervicals, seventeen dorsals, four lumbars, and four sacrals[6]. Slightly disarticulated, but near the sacrum, were also found six of the proximal caudal vertebræ. The exact number of caudals is, therefore, not as yet exactly known.

Atlas.—The atlas is broadly expanded laterally. This is due in a great measure to the expanse of the transverse process (See Plates XLVII and LVI). The posterior face of the transverse process at the base is pierced by a well developed arterial canal. The atlantal foramen is also of normal size. The neural spine is well developed and the cotyli for the occipital condyles are deeply excavated, while ventrally the arch is well rounded from side to side with but slightly developed or no hypapophyses. The articulation for the axis is well expanded laterally, extending outwardly on the base of the transverse process.

Axis.—The axis has a very prominent and sharp ventral keel, which terminates posteriorly in a rugose tubercle, triangular in outline. The neural spine is well elevated, very heavy, and triangular in cross-section, with the apex of the triangle directed forwards. The articulation for the atlas is well expanded laterally to fit the corresponding surface on the atlas, already described. The transverse process of the axis is not very prominent.

Remaining Cervicals.—The third, fourth, and fifth cervical vertebræ are very nearly uniform in size and in structural details. The ventral keel is prominent and sharp on the third and fourth, but back of the fourth this keel becomes gradually lighter. On the fifth cervical the posterior wing of the transverse process is slightly more rugose on the external face than is the case on the transverse process of the preceding vertebræ. The neural spine is also slightly higher than

[4] Bull. A. M. N. H., Vol. XXIV, 1908, p. 612.

[5] Field Mus. N. H., Vol. IV, 1912, p. 31.

[6] The number of sacrals varies from four to five, (see later under *sacrum*).

on the third and fourth cervicals. The sixth cervical has the usual hatchet-shaped ventral portion of the transverse process, which in this individual extends well beyond the centrum both in front and back. The upper portion, or the true transverse process, is well developed, trihedral in section, and extends directly outward from the side of the vertebra. The neural spine, though thin, is normal in height. The transverse process of the seventh cervical, as is usual in the perissodactyla, lacks the inferior lamella, but the process itself is prominent and extends laterally beyond that of the first dorsal. The neural spine of this vertebra is well elevated over the arch and terminates in a sharp trihedral point.

Dorsals.—There is a sudden rise of the neural spines of the anterior dorsals which then gradually decrease in height until the twelfth is reached. At this point the neural spines gradually take on the more attenuated characters of the lumbar vertebræ. On the eleventh and twelfth dorsals the post-zygapophyses are larger and more elevated over the prezygapophyses of the succeeding vertebræ; and the interlocking condition characteristic of the lumbars does not begin to take place until the fifteenth dorsal is reached.

Lumbar vertebræ.—The transverse process of the lumbar vertebræ are moderately expanded laterally, and are quite attenuated. The anterior border has a curve from the base outwards and forwards while the posterior border is more nearly straight. The transverse process of the last lumbar has the anterior

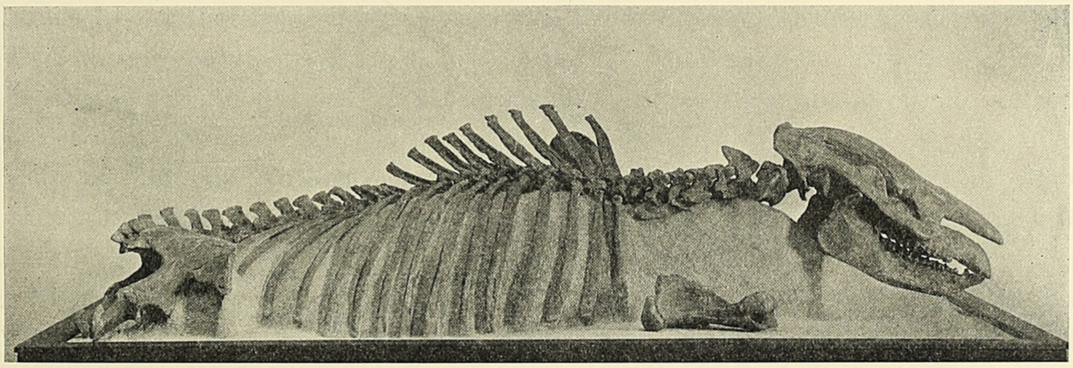

FIG. 3. *Dolichorhinus longiceps* Douglass. No. 12,200, Field Museum of Natural History. About one-sixteenth natural size. Showing the skeleton practically in the position in which it was found. (Courtesy of the Field Museum of Natural History).

and posterior borders more nearly parallel, and the process itself is also smaller than on the preceding vertebræ. The zygapophyses of the lumbars are well interlocked and present features not unlike those in the recent horse.

Sacrals.—There are in No. 11,072, as stated above, four coössified sacral vertebræ, of which the two anterior carry the heaviest neural spines. The third sacral has a slightly reduced spine, while in the fourth the reduction is more noticeable. All of the spines are close together and show a tendency to coalesce, but are distinctly differentiated one from the other. The ilium is supported mainly by the two anterior vertebræ, though the pleurapophyses are well developed throughout the sacrum, and it is completely consolidated with the ilium. The sacrum of *Dolichorhinus* varies considerably in regard to the number of ankylosed centra, and also in the detailed structure of the neural spines. In the collection of the Carnegie Museum are two sacra (Nos. 3,840 and 11,071) which have five coössified centra. No. 11,071 also shows a wider spacing between the neural spines, and the spines themselves are more expanded fore-and-aft at their summits than those of No. 11,072. Mr. E. S. Riggs of the Field Museum of Natural History has made a positive statement (Field Museum Publications, No. 159, Geol. Ser., Vol. IV, p. 31), that the specimen in Chicago has four sacrals. A recent communication from Riggs confirms his published statement and he adds that the neural spines are close together but distinct from one another. This description appears to agree with the conditions found in our No. 11,072. (See Plate XLVII, fig. 2.) Professor Osborn has apparently given four centra to the sacrum in his restoration of *Dolichorhinus* (Bull. A. M. N. H., Vol. XXIV, p. 612).

Caudals.—The caudal region is, as stated above, p. 412, represented by six vertebræ, which pertain to the proximal portion of the tail. The exact number of caudals is not known, but it does not appear unlikely that Professor Osborn, who has given approximately twenty as the correct number, is right, especially since he appears to have some vertebræ, which are represented in the distal portion of the tail in his restoration (*l. c.*, p. 612). The caudal vertebræ which belong to our No. 11,071 display the characteristic titanotheroid features in having with the exception of the first, well developed and forwardly directed chevrons, which are solidly coössified with the centra. The neural spines of the first three caudals have their summits expanded fore-and-aft like those of *Brontops dispar;* the transverse processes are heavy; and the prezygapophyses are located high on the pedicle as in the Oligocene genus. The vertebra, which is designated as the first caudal, has no chevron, while on the second the processes are broken, but indicate that there was originally a chevron of considerable size. On the third of the series the chevron is preserved and has a length of about 24 mm., while that of the fourth is about 35 mm. long. Back of the fourth caudal the chevrons appear to be wanting and the neural spine is also reduced.

RIBS.

The ribs are heavy, flat, broad, but not especially long. They are not unlike those of the Oligocene titanotheres, and thus indicate a large thorax, with but a short space between the last rib and the antero-superior border of the ilium, as is the case in most Perissodactyla. The last rib is suddenly reduced both in length and thickness, but retains a perfect and enlarged ventral end for cartilaginous attachments. The first and second sternebræ are in position. The manubrium is quite long, expanded and truncated immediately in front of, and constricted back of, the attachments for the first pair of ribs. Back of this constriction, the bone is sub-triangular in cross-section and gradually expands posteriorly, terminating in a truncated and rugose end. The succeeding segment is less than one-half the length of the presternum and is quadrate in outline.

Measurements.	No. 11,072	No. 11,071
Greatest length of skull	620 mm.	600 mm.
Length of superior dentition, I^1 to and including M^3	293[7]	298
Length of premolar series, including diastema back of P^1	84	84
Length of molar series	120	120
Greatest length of mandible	465	480
Length of inferior dentition I_1 to and including M_3	290	304
Length of premolar series, including diastema back of P_1	93	92
Length of molar series	125	120
Total length of vertebral column measured along the curves of the back bone	1650 mm.	
Length of cervical region	400 mm.	
Length of dorsal region	750 mm.	
Length of lumbar region	250 mm.	
Length of sacral region	145 mm.	
Length of tail as represented by vertebræ present	54 mm.	
Length of first rib	245 mm.	
Length of seventh rib	510 mm.	
Length of last rib	310 mm.	
Length of manubrium	123 mm.	
Length of sternebra	58 mm.	

FORE LIMB

The fore limb of No. 11,071 was found in position.

Scapula.—With the exception of slight crushing of the spine, the scapula is perfectly preserved, and thus for the first time we are able to ascertain its complete and correct outline. From the incomplete scapula described and figured in an earlier publication[8] Peterson was led to believe that "the general outlines of the scapula are on the whole more suggestive of the Rhinocerotidæ than the titanotheres." This is now seen to be erroneous, since the complete scapula before us, shows that it is conformed to that of the titanotheres. The bone, however, is proportionally longer and slenderer than in *Brontops dispar*, and the

[7] The incisors of the upper and lower jaws, as well as the canines, are restored, and the measurements are only approximate.

[8] Peterson, Annals Car. Mus., Vol. IX, 1914, p. 134.

lower portion of the blade has the appearance of being thrust forward as in *Diceratherium*, while the upper part differs from the latter by extending forward instead of backward, thus giving the coracoid border a sinuous curve above the supra-scapular notch, which is well illustrated on Plate XLVIII, fig. 2. The spine is quite prominent, as in the Oligocene titanotheres, but the supra-spinous fossa is of relatively greater antero-posterior diameter than in the latter. The infra-spinous fossa is subtriangular in outline, chiefly due to the prominent and angular process for ligamentary attachments. There is relatively a greater distance from this process to the extreme superior border of the scapula than in *Brontops dispar*, which gives the bone the proportionally greater length and slenderness referred to above. The glenoid cavity is ovate in outline with a beak-like process of considerable size directly in front. The coracoid process is rather small and more distinctly separated from the border of the glenoid cavity than in *Brontops dispar*. The latter has a heavy rugose ridge extending from the antero-external angle of the glenoid cavity to and across the coracoid process, which does not occur in *Dolichorhinus*. The inner face of the blade of the scapula is quite smooth, concave from above downward, and convex antero-posteriorly. The subscapular fossa is not deep or large.

Humerus.—The humerus of No. 11,071 has been laterally crushed. The distal end is especially affected by this crushing, so that the trochlea and anconeal fossa appear too narrow, and the shaft too long, when compared with the uncrushed humeri of other individuals. In No. 11,072, on the other hand, the bone has received vertical crushing, so that the humerus appears too short. The humerus of No. 2,865 described as *Dolichorhinus longiceps* by Peterson[9] retains the original shape and serves well as a guide. The articular surface of the head extends downwards on the posterior face to a rather unusual extent, and in this respect is unlike that in the Oligocene genus *Brontops* and more nearly suggests some rhinoceroses of the Oligocene (*Trigonias* and *Hyracodon*). The greater tuberosity has the same relative height and antero-posterior extent upon the head as in *Brontops dispar*, but transversely it has proportionally a smaller diameter. The deltoid groove is deep as in *Brontops*, due to the development of the lesser tuberosity and the hook-like process bordering the groove on the ulnar side. The development of the external tubercle on the deltoid ridge is very much less than in *Brontops dispar*. This together with the great development in the region of the ectepicondyle, or the supinator ridge in the latter genus, is not developed nearly as greatly as in *Dolichorhinus*. The distal trochlea is oblique as in *Brontops dispar*, though deeper. The internal condyle takes up the greater portion of the

[9] Peterson, Annals Car. Mus., Vol. IX, 1914, p. 134.

articulation, the external condyle chiefly consisting of a small facet on the anterior face of the trochlea external to the heavy intercondylar ridge. In fact the general proportions of the humerus as a whole recall the Oligocene rhinoceroses.

Radius and Ulna.—The radius and ulna are crushed laterally in the same way as the humerus described above. This crushing has, no doubt, increased the length, so that both the humerus and the lower part of the limb appear relatively longer, when compared with the more perfectly preserved limb of *Dolichorhinus longiceps* described by Peterson, (*l. c.*, p. 134.) As in that specimen, the radius and ulna of No. 11,071 are coössified at the upper and lower ends, a condition unlike that found in these bones in *Brontops dispar*, where they are separated throughout. The head and distal end of the radius in *Brontops* are also seen to be more enlarged than in the present genus. The bones are on the whole relatively longer in *Dolichorhinus* than in *Brontops*, even when proper allowance is made for the crushing referred to above. Besides the greater slenderness of the ulna, the region of the olecranon is less developed in the form from the Uinta; consequently there is not that great backward projection of the olecranon process seen in *Brontops dispar*. The bones are therefore more nearly like those of the Oligocene rhinoceroses than of the true titanotheres.

Although the humerus of the genus *Eotitanotherium*[10] from the Uinta is in general construction typical of the titanotheres of the Oligocene, the radius and ulna (*l. c.*, p. 44) are slender and more nearly like those of *Dolichorhinus*.

The manus of *Dolichorhinus* was described by O. A. Peterson (*l. c.*, pp. 135–137), but a closer comparison of the elements of the manus in the three genera *Eotitanotherium*, *Dolichorhinus*, and *Brontops* is here given to aid the student.

Scaphoid.—The scaphoid of *Dolichorhinus* is actually higher than in *Eotitanotherium osborni* (C. M., No. 2,860). The scaphoid of the latter is a larger bone, especially in the fore-and-aft dimensions, and, as Peterson has already stated, (*l. c.*, p. 135), the anterior articulation for the magnum is of much larger size, due to the larger descending and truncated mass of the bone in *Eotitanotherium*, a distinct feature of the Oligocene forms (Compare *Brontops*). A second feature very noticeable is the facet for the lunar along the ulnar face. In *Dolichorhinus* this facet is located on an overhanging lip near the dorsal face, and forms nearly one-half of a circle; while in *Eotitanotherium* it runs in an almost straight direction fore-and-aft as in *Brontops dispar*. The radial surface of the scaphoid in *Dolichorhinus* is more convex than it is in *Eotitanotherium*, and in this respect *Dolichorhinus* from the Uinta and *Brontops* from the Oligocene are more nearly alike. There is no noteworthy difference between the scaphoid of No. 11,071, and

[10] Peterson, Annals Car. Mus., Vol. IX, 1914, p. 43.

of No. 2,865, which Mr. Peterson described as belonging to *Dolichorhinus longiceps* (*l. c.*, p. 135).

Lunar.—The lunar has a greater constriction of the articulation for the radius; and the palmar portion of this articulation is more oblique downward and outward than in *Brontops*. The greater degree of this constriction in *Dolichorhinus* is chiefly in order to accommodate the greater convexity of the articulation of the scaphoid described above. The broad facet for the unciform is seen to be equally broad in *Brontops dispar*, but, as Peterson has already observed (*l. c.*, pp. 135–136), the latter has the posterior portion of this facet suddenly concave nearly to the same degree as the facet for the magnum. In *Dolichorhinus*, on the other hand, the facet for the unciform does not extend so far back, and has a more evenly convex surface from the front backward, and the posterior portion of the two facets, that for the unciform and that for the magnum, besides being dissimilar, are more distinctly separated by a ridge, which extends lower down than is the case in *Brontops dispar*. The lunar of No. 11,071 appears to have the anterior portion of the facet for the radius narrower than is the case in No. 2,865, described in 1914. Otherwise there is little or no difference in this bone in the two animals.

Cuneiform.—The cuneiform of *Dolichorhinus* is relatively high, when compared with *Brontops dispar*, and is, no doubt, also higher than in *Eotitanotherium*. As Peterson has already stated (*l. c.*, p. 136) the facet for the pisiform occupies a relatively greater transverse area than in *Brontops*, but the ulnar portion of the cuneiform has relatively a smaller antero-posterior diameter, so that the facet for the radius has a triangular outline with the apex directed towards the ulnar face, while in *Brontops dispar* the facet is subovate, the external and internal portions of the facet having equal dimensions. The radial face carries the two facets for the lunar usually found in the Perissodactyla, the superior being somewhat less overhanging than in *Brontops*, due to the smaller development of the dorsal radial angle of the cuneiform. The distal face is entirely taken up by the facet for the unciform. The latter facet is more evenly concave from side to side than in *Brontops*, and is really more analogous to that in Miocene rhinoceroses (Compare *Diceratherium*). The differences in the cuneiform of No. 11,071 and No. 2,865 are slight.

Pisiform.—Peterson has observed that the pisiform of *Dolichorhinus* differs from that of *Eotitanotherium* and the Oligocene titanotheres generally by being proportionally heavier and shorter. The transverse diameter of the facet for the ulna is relatively smaller, while that for the cuneiform is greater than in *Brontops dispar*. The pisiform of *Eotitanotherium* (C. M., No. 2,860) is too much crushed at the proximal end to admit of an accurate comparison. This bone of the two latter genera is, however, remarkably similar in having attenuated shafts and deep terminal tuberosities, which have already been pointed out by Peterson (*l. c.*, p. 45). There is no noteworthy difference in the pisiform of the present specimen and that described earlier (*l. c.*, p. 136).

Trapezium.—The trapezium is relatively large when compared with *Brontops dispar.* In an earlier publication it was observed that there are "three articulating facets on the ulnar angle; a large median surface for the trapezoid and two smaller facets separated from the larger by well defined ridges, and articulating, one with the scaphoid, and the other with Mc. II," (Peterson, *l. c.*, p. 136). The trapezium as a whole has actually a greater vertical diameter than in *Brontops.* This is chiefly due to the downward projecting process which is apparently absent in the Oligocene genus. The differences in the trapezium of the present specimen and the one described earlier are only of very minor importance.

Trapezoid.—The trapezoid of No. 11,071 is narrow, but has a proportionally greater antero-posterior diameter than in either *Eotitanotherium* or *Brontops.* The surface for the scaphoid is saddle-shaped, as in the titanotheres generally, but the palmar-radial portion of the facet extends further back, due to an extended tubercle which is not, however, nearly so well developed in *Eotitanotherium* or *Brontops.* Radially the bone bears a large flat facet for the trapezium, while on the ulnar side there is, besides the large facet for the magnum, a second very small facet on the palmar-superior angle, which comes in contact with the posterior elevated portion of the magnum upon flexion of the carpals. This second facet on the ulnar face of the trapezoid is very much better developed in both *Eotitanotherium* and *Brontops.* (*Cf.* Peterson, *l. c.*, p. 136). Distally the entire bone is taken up by the saddle-shaped facet for Mc. II, which is slightly less convex fore-and-aft than the proximal face. The transverse diameter of the trapezoid in No. 11,071 is less, and the antero-posterior diameter greater, than in No. 2,865. This is mainly due to the greater development of the palmar tubercle in No. 11,071 referred to above, and the smaller development of the radial angle. These characters may be of specific value, but most probably are only individual differences.

Magnum.—The magnum differs from that bone in *Brontops dispar* in one or two important characters. The head of Mc.IV does not touch the palmar ulnar angle of the magnum so as to form a facet, as in *Brontops*, and the palmar tuberosity has a relatively greater transverse and a smaller vertical diameter. The latter character, together with the steep slope of the articular facet for the unciform and the relatively greater height of the magnum when compared with that in *Brontops*, was noted in a former paper (Peterson, *l. c.*, p. 136). Unfortunately the magnum of *Eotitanotherium* is not known, and Mc.IV of the same genus is also injured along the radial border of the head. There are no differences worthy of mention between the magnum in Nos. 11,071 and 2,865.

Unciform.—The unciform is relatively higher than in *Brontops*. The region of the proximal facets (those for the lunar and cuneiform) are notably elevated above the palmar tuberosity, when compared with *Brontops*. In the latter there is, however, an elevated and hemispherical posterior portion of the facet for the lunar, which also articulates with the plantar-radial part of the facet for the cuneiform, not found in *Dolichorhinus*. These characters, together with the steeper slope of the articulation for the magnum of this bone in the two genera has already been observed. (*Cf.* Peterson, *l. c.*, p. 136). The articulations for the lunar and cuneiform in the unciform of No. 11,071 are greater in their antero-posterior diameters than in No. 2,865, while the palmar tuberosity is less developed. These are, no doubt, individual differences, which should be regarded as of minor importance.

Peterson (*l. c.*, p. 137) states that the metacarpals of *Dolichorhinus* are relatively short, when compared with those in *Eotitanotherium*. On making a comparison with the metacarpals in *Brontops dispar*, on the other hand, it is plain that those in *Dolichorhinus* are longer and slenderer in proportion. The head of Mc.III rises higher, giving a greater elevation to the magnum than in *Brontops*. This feature in *Dolichorhinus* is more nearly the condition found in the rhinoceroses. In *Dolichorhinus* the radial face of the head of Mc.IV only articulates with Mc.III, while in *Brontops* there is a small facet back of that for Mc.III, which touches the posterior ulnar angle of the distal articulation of the magnum. This facet furnishes additional support for the fourth digit in the Oligocene titanotheres and has already been described above. The shafts of the metacarpals are rather flat and straight, which is characteristic of the titanotheres. In *Dolichorhinus* the distal ends of the metacarpals are not enlarged laterally as much as in *Brontops*, while in the fore-and-aft direction they are equally developed in the two genera. The carina of the distal trochlea, in the two forms is also equally developed. There is little or no difference in the metacarpals of No. 11,071 and those of No. 2,865.

The sesamoids are well developed, especially in their plantar-dorsal direction. They are sometimes found to be coössified and have between them a tendinal groove on the plantar face of the coössified bones.

The phalanges are characteristically titanotheroid in all their main features, that is to say, they are broad, flat, and rather short. Those of the proximal row are about twice the length of those in the median row. The terminal phalanges are very short, quite rugose, and truncated anteriorly, indicating a blunt horny covering.

Measurements.	No. 11,071	No. 11,072
Scapula, greatest length	395 mm.	
Scapula, greatest diameter across the blade	205 mm.	
Scapula, antero-posterior diameter just above articular surface for humerus	92 mm.	
Scapula, greatest antero-posterior diameter of head of scapula	100 mm.	103 mm.
Scapula, antero-posterior diameter of glenoid articulation	73 mm.	78 mm.
Scapula, transverse diameter of glenoid articulation	57 mm.	57 mm.
Humerus, greatest length	340 mm.	285*mm.
Humerus, length from articulating head to distal end	302 mm.	260*mm.
Humerus, greatest transverse diameter of distal end	77*mm.	100 mm.
Humerus, greatest transverse diameter of trochlea	62*mm.	77 mm.
Ulna, greatest length	315 mm.	
Radius, greatest length	328 mm.	
Radius, transverse diameter of head	65*mm.	
Radius, transverse diameter of distal end (distal end of ulna included)	83*mm.	
Manus, greatest length	225 mm.	
Carpus, greatest vertical diameter	58 mm.	
Carpus, greatest breadth, measured across the top row of carpals	87 mm.	
Scaphoid, greatest transverse diameter	43 mm.	
Scaphoid, greatest antero-posterior diameter	33 mm.	
Scaphoid, greatest vertical diameter	31 mm.	
Lunar, greatest vertical diameter	34 mm.	
Lunar, greatest transverse diameter	30 mm.	
Lunar, greatest antero-posterior diameter	41 mm.	
Cuneiform, greatest antero-posterior diameter	25 mm.	
Cuneiform, greatest transverse diameter	41 mm.	
Cuneiform, greatest vertical diameter	26 mm.	
Pisiform, greatest length	52 mm.	
Pisiform, vertical diameter of free end	27 mm.	
Pisiform, greatest vertical diameter of proximal end	20 mm.	
Pisiform, greatest antero-posterior diameter of proximal end	25 mm.	
Trapezium, greatest antero-posterior diameter	13 mm.	
Trapezium, greatest vertical diameter	27 mm.	
Trapezoid, greatest vertical diameter	18 mm.	
Trapezoid, greatest transverse diameter	20 mm.	
Trapezoid, greatest antero-posterior diameter	31 mm.	
Magnum, greatest antero-posterior diameter	48 mm.	
Magnum, greatest transverse diameter	18 mm.	
Magnum, greatest vertical diameter	38 mm.	
Unciform, greatest vertical diameter	40 mm.	
Unciform, greatest transverse diameter	41 mm.	
Unciform, greatest antero-posterior diameter	42 mm.	
Metacarpal II, greatest length	122 mm.	
Metacarpal III, greatest length	128 mm.	
Metacarpal IV, greatest length	115 mm.	
Metacarpal V, greatest length	103 mm.	
Phalanges, length of the total series, digit II	53 mm.	
Phalanges, length of the total series, digit III, approximately	55 mm.	
Phalanges, length of the total series, digit IV	62 mm.	
Phalanges, length of the total series, digit V	55 mm.	

* Indicates distortion and unreliable measurements.

HIND LIMB.

Pelvis.—The pelvis of *Dolichorhinus* may be said to combine the characters of the Oligocene rhinoceroses and the titanotheres. The ilium is evenly rounded above and the pubic symphysis is heavy and well coössified, with a tendency to the heavy downward projecting hook at the posterior inferior extremity of the pubis, as in the titanotheres; while the gluteal surface of the ilium is more concave, the shaft longer, the sacro-sciatic notch deeper, and the ischium and pubis longer, as in the rhinoceroses. The author has previously observed (*l. c.*, p. 47) that the ilium of *Eotitanotherium osborni* has a relatively longer shaft than is the case in *Brontops*. In *Dolichorhinus* the ilium is broadly expanded across the region of the gluteal muscles terminating above in a recurved process with its summit evenly rounded fore-and-aft, enlarged and rugose transversely, and with a liberal antero-posterior dimension. The point of the ilium consists of an evenly rounded process. The crest of the ilium is, as stated above, well rounded, while behind the flare is suddenly contracted into the rather long shaft, producing deep notches above and below, of which the sacro-sciatic is the deeper partly because of the backward prolongation of the sacrum and the prominent ischial spine. The acetabulum is evenly rounded, deep, its upper border heavier than the lower; the cotyloid notch wide; and the pit for the round ligament rather large. The ischium, though short, is relatively longer than in *Brontops*. Its shaft is trihedral in cross-section and expands suddenly behind, terminating in a truncated end, which is vertically deep. This vertical depth is due in part to the prominent ischial tuberosity, but more especially to the ramus, which extends downwards to meet the pubis. The obturator foramen is large and ovate in outline. The shaft of the pubis below the acetabulum is well proportioned and the symphysis is solidly coössified. The ramus on the border of the obturator foramen is rather slender and trihedral in cross-section.

The pelvis of No. 11,072 is crushed fore-and-aft, especially on the right side, so that the shaft of the ilium appears short. The ischium is also more or less affected by this crushing. In No. 3,840 the pelvis is more perfectly preserved and has been partly used in preparing the above description. (See Plate L.)

Femur.—Four femora were found by Mr. Douglass in the quarry near the Wagonhound Canyon. These bones vary in shape, but more especially in size, no doubt due to sex, individual differences, and to crushing in one way or another. The largest of these four femora is provisionally referred to No. 11,072, described above. The head is rounded and the pit for the ligamentum teres is well developed, but the neck is short and affords comparatively limited surface for the insertion of the capsular ligament of the hip-joint. The greater trochanter is slightly higher than the head and at its top somewhat laterally expanded, a typical titanotheroid feature. The digital fossa is small, which is also characteristic of *Brontops*. The upper anterior face of the shaft has a broad surface indented by a rather shallow fossa, which extends well downwards. Behind there is a deeper fossa, which is bordered on the fibular side by a heavy ridge descending from the trochanteric mass, and on the tibial side by a rather sharp ridge, which begins immediately below the rim of the articulation and continues downwards to the apex of the lesser trochanter. The third trochanter is of moderate size in the femur provisionally referred to No. 11,072, while on the bone referred to No. 11,071 it is larger and gives a twisted appearance to this region of the shaft, viewed from behind. (See Plate LII, fig. 2.) Below the third trochanter the shaft is D-shaped in No. 11,072, while in some of the other specimens this region is more or less trihedral in cross-section. These differences are to some extent due to crushing. The lower extremity is not greatly expanded, the inter-condylar notch and the articulating surfaces of the condyles being rather narrow. The rotular trochlea is rather evenly convex from side to side and the lateral borders are thin and sharp.

There is not much difference in size or in the general details of structure in the femur of *Dolichorhinus* and *Eotitanotherium*. In the latter the supracondylar fossa is, however, shallower, and the fossa above the rotular trochlea deeper and larger than in *Dolichorhinus* and in *Brontops dispar*, as already noted by Peterson, (*l. c.*, p. 47).

Patella.—The patella is higher than broad as is usual in the titanotheres. The anterior face of the bone is unevenly convex, the tibial border being heavier than the fibular. Near the top along the inside border is a large truncated tubercle for muscular attachments. The articulating surfaces for the rotular trochlea of the femur are divided by a heavy and vertical ridge. The articulation on the tibial side of this ridge is slightly larger than that on the fibular side. The patella is titanotheroid in every respect.

The tibia, fibula, and hind foot were found in close proximity to the smaller skeleton, No. 11,071 and are provisionally assigned to it.

Tibia.—The tibia is approximately three-fourths the length of the four femora mentioned in the foregoing description. The spine, which separates the articulating surfaces of the head, is prominent, especially on the fibular side and the articulating surfaces themselves are well expanded, furnishing a liberal support for the condyles of the femur. The cnemial crest is not large and slopes rather rapidly in its downward course, the upper part of the shaft being distinctly triangular in cross-section. The middle region of the shaft may be said to have four faces, the tibial and fibular being flat, while the posterior and postero-tibial are more rounded. The lower portion of the shaft is well demarcated, especially by the prominent ridges in front and on the fibular angle. The distal trochlea is divided by a heavy rounded ridge. The tibial portion of the trochlea is narrow and evenly convex fore-and-aft, as well as from side to side, while the fibular portion slants upward at an angle of 60° or more, so that when the tibia is placed on the astragalus there is a quite noteworthy outward turn at the ankle-joint. The distal end of the tibia does not come in contact with the calcaneum.

The tibia in *Eotitanotherium osborni* described by Peterson (*l. c.*, p. 48) is no heavier than that bone in *Dolichorhinus*, but is nearly one-fourth longer. Even when the crushing of the tibia in *Eotitanotherium* is taken into proper considera-tion it is quite plain that this bone in that genus is not as distinctly marked by ridges extending up and down on the shaft as in *Dolichorhinus*.

Fibula.—The upper end of the fibula is solidly coössified with the tibia. The reduction of the shaft is in about the same ratio as in *Brontops dispar*. The antero-posterior diameter of the distal end is twice the transverse diameter. The contact with the tibia is quite rugose, but coössification does not take place. The articu-lation for the astragalus is liberal in dimension, and on the posterior distal angle there is located a small facet, which comes in contact with the calcaneum on flexion of the ankle-joint.

In *Eotitanotherium* the ankle-joint does not appear to be so much thrown outward as in *Dolichorhinus* and the whole aspect of the hind limb appears lighter. In *Brontops dispar*, on the other hand, the hind limb has more nearly the propro-tions of *Dolichorhinus*, while the ankle-joint is more in line with the shaft of the tibia and recalls that of *Eotitanotherium*.

The hind foot of *Dolichorhinus* is very nearly complete in No. 11,071, the sesamoids and phalanges being the only parts not recovered. The relative height of the fore and hind feet is approximately the same as in *Brontops dispar*. In *Eotitanotherium* the feet, as well as the limbs, are longer and slenderer, as has already been pointed out by Peterson (*l. c.*, pp. 46–50).

Astragalus.—The astragalus in detail is much like that of *Eotitanotherium*. In the latter genus the part below the trochlear groove is, however, longer; the ectal and cuboidal facets are united on the plantar face; the vertical ridge on the tibial face is less developed below and the facet for the cuboid has a more direct distal location. The two last mentioned characters in *Dolichorhinus* are obviously more like what is seen in *Brontops*, where the comparatively large facet for the cuboid is directly distal and the whole inside face of the bone near the articular facet for the navicular has developed into a heavy, rounded, and rugose ridge. In *Dolichorhinus* the ectal and cuboidal facets on the plantar face are distinctly separated by an excavation as in *Brontops*, and unlike *Eotitanotherium* where these two facets are united, as shown by Peterson. The external or fibular ridge of the astragalar trochlea is extended further back against the tuber of the calcaneum than in *Brontops*, so that the tibia does not come in contact with the calcaneum on flexion as in *Brontops*. On the whole the width of the astragalus in *Dolichorhinus* is slightly greater than the length. In *Brontops* the width is very considerably greater than the length, while in *Eotitanotherium* the length of the bone is greater than the width.

Calcaneum.—The most noticeable and distinctive feature of the calcaneum in *Dolichorhinus* is the broad plantar face of the tuber calcis, which is different from both *Brontops* and *Eotitanotherium*. In the two latter the tuber of the calcaneum is similar in its general details of structure, as well as in its position in the articulated foot. In *Eotitanotherium* and in *Brontops* the fibular face of the tuber calcis, when in the articulated foot, has a decided inward dip, while in *Dolichorhinus* the external or fibular face is more nearly vertical. The extremity of the tuber in *Dolichorhinus* is also more enlarged than in the other two genera. In *Dolichorhinus* the proximal astragalar facet is raised above the upper margin of the tuber calcis as in *Brontops*, but there is no directly posterior facet for the lower end of the tibia, as in the latter. On the fibular angle there is, however, a small facet, which meets a corresponding facet on the fibula. The greater process of the lower end is shorter, and the lesser process is longer than in *Eotitanotherium*. In this respect it thus appears that the lower end of the calcaneum in *Brontops* and *Dolichorhinus* are more alike, they having their distal processes more nearly on a line at right angle with the axis of the bone than in *Eotitanotherium*, in which the facet for the cuboid is more slanted inwardly and upwardly and the lesser process not descending so low.

Cuboid.—The cuboid in general appearance is more rhinoceroid than titanotheroid. It is high, rather narrow, with the plantar tuberosity large, hook-like, and extending well below the articulating surface for the fourth metatarsal. The facet for the fourth metatarsal occupies the entire distal face as in *Diceratherium*, while in the Oligocene titanotheres there is in addition a facet for Mt. III on the tibial angle of the cuboid. On the tibial face there are four facets. Two of these articulate with the navicular and are located, one on the angle of the articulation for the astragalus, and the other on the upper portion of a lip-like projection on the tibial face of the bone. The other two facets articulate with the ectocuneiform. One of these takes up the inferior portion of the lip-like projection referred to above and the other is located on the tibial angle of the facet for Mt. IV. The proximal face is taken up by the articular facets for the calcaneum and astragalus. These two facets are separated by a rounded ridge, almost directly fore-and-aft in position. The facet for the calcaneum takes up two-thirds of the area, while that for the astragalus covers one-third of the proximal face along the tibial side of the bone. The dorsal, plantar, and fibular faces are rugose, but quite distinct from one another, due to the rather prominent vertical ridges on the antero- and postero-fibular angles.

In the Oligocene titanotheres the cuboid is more depressed, the proximal facets placed at greater angles from one another, the distal face with two facets instead of one, and the tibial face has a long contact with the ectocuneiform. In *Eotitanotherium* the cuboid is not known.

Navicular.—The navicular, though relatively somewhat higher, has the breadth characteristic of the titanotheres in general. The articulation for the astragalus is evenly concave from before backward, and not basin-shaped, as in some of the titanotheres. The fibular portion of the facet is also more gently rounded in a downward direction, while in *Brontops* there is a more decided ridge separating the two portions of the facet, and the fibular portion is directed downward at a greater angle. Distally the bone is convex in all directions, not unlike what is seen in the true titanotheres, and the facets for the cuneiforms are slightly separated by an almost imperceptible ridge. The fibular face is broadly excavated in the middle; in front and back of this excavation are facets articulating with the cuboid. This excavation is, however, not as deep as in the rhinoceroses, for example *Diceratherium*. The dorsal face is gently and evenly rounded, with a shallow and rugose groove extending nearly across the entire front of the bone. The tibial and plantar faces are broken in our specimens.

Ectocuneiform.—The ectocuneiform has a greater vertical diameter than the navicular. The bone is titanotheroid in its general outlines. In detail it differs slightly from the titanotheres, the most noticeable difference being the presence of two facets for the cuboid separated by a shallow excavation, whereas in *Brontops* the articulating surface is continuous. On the tibial face the bone articulates with Mt. II and with the mesocuneiform. Distally the articulation for Mt. III, as usual, occupies the entire surface. This facet is evenly concave fore-and-aft, nearly flat transversely, while in *Brontops* the surface is gently convex from side to side. The proximal face has two articulations: the larger, which is gently antero-posteriorly concave, articulating with the navicular; the smaller, located on the postero-fibular angle and articulating with the corresponding facet on the lower face of the projecting tubercle on the tibial face of the cuboid. The lower anterior portion of the fibular face is developed into a truncated process. This process touches the cuboid by an articular facet, which does not extend backwards, as generally is the case in the titanotheres. The dorsal face is gently rounded and rugose, while there is no tuberosity on the plantar surface.

Mesocuneiform.—The mesocuneiform is considerably reduced in size. Its proximal face is concave from side to side, and very gently concave from front to back. The articulation for the second metatarsal is nearly straight in the antero-posterior direction, while laterally it is convex. The antero-fibular angle is developed into a rounded and blunt process, while the dorso-tibial portion is nearly a plane surface, due to a vertical ridge, which separates the dorsal and tibial faces of the bone. The tibial face is much injured in the specimen I am describing. The fibular face is almost vertical and presents nearly a straight contour fore-and-aft. There are apparently three facets for the ectocuneiform, one above and two below. The posterior face is also injured. Whether or not there was an entocuneiform present, as in *Brontops*, cannot be determined from this specimen, due to the injury which the mesocuneiform has received.

Metatarsals.—The metatarsals are shorter and heavier than in *Eotitanotherium*. They are also different in general shape, those in the latter genus having the shafts more rounded or cylindroid, especially the second metatarsals. The shaft of this bone in *Dolichorhinus* is throughout more trihedral; the dorso-proximal portion being especially developed in the fibular direction. The articulation on the proximal end is evenly concave from side to side to correspond with the cuneiform, and there is an articulation on the plantar tibial face of the head, possibly for a rudimentary first metatarsal. If the latter metatarsal was represented, there was also undoubtedly an entocuneiform. The distal end is very little wider than the shaft and the articular surface for the phalanx differs in no noteworthy respect from that in the titanotheres generally.

The chief distinguishing feature of the third metatarsal is its single articulating surface for the ectocuneiform, while that in *Brontops* and the titanotheres generally shares the articulating surface with the cuboid, as stated above. Furthermore the articulations for Mt.IV in *Brontops* is connected by a prominent ridge along the upper edge of the head, while in *Dolichorhinus* this area is deeply excavated clear through to the proximal articulation, leaving these two facets widely separated on a lip-like projection on the dorsal and plantar angles of the head. The shaft is flat as in the titanotheres, and, as in Mt.II, the distal end is slightly wider than the shaft. The metapodial keel is confined to the posterior portion of the articulation.

The fourth metatarsal is slightly arched forward, but not to the extent seen in *Eotitanotherium*. The articulation for the cuboid is also less convex fore-and-aft, the surface being flat, more nearly as in *Brontops*. From the latter genus it differs, however, by having the anterior articulation for Mt.III the larger; whereas in *Brontops* the posterior articulation is the larger. This may be only an individual character. The shaft is heavy and trihedral in section. The distal end is no wider than the lower portion of the shaft and the trochlea is rather narrow, quite convex antero-posteriorly, and very gently convex transversely. The carina is of medium size.

Measurements.

	No. 11,071	No. 11,072
Pelvis, greatest length	485 mm.	419*mm.
Femur, greatest length	457*mm.	444 mm.
Tibia, greatest length	335 mm.	
Tibia, antero-posterior diameter of head	104 mm.	
Tibia, transverse diameter of head	100 mm.	
Tibia, transverse diameter distal end, fibula included	83 mm.	
Tibia, antero-posterior diameter distal end	61 mm.	
Pes, greatest length, phalanges not included	280 mm.	
Tarsus, greatest length, tuber of calcaneum included	145 mm.	
Calcaneum, greatest length	112 mm.	
Calcaneum, vertical diameter of free end of tuber calcis	41 mm.	
Calcaneum, transverse diameter of free end of tuber	38 mm.	
Calcaneum, transverse diameter of distal end	58 mm.	
Astragalus, transverse diameter	73 mm.	
Astragalus, vertical diameter	65 mm.	
Cuboid, vertical diameter dorsal face	34 mm.	
Cuboid, greatest transverse diameter	37 mm.	
Navicular, greatest vertical diameter	19 mm.	
Ectocuneiform, greatest vertical diameter	22 mm.	
Ectocuneiform, transverse diameter	29 mm.	
Ectocuneiform, antero-posterior diameter	36 mm.	
Mesocuneiform, vertical diameter	13 mm.	
Mesocuneiform, transverse diameter	19 mm.	
Mesocuneiform, antero-posterior diameter	30 mm.	
Metatarsal II, greatest length	128 mm.	
Metatarsal III, greatest length	132 mm.	
Metatarsal IV, greatest length	120 mm.	

* Indicates distortion and unreliable measurement.

RESTORATION OF THE SKELETON OF DOLICHORHINUS

(Plates LV and LVI).

The restoration of the skeleton of *Dolichorhinus* represented on Plate LVI is based upon the two skeletons Nos. 11,071 and 11,072, described in detail in the foregoing pages. The two skeletons are imbedded in half relief on a hard, brown, sandstone of fine texture (Plate LV). As already stated in the early part of this paper, the skeleton No. 11,072 consists of the nearly complete skull with lower jaws articulated and entire trunk. Parts of the fore limbs were found imbedded nearly in their proper position. No. 11,071 was found somewhat more disarticulated, but the association of the different parts is comparatively easy, since this specimen is a smaller and younger individual than No. 11,072. This second specimen also has the skull and lower jaws attached to the neck, the anterior portion of the trunk in position, but the posterior portion was disturbed, and the limbs, though found in close proximity, were disarticulated before final interment. These two specimens supplement one another most admirably and from them it has been possible to effect a restoration which is thought to be very nearly correct in all its main proportions.

The most characteristic feature of the animal is its long and narrow head. Among the titanotheres, the head of *Dolichorhinus* is rather unusual in having a decided convexity fore-and-aft as well as laterally in the region of the posterior portion of the frontals and the parietals. The maxillaries are long and slender and the nasals are long and deeply excavated laterally as is usual in the long-nosed titanotheres. To compensate for the elongated head, the neck is proportionally short. The trunk is typically titanotheroid, the thorax being long and the lumbar region short. The depth of the thoracic cavity is not excessive, as indicated by the ribs. The sacrum has usually four coössified vertebræ; this varies, however, as five centra are sometimes found. The proximal portion of the tail has chevrons characteristic of the Oligocene titanotheres (Compare *Brontops dispar*) and the length of the caudal appendage is approximately that of the latter genus.

As has been stated, the limbs are in part those of No. 11,071 and, as that individual is slightly smaller, the appendicular portion of the restoration, as represented on Plate LVI, may be a few centimeters shorter than would possibly be the case, were all the limb bones preserved in No. 11,072.

Plate LVII represents *Dolichorhinus* in the flesh to guide the eye, as to the probable appearance of this curious titanothere. This illustration brings out the elongated head and the slenderness of the anterior region of the neck in comparison with the true rhinoceros-like appearance of the trunk.

Measurements.

Height of skeleton at fore limbs	123 cm.
Height of skeleton at hind limbs	114 cm.
Greatest length of skeleton	234 cm.
Length of skeleton from end of pubis to posterior face of seventh cervical	135 cm.
Length of neck	40 cm.

Plate LV represents *Dolichorhinus longiceps* as finally prepared for exhibition in the Gallery of Fossil Mammals in the Carnegie Museum. The head, neck, and trunk remain in the original position in which they were found in the field. A portion of the left scapula and the humerus belonging to the trunk were found very nearly in the position in which they are placed in the exhibit, while the lower part of the fore limb and foot is partly or wholly restored from the opposite member. The right fore limb, as stated before, is complete and belongs to No. 11,071. The left femur is inserted, as probably belonging to specimen No. 11,072. As in the fore limb, the lower portion of the left hind limb and pes are restored from the opposite side. The caudals present with No. 11,072 have been worked out in half relief, in the same manner as the trunk and neck, and are mounted very nearly in the position in which they were originally found.

REVIEW OF THE SPECIES OF DOLICHORHINUS HATCHER[11] IN THEIR ORDER OF PUBLICATION.

1. **Dolichorhinus hyognathus** (Scott and Osborn).

Palæosyops hyognathus Scott and Osborn, Trans. Amer. Philos. Soc. N. S., Vol. XVI, Part III, Aug. 20, 1889, p. 513.

Type: Lower jaw, No. 10,273, Princeton Museum.

Locality: Washakie Basin, Wyoming.

Horizon: Upper Eocene, Horizon B of the Washakie Beds.

Original Description: "In the Washakie beds is found a large species, about the same size as *P. vallidens* Cope, which is provisionally referred to *Palæosyops* (*P. hyognathus*, spec. nov., Princeton collection No. 10,273). This is represented by a lower jaw seven-eighths as large as the type mandible of *Diplacodon*. As in the latter, the incisors form a close procumbent series; the tips forming a gently arched line when seen from above. The symphysis is extremely long (11 cm.) and shallow; the canines are rather small and semi-procumbent. The molar-premolar series measures 24.5 cm., the last molar measures 6.5 cm.; in *Diplacodon elatus* the same measurement is 10 cm. Unfortunately the premolar crowns are

[11] Hatcher separated *Dolichorhinus* from other Eocene titanotheres in 1895. Amer. Nat. Vol. XXIX, p. 1090.

broken; it is probable that one or two of the premolars will be found to be like the molars. The characters of the chin and symphysis are significant of close relationship to *Diplacodon elatus.*"

Mr. Charles Earle in his important "*Memoir Upon The Genus Palæosyops Leidy, And Its Allies*" (Jour. Acad. Nat. Sci., Phila., Vol. IX, 1884, pp. 348–350, Plate XI, figs. 10, 11), has furnished us with a description and excellent illustrations of the fragmentary type of *Dolichorhinus hyognathus.*

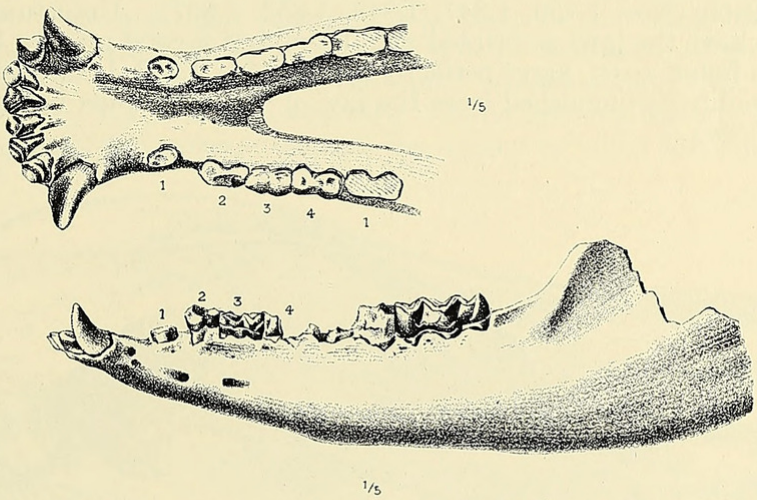

FIG. 4. *Dolichorhinus hyognathus* (Osborn) *Type.* No. 10,273, Princeton University Museum. (After Charles Earle.)

From Earle's description and illustrations together with the description of Scott and Osborn *Dolichorhinus hyognathus* is clearly seen to be a distinct species. The long symphysis and vertical ramus, the rapidly tapering horizontal ramus, and the apparent lack of the long and descending lobe of the inferior border of the ramus near the posterior end of the angle are characters which cannot be dismissed as merely individual. These facts taken together with the opinion already expressed by Mr. Riggs[12] constrain me to regard *D. hyognathus* as at least specifically distinct from any of the species of the Uinta deposits.

2. **Dolichorhinus cornutus** (Osborn).

Telmatotherium cornutum Osborn, Bull. A. M. N. H., Vol. VII, 1895, pp. 90–94.

Type: Skull No. 1,851, Collection American Museum of Natural History.

Paratypes: Skulls Nos. 1,850, 1,847, 1,848, 1,852, and 1,837[13]. Lower jaws No. 1,857, 1,858, 1854 and 1,855. Collection A. M. N. H.

[12] Field Museum of Natural History, Geol. Ser., Vol. IV, 1912, p. 32.

[13] In a later publication Professor Osborn used the skull bearing No. 1,837 as the type of his species *D. intermedius.* (Bull. Amer. Mus. Nat. Hist., Vol. XXIV, 1908, p. 611.

Locality: Uinta Basin, eastern part.

Horizon: Uinta Eocene, upper part of Horizon B.

Original Description: "Incisors $\frac{3}{2}$. [$\frac{3}{3}$]* Premolar-molar series, 208 mm. A narrow diastema. Upper canines lanceolate. Long premaxillary symphysis. A well-developed nasofrontal protuberance. Top of cranium completely flattened. No sagittal crest. An infraorbital process upon malar.

"The type of this species is a fine skull (No. 1,851), while several other well-preserved skulls from the same levels give us all the cranial characters and the superior dentition (Nos. 1,850, 1,847, 1,848, 1,852, 1,837). Unfortunately none of these skulls have the jaws associated with them, but several more or less perfect jaws, although found apart, agree perfectly in size (Nos. 1,857, 1,858, 1,854, 1,855); they are all readily distinguished from the jaw of *T. hyognathum* by the presence of *only two incisors*.

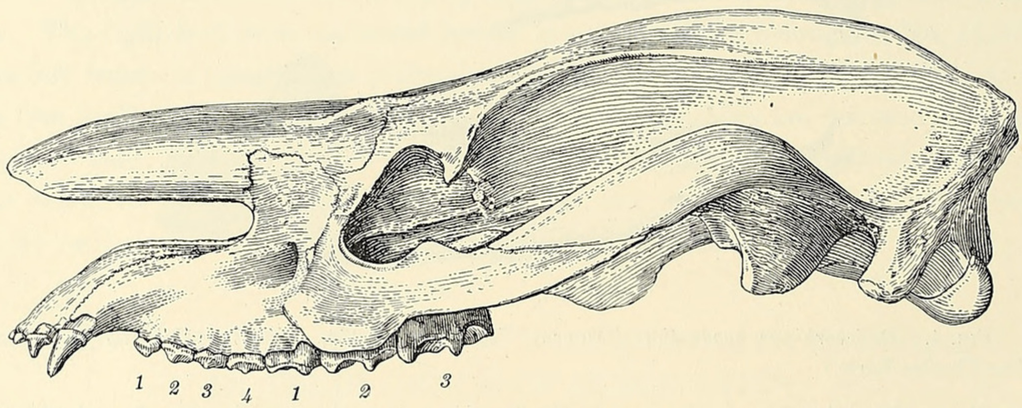

FIG. 5. *Dolichorhinus cornutus* (Osborn). *Type*. No. 1,851, Amer Mus. Nat. Hist. Side view, one-fourth natural size. (After Osborn.)

"This species is remarkable for its very long flat-topped cranium and its incipient knob-like osseous horns borne chiefly upon the nasals but partly upon the frontals. These horns project laterally and rise slightly above the general surface, and are best seen in the anterior view, Fig. 10. These characters and the absence of the fronto-parietal and inter-parietal sutures all point well towards *Titanotherium*, but the premolars are still absolutely simple, showing no trace of the postero-internal cusps which characterize *Diplacodon elatus*.

"Other striking peculiarities are the upward arching midcranial region, the extremely long, narrow, and laterally decurved nasals; the strong infraorbital shelf upon the malars (seen also in *T. megarhinum*), the slender zygomatic arch, the low occiput, the backward extension of the posterior nares by the palatines, and the partial inclosing of the roof of the pharynx by the pterygoids.

"More in detail (No. 1,851) the *nasals* almost overhang the premaxillaries, they are laterally compressed above the infraorbital foramina so as to give the impression of distal expansion; the median fronto-nasal suture extends back beyond the mid-orbital line, but laterally the nasals terminate just above the orbits so as to include most of the incipient horn. The *premaxillary* symphysis

* Inserted by O. A. Peterson.

is elongate as in *T. validum.* The *maxillaries* are shut off by the very narrow lachrymals from the anterior border of the orbits. The infraorbital foramen is placed above M^1 in front of the malar suture. The *malars* extend sharply upon the side of the face and then dip into the outwardly projecting shelf; with an obtuse postorbital knob. The *frontals* exhibit a prominent postorbital hook; there is a delicate lateral ridge marking the limits of the temporal fossa; between these ridges the cranium is arched both from side to side and antero-posteriorly, presenting a very different form from the concave profile of even the oldest known Titanothere; there is a slight constriction in the posterior third, but the cranium is even here two inches wide, and there is not the semblance of the crest seen in *T. vallidens;* the entire absence of the upper cranial sutures even in the young individuals (No. 1,847) is a noteworthy Titanothere character. Owing to the sudden dipping of the superior contour the occiput is rather low and subquadrate in outline.

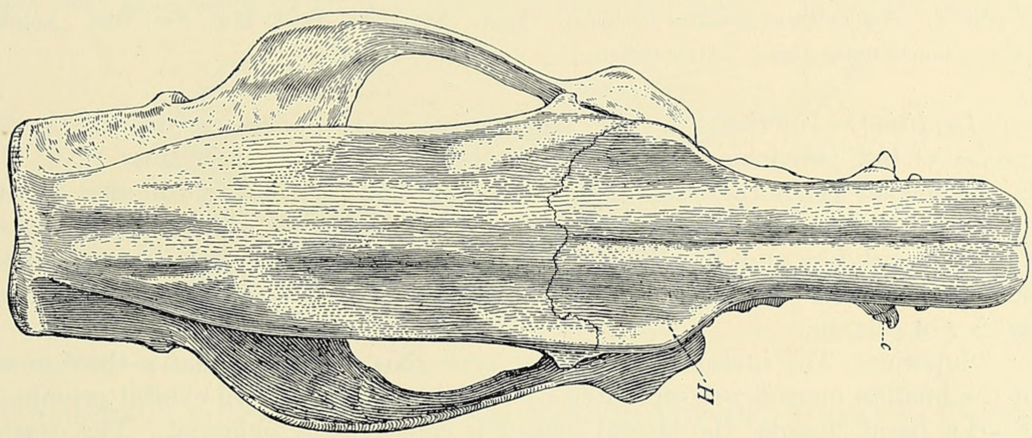

FIG. 6. *Dolichorhinus cornutus* (Osborn). *Type.* No. 1,851, Amer. Mus. Nat. Hist. Superior view, one-fourth natural size. (After Osborn.)

"In side view the faint temporal ridges can be traced to the superior angle of the occiput. The zygomatic arch is very slender; it arches slightly upwards and very much less strongly outwards than in *T. vallidens.* The postglenoid process is very thick in antero-posterior section.

"In palatal view we observe a diastema between the median incisors and a post-canine diastema of 28 mm. The molar series are placed closely parallel so that the palate is long, narrow and deeply arched, and the posterior nares opens far back behind the last molar. The deep and long pterygoids arch towards each other in the median line, forming a deep fossa.

"*Foramina.*—The alisphenoid canal is very long; the for. ovale is widely separated from the for. lac. medium; the for. lac. medium and the for. lac. posterius are very small and partly confluent; the condylar foramen is midway between the condyles and the for. lac. medium.

"*Lower Jaw.*—The most perfect of the lower jaws is No. 1,857; it ragees in size exactly with the type skull No. 1,851. In proportion it is rather shallow and slender, but presents somewhat more angulation of the chin than in *T. hyognathus.* The most distinctive character is the extremely long hook-shaped coronoid process which extends back over the condyle. The symphysis is long and rather shallow.

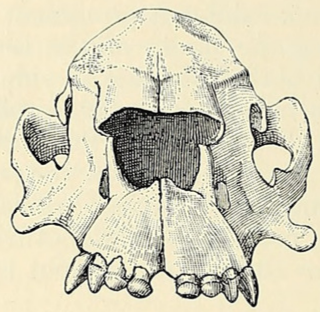

FIG. 7. *Dolichorhinus cornutus* (Osborn). *Type.* No. 1,851, Amer. Mus. Nat. Hist. Anterior view, one-fourth natural size. (After Osborn.)

"*Dentition.*—Inferior: A very distinctive and progressive feature is the presence of but two incisors in the lower jaw. The formula is thus $I\frac{3}{2}$, $C\frac{1}{1}$, $P\frac{4}{4}$, $M\frac{3}{3}$. A second Titanothere feature is seen in the relatively short, rounded canines of the lower jaw, which present a wide contrast with the compressed lance-shaped tusks of *T. validum* and *T. cultridens*; an especial feature is the absence of enamel upon the fang. It is to be noted, however, that the specific reference of these jaws is not certain.

"Superior: The incisor series of the type (No. 1,851) present a third circle, but the median incisors are separated by a slight space; they all exhibit prominent posterior basal cingula; the lateral incisor is considerably enlarged. The *canines* have short, outwardly and forwardly directed but slightly incurved crowns, with rather sharp borders, a suboval section and posterior basal cingula. Behind a short diastema is the first *premolar*, a simple, conical crown with an internal basal ridge; the second, third and fourth premolars exhibit *single* blunt or rounded internal cones, incomplete cingula, a strong antero-external (parastyle) and a feebler postero-internal (metastyle) ridge. The *molars* have the generic conformation; the third molar is the largest of the series, and exhibits a strong parastyle and mesostyle and a feebler metastyle; there is a strong cingulum at the outer base of the paracone, and a feebler one at the outer base of the metacone; the hypocone is feebly developed upon M^3. All these teeth are well worn, and the animal was fully adult.

"The superior dentition of No. 1,850 belongs to a younger animal with sharply defined characters. Here we see more plainly the resemblances to the type of *T. cultridens*. The canines are laniariform, with sharp lateral edges, basal cingula less marked and enamel continued far down. The outer faces of the premolars and molars are prominent and closely approximated to the internal cusps. We observe also a trace of the paraconule upon M^2, and a distinct paraconule upon M^3. In this specimen the pterygoids are long and not so deep."

3. **Dolichorhinus heterodon** Douglass.

Dolichorhinus heterodon Douglass, Annals Carnegie Museum, Vol. VI, 1909, p. 310.

Type: Skull. No. 2,340, Collection Carnegie Museum.

Locality: Uinta Basin, Utah. (Six or seven miles northeast of Well No. 2)[14].

Horizon: Uinta Eocene. Upper part of horizon "B" or lower part of horizon "C".

Original Description: "The skull is long, narrow, and moderately high. The face is short and the brain-case long. The free nasals are long, the posterior opening of the anterior nares extending well backward toward the orbit. The lower border of the nasals approach each other, but this is probably in part due to lateral crushing. The infraorbital foramen is large. The infraorbital shelf is represented by a protuberance, which is thickened on the free outer surface. If there were horn-cores above the orbit they were very small. The long brain-case

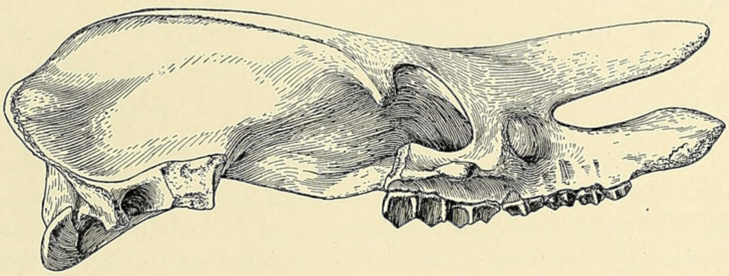

FIG. 8. *Dolichorhinus heterodon* Douglass. *Type*. No. 2,340, Car. Mus. Cat. Vert. Fossils. Side view, one-fifth natural size. (After Douglass.)

was apparently arched from before backward, the posterior descent to the crest of the occiput being very steep, though this may be somewhat exaggerated by crushing. The occipital condyles are very large. The median portion of the occiput above them is convex while above this there is a large concavity. The postglenoid processes are not excessively large.

"The premolars are small, the last being very decidedly smaller than the first molar. The first premolar is not preserved, but it was evidently a simple

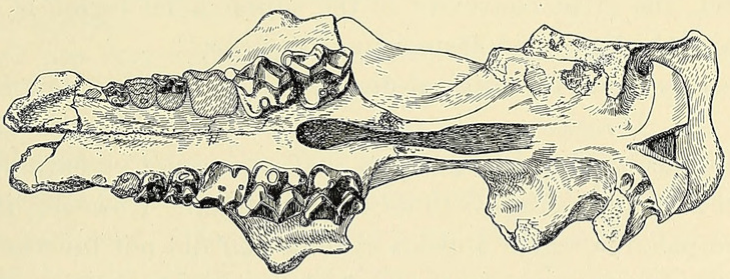

FIG. 9. *Dolichorhinus heterodon* Douglass. *Type*. No. 2,340, Car. Mus. Cat. Vert. Fossils. Palatal view, one-fifth natural size. (After Douglass.)

[14] Reference to local stations established by the Barber Asphaltum Company which operated in that country during the time in which the collection was made upon which Mr. Douglass based his work.

tooth. In the last three premolars there is a lobe or buttress on the antero-external portion of the tooth, which makes the anterior margin oblique. The inner cusps (deuterocones) are low with rounded summits. They are more nearly opposite the postero-external than the antero-external cusps. There are inner cingula on P^3 and P^4. The antero-internal cusp in M^2 is quite high and M^1 conical. The postero-internal cusp is due simply to an increase in height of the cingulum."

Measurements.

Total length of top of skull from end of nasals to crest of occiput	500 mm.
From anterior of orbit to front of nasals	160 mm.
From anterior of orbit to posterior part of narial opening of front of nasals	55 mm.
Width of occiput	128 mm.
Height of occiput	140 mm.
Length of molar premolar series	190 mm.
Length of premolar series	75 mm.
Length of molar series	115 mm.
Length of P^2	20 mm.
Width of P^2	16 mm.
Length of P^3	21 mm.
Width of P^3	20 mm.
Length of P^4	24 mm.
Width of P^4	27 mm.
Length of M^1	34 mm.
Width of M^1	35 mm.
Length of M^2	46 mm.
Width of M^2	42 mm.
Length of M^3	48 mm.
Width of M^3	42 mm.

Mr. E. S. Riggs of the Field Museum has found that *D. heterodon* compares in many respects quite closely with his proposed species, *Mesatirhinus superior* (Field Mus. Publ. Geol. Ser., IV, 1912, p. 26). Further on in the same publication, p. 35, Riggs states: "If this figure (given in Douglass' original paper) of the nares is correct, the great convexity in the supracranial region is the chief distinction between this form and *Mesatirhinus superior*."

On again consulting the original description and the type of *D. heterodon* it appears that Mr. Douglass made no mention of the posterior nares, perhaps because the specimen is much crushed in that region and no entirely satisfactory statement can be made in regard to its true condition. However, the post-narial opening in the palatine region appears shallow and did not function as the post-narial opening. In other words, it appears that an opening is indicated in the illustration, where in reality a shallow depression should have been represented, such as is usually found in more perfectly preserved crania of *Dolichorhinus* (See pl. XLVI). The anterior portion of this depression in the type of *D. heterodon* has been much distorted by crushing. By very careful study it is possible to partly make out the original condition, and it is shown that a thin bony septum divided the narial from the main oral cavity. This thin bony structure in most skulls of *Dolichorhinus* is usually broken and does not, therefore, allow accurate study. Furthermore, there is between the hamular processes just such a recession as Riggs speaks of in his description of *D. fluminalis*. This cavity is partly indicated in Douglass' figure, which is reproduced in fig. 9. It also may here be stated that Mr. Douglass with his customary caution explicitly stated that the steepness of the posterior descent to the crest of the occiput may be exaggerated by crushing. There can be no question that *D. heterodon* is correctly referred to the genus *Dolichorhinus*.

4. **Dolichorhinus longiceps** Douglass.

Dolichorhinus longiceps Douglass, Annals Carnegie Museum, Vol. VI, 1909, p. 312.

Type: Skull No. 2,347. Car. Mus. Cat. Vert. Fossils.

Locality: Uinta Basin, Utah. One-half mile east of Well No. 2, near Bonanza.

Horizon: Uinta Eocene, Lower part of Horizon B.

Original Description: "This skull in general outline is very much like that of *Dolichorhinus hyognathus*, though broader. In describing it I prefer to point out the characters which distinguish it from that species. Apparently it is somewhat broader proportionally than that of *D. hyognathus*. The skull is somewhat crushed, but it evidently was not flattened on top. The present specimen had no heavy protuberances or horn-cores, though there may have been the slightest beginning of such. There is a rather narrow shelf, or lateral expansion of the malars, with rounded outer borders, beneath the anterior portion of the orbit, but it is not like the infraorbital process of *D. hyognathus*. The postorbital hook does not appear to have been long or prominent. Evidently the zygomatic arches extended laterally outward more than in the last-named species; the postglenoid processes are not nearly so heavy; the palate is broader; the top of the cranium, though there is no zygomatic arch (sagittal crest)* becomes narrower anterior to the crest of the occiput.

"The teeth are very similar to those of *Dolichorhinus heterodon*, so much so, that, if only the teeth were known, they might be referred to that species. They, as well as the skull, are larger."

As Mr. Douglass states, the skull is somewhat depressed by crushing and there are numerous fractures in the region of the frontals and parietals, which are filled with sediment. These fractures most likely account to a considerable measure for the breadth which Douglass mentions. The breadth of the palate is no doubt brought about by the same cause. The postorbital hook-like process is not completely preserved on either side, so that its size or general detailed

* Supplied by O. A. Peterson.

structure cannot be fully ascertained. In the region of the postglenoid process the type is also imperfectly preserved. One cannot rely too much on the size or shape of this process in the type.

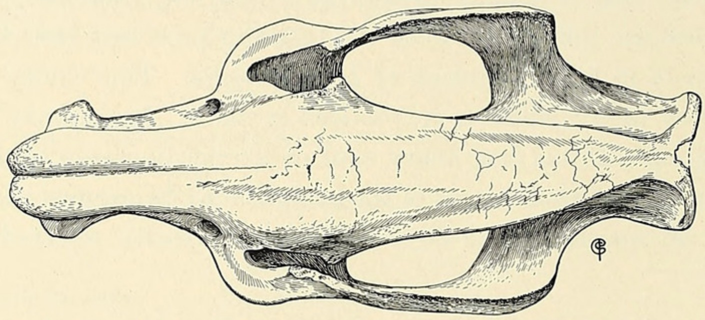

FIG. 10. *Dolichorhinus longiceps* Douglass. *Type.* No. 2,347, Car. Mus. Cat. Vert. Fossils. Superior view, one-sixth natural size. (After Douglass.)

The rest of the characters given in the original description may, or may not, be individual or sexual differences of *Dolichorhinus cornutus.* The difference in the geological horizon and the fact that no skull with large osseous knobs on the nasal have as yet been found in lower horizons are, however, of considerable interest, and may provisionally be accepted as indicating specific differences.

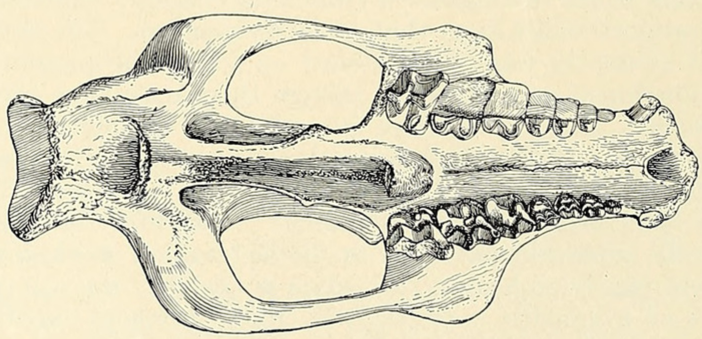

FIG. 11. *Dolichorinus longiceps* Douglass. *Type.* No. 2,347. Car. Mus. Cat. Vert. Fossils. Palatal view of cranium. One-sixth natural size. (Redrawn after Douglass.)

MEASUREMENTS.

Length of top of skull	590 mm.
Length of free nasals	150 mm.
Length of skull posterior to anterior portion of orbit	393 mm.
Length of skull at glenoid articular surface	267 mm.
Width at infraorbital shelves	247 mm.
Length of molar-premolar series	192 mm.
Length of premolar series	88 mm.
Length of molar series	112 mm.
Length of P^1	15 mm.

Width of P^1	11 mm.
Length of P^2	20 mm.
Width of P^2	20 mm.
Length of P^3	24 mm.
Width of P^3	25 mm.
Length of P^4	27 mm.
Width of P^4	31 mm.
Length of M^1	30 mm.
Width of M^1 about	37 mm.
Length of M^2	37 mm.
Width of M^2	44 mm.
Length of M^3	41 mm.
Width of M^3	43 mm.

5. **Dolichorhinus intermedius** Osborn.

Dolichorhinus intermedius Osborn, Bull. A. M. N. H., Vol. XXIV, 1908, p. 611.

Type: Skull No. 1,837, Coll. American Museum of Natural History.

Locality: Uinta Basin, northeastern Utah.

Horizon: Uinta Eocene, Horizon B.

Original Description. "Specific Characters,.—Level Uinta B. Distinguished from *D. hyognathus* (Scott and Osborn) by (1) its inferior size pm^1, m^3, = 179), M^1 m^3, = 109 mm.; (2) premolars less progressive, with subconic deuterocones; (3) all cingula less robust; (4) nasals more pointed and less expanded distally; (5) infraorbital shelf of malar relatively narrow."

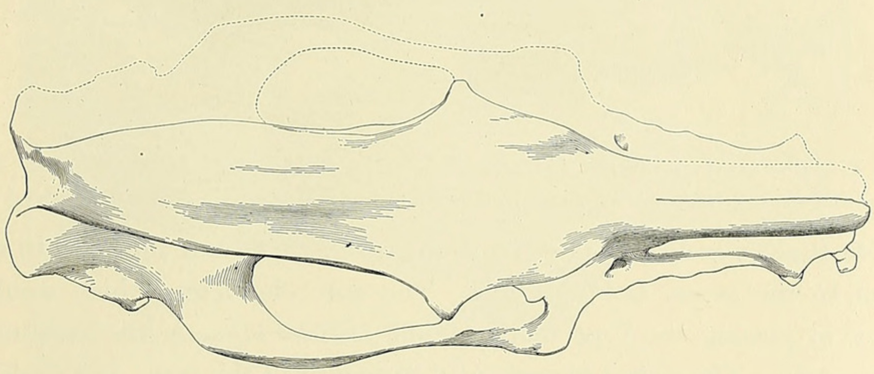

FIG. 12. *Dolichorhinus intermedius* Osborn. *Type*. No. 1,837, Amer. Mus. of Nat. Hist. Superior view, one-fourth natural size. (After Osborn.)

In the foregoing brief description of this species all of the characters except those mentioned under "(2)" might well represent the individual or sexual differences existing in *D. cornutus*. Nevertheless, the species is here accepted, as proposed by Osborn.

A number of skulls from the Uinta beds in the collection of the Carnegie Museum are provisionally referred to *Dolichorhinus intermedius* Osborn. Of these Nos. 3,094, 3,095, and 3,096 are the best preserved specimens. So far as comparison based upon Osborn's description and illustration can be used this material agrees fairly well with the type in the American Museum.

6. **Dolichorhinus superior** (Riggs).

Mesatirhinus superior Riggs, Field Museum of Natural History. Geological Series, Vol. IV, No. 2, p. 26, Plate VI.

Type: Skull No. 12,188, Field Museum of Natural History.

Locality: "Upper Metarhinus Sandstones, White River divide." Northeastern Utah.

Original Description: "Specific Characters: Skull 485 x 255 mm., molar series 182 mm., nasals free to a point over last premolar, infraorbital process present, arches slender anteriorly, nasals infolded at margins, sagittal area expanded, canines small, P^2 and P^3 oblique to axis of series. Molars relatively small, strong hypocone on M^3, posterior nares opening opposite the anterior margin of last molar."

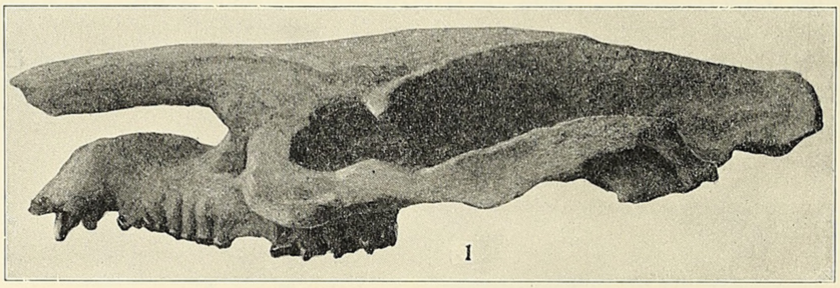

FIG. 13. *Dolichorhinus superior* (Riggs). *Type*. No. 12,188, Field Mus. Nat. Hist. Side view, about one-fifth natural size. (After Riggs.) (Courtesy Field Museum of Natural History.)

From Riggs' illustrations of *Mesatirhinus superior* I am impelled to refer the specimen to the genus *Dolichorhinus*. The only character, which would cause hesitancy in placing the type in the genus *Dolichorhinus* is the position of the posterior nares. The writer has recently re-examined the type, and finds, as Mr. Riggs states, that the opening of the postnares is shown as being well forward. This region in the type is, however, not satisfactorily preserved, and the lower wall of the narial passage may well have existed as in other specimens. Back of the anterior margin of the median pterygoid fossa the pterygoids, and the base of the skull, as Riggs states, are wanting. The facial profile is clearly like that of the genus *Dolichorhinus*. The breadth or narrowness of the cranium along the sagittal suture in *Dolichorhinus* are in my opinion purely individual and sexual characteristics; and the strong hypocone on M^3 might well be an individual feature

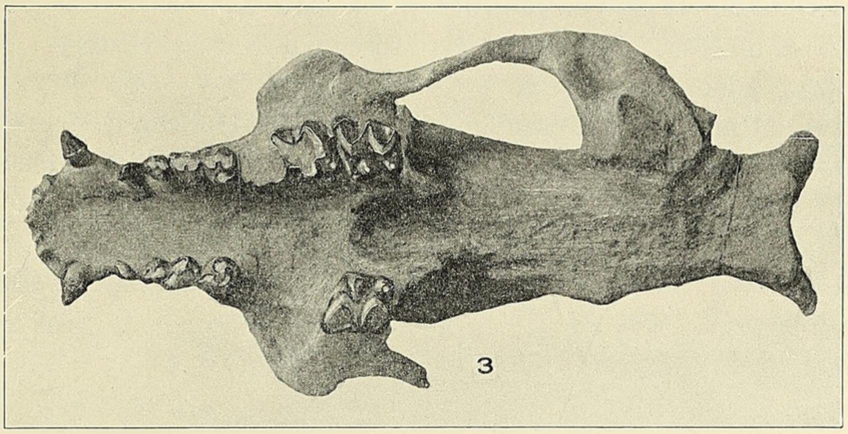

Fig. 14. *Dolichorhinus superior* (Riggs). *Type.* No. 12,188, Field Museum Nat. History. Palatal view, about one-fifth natural size. (After Riggs.) (Courtesy Field Museum of Nat. History.)

not especially characteristic of early types of the titanotheres. Finally in comparing Mr. Riggs' illustration of *Mesatirhinus superior* with his figures of *Dolichorhinus fluminalis* and other species of *Dolichorhinus*, one observes striking similarities, which Riggs himself observed (*l. c.*, p. 26).

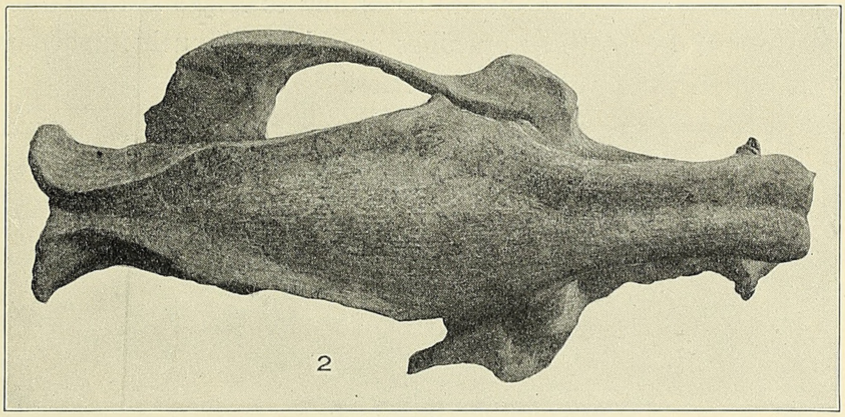

Fig. 15. *Dolichorhinus superior* (Riggs). *Type.* No. 12,188, Field Mus. Nat. Hist. Superior view, about one-fifth natural size. (After Riggs.) (Courtesy Field Museum Natural History.)

It may be stated here that a comparison of *Mesatirhinus superior* Riggs does not show close agreement either with *Mesatirhinus megarhinus* Earle (Jour. Acad. Sci. Philad., (2), Vol. IX, 1884–1895, pp. 320 *et seq.*, Plate XII, fig. 5) or with *Mesatirhinus petersoni* Osborn, Bull. A. M. N. H., Vol. XXIV, p. 608, fig. 12.

7. Dolichorhinus fluminalis Riggs.

Dolichorhinus fluminalis Riggs, Field Museum of Natural History, Publication No. 159, Geol. Series, Vol. IV, 1912, p. 33, Plate X.

Type: Skull No. 12,205, Coll. Field Museum of Natural History.

Locality: Uinta Basin, Utah.

Horizon: Uinta Eocene, "Amynodon Sandstone" Horizon B.

Original Description: "Specific characters: Skull, small and narrow (520 x 230 mm.), facial region much shorter than cranial, nasals narrow and slightly tapering, posterior nares opening between hamular processes, post-orbital process of jugal back of the last molar, molar-premolar series 171 mm.; canines short and recurved, incipient horn-cores in the form of high narrow ridges."

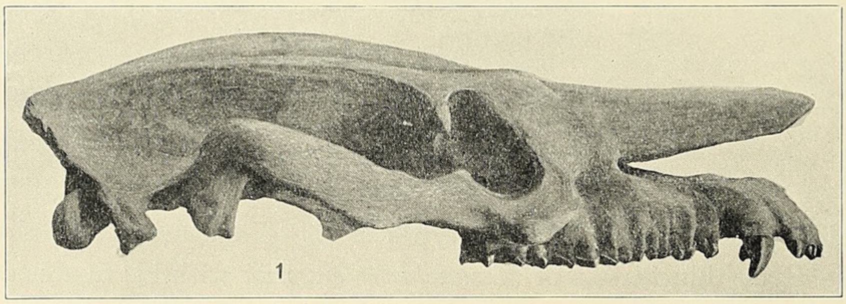

FIG. 16. *Dolichorhinus fluminalis* Riggs. *Type*. No. 12,205, Field Mus. Nat. Hist. Side view, about one-fifth natural size. (After Riggs.) (Courtesy Field Museum Natural History.)

The chief character of this species according to Riggs is the position of the postnares. He states that these openings are placed "much further back in *D. fluminalis* than in any other described species."

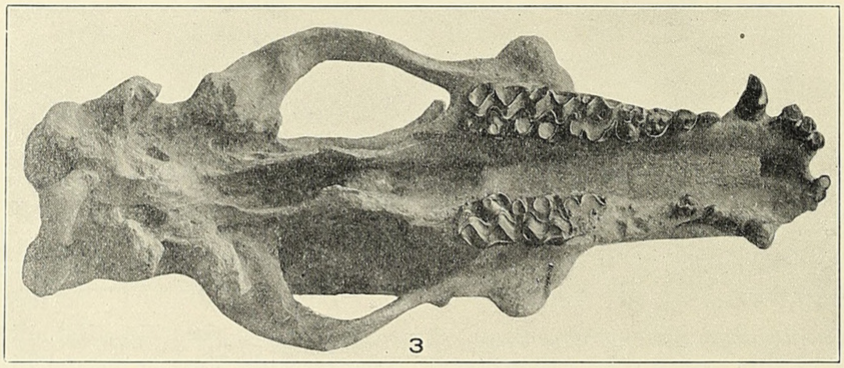

FIG. 17. *Dolichorhinus fluminalis* Riggs. *Type*. No. 12,205, Field Mus. Nat. Hist. Palatal view, slightly more than one-fifth natural size. (After Riggs.) (Courtesy Field Museum Natural History.)

As the result of his studies the writer is of the opinion that the position of the posterior nares in *Dolichorhinus* is a character of generic rank. It has been seldom observed by students, because of the fraility of this region of the skull. As in the case of the foregoing species the writer provisionally accepts Mr. Riggs' *D. fluminalis*, the original description of which continues as follows: "The skull is slender, light, and complex in structure as compared with the massive and rounded *D. cornutus*. The molar teeth are no longer in the crown than those of *Metarhinus earli*. The jugal process of the maxillaries arises at a point back of the last molar rather than beside it as in *D. longiceps*. There is no offset in the palate between the last molars, though the primary position of the posterior narial opening is marked by a slight rugosity.

"*D. fluminalis* is most nearly related to *D. intermedius*. The skull exceeds in length the type of that species in the ratio of 520:465 mm. The molar teeth are proportionately much smaller; the series measures relatively 99:109 mm. The position of the posterior narial opening is the most distinctive character, appearing much farther back in *D. fluminalis* than in any other described species. The two forms agree more closely in the tapering form of the nasals and in the narrow recess separating them from the maxillaries."

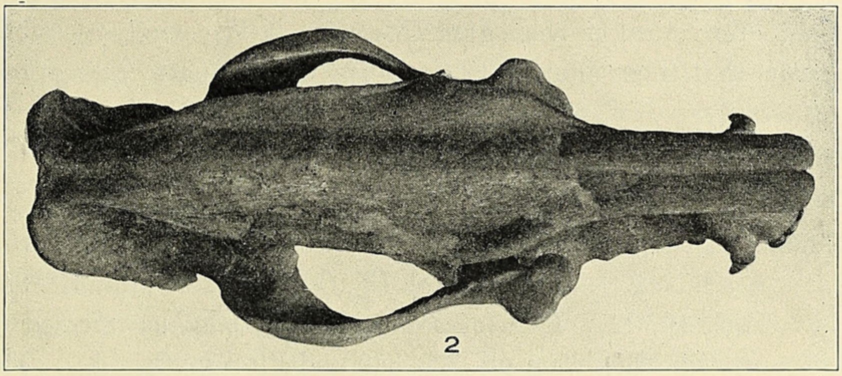

FIG. 18. *Dolichorhinus fluminalis* Riggs. *Type.* No. 12,205, Field Mus. Nat. Hist. Superior view, slightly more than one-fifth natural size. (After Riggs.) (Courtesy Field Museum of Natural History.)

Measurements of *D. fluminalis* taken from Mr. Riggs' Paper.

Skull, length incisors to condyles	520 mm.
Skull, breadth across arches	233 mm.
Skull, breadth above orbits	116 mm.
Skull, length of free nasals	137 mm.
Skull, greatest breadth of nasals	57 mm.
Skull, length of molar-premolar series	171 mm.
Skull, length of molar series	105 mm.
Skull, length of crown of canine	32 mm.
Skull, diameter, crown of canine	18 mm.
Skull, narrowest point in sagittal area	44 mm.

A description of the posterior nares in one or two skulls of *Dolichorhinus* in the collection of the Carnegie Museum has already been given on page 409. Whatever was the cause for the backward shifting of the postnares, it seems probable that this specialization was brought about in a comparatively short time; perhaps beginning with the ancestral forms in the Middle Eocene. In *Dolichorhinus*, and probably also in *Sphenocœlus*, the naso-palatine passage back of the palatine plate has an exceedingly fragile floor and its backward extension is a condition entirely unusual in the mammalia.

The dentition of these long-nosed titanotheres is complete, functioning freely. The incisors and canine are not materially changed from those of earlier types (Compare *Palæosyops*), even if they had aquatic habits, as suggested by Mr. Riggs[15]. There is nothing in the dentition to suggest this. Together with the recession of the posterior nares we have as outstanding features the long nasals, the convexity of the parietal region, the long and slender upper and lower jaws in contrast with other titanotheres from the upper Uinta and especially those of the Oligocene, which are all short-faced with saddle-shaped skulls and crowded premolars. The limbs of *Dolichorhinus* are in every way adapted in their general proportions to terrestrial movement. However, it is entirely possible, as Mr. Riggs suggests, that these animals at times fed upon aquatic vegetation.

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[15] Field Mus. Nat. Hist., Geo. Ser., Vol. IV, 1912, p. 41.

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On a New Species of Diplacodon with a Discussion of the Relations of that Genus to Telmatotherium. Amer. Naturalist, Vol. XXIX, 1895, pp. 1084–1090. Describes *Diplacodon emarginatus* and discusses relationship of the titanotheres. Postscript, p. 1090, divides the genus *Telmatotherium,* and establishes two additional genera, *Manteoceras* and *Dolichorhinus.*

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PETERSON, O. A.

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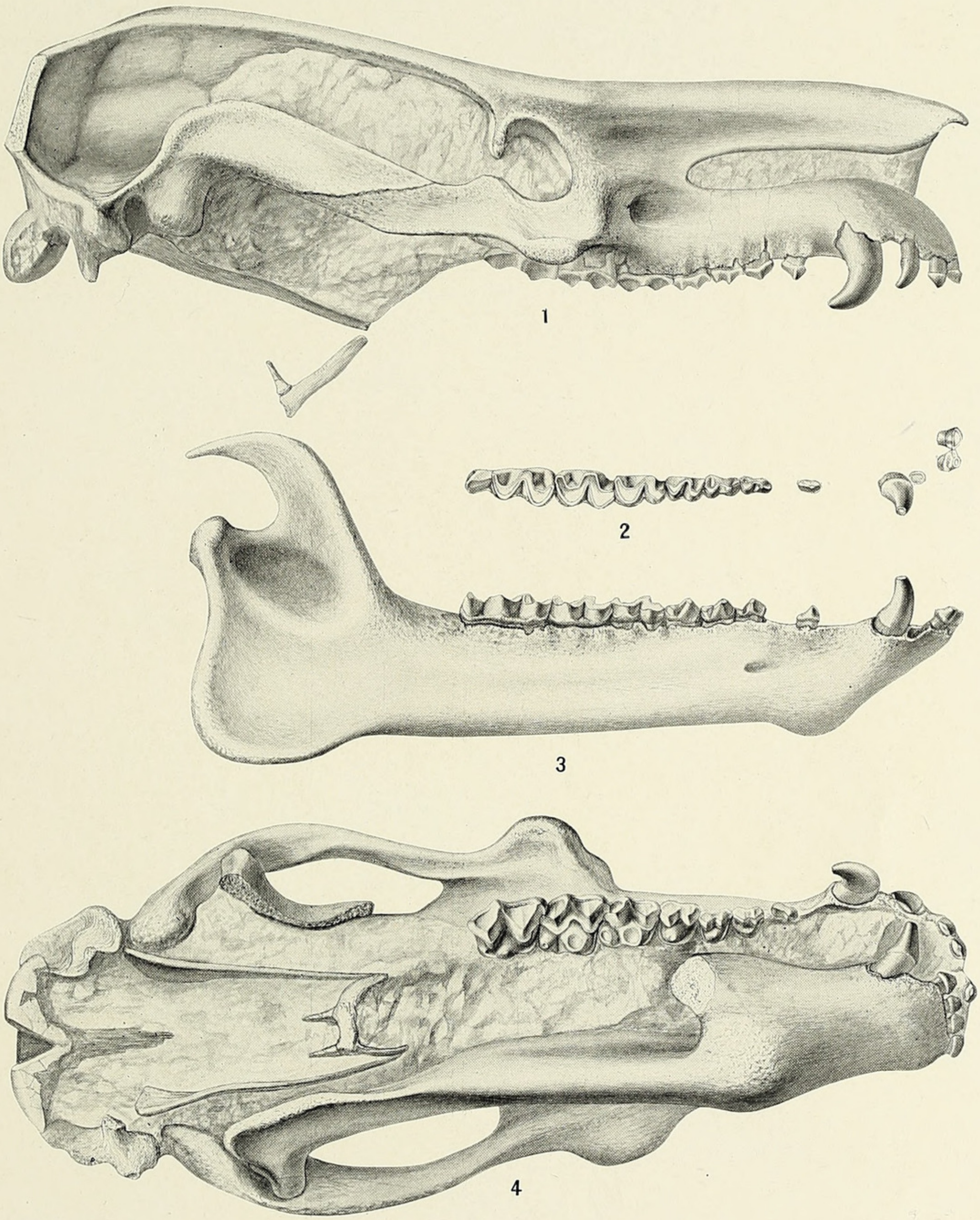
EXPLANATION OF PLATE XLIV.

Dolichorhinus longiceps Douglass, C. M. Cat. Vert. Foss., No. 11, 071.

FIG. 1. Side view of skull and hyoid apparatus.
FIG. 2. Crown view of lower dentition.
FIG. 3. Side view of lower jaw.
FIG. 4. Crown view of upper dentition, inferior view of hyoid arch and mandible.

(All figures one-fourth natural size)



Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE XLV.

Dolichorhinus longiceps, C. M. Cat. Vert. Foss., No. 11,072.

Fig. 1. Side view of skull and lower jaws.

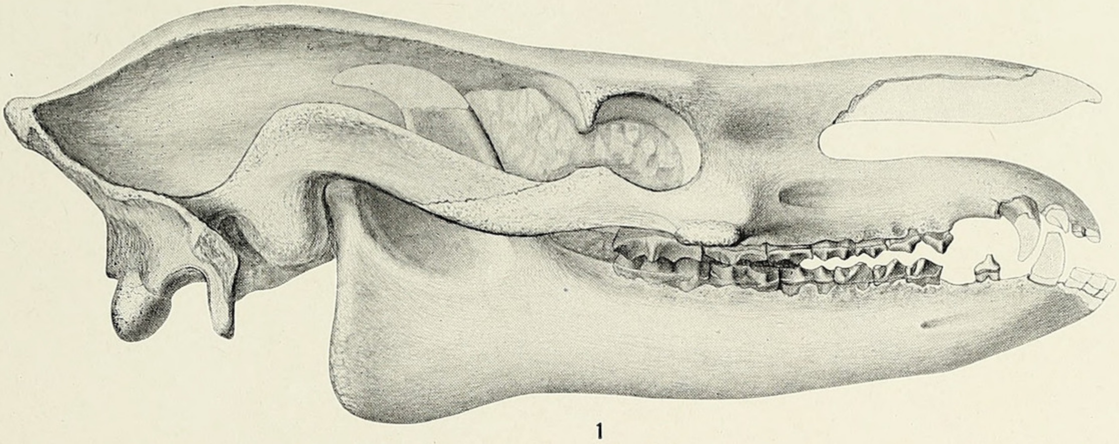
Dolichorhinus intermedius Osborn, C. M. Cat. Vert. Foss., No. 3,117.

Fig. 2. Palatal view, showing the primary position of the postnares, the median vomerine plate, and the cranial foramina.

Dolichorhinus longiceps Douglass, C. M. Cat. Vert. Foss., No. 11,080.

Fig. 3. Palatal view of skull. The excavations indicated on the right choana were probably made by *Dermestes* shortly after the death of the animal.

(All figures one-fourth natural size)



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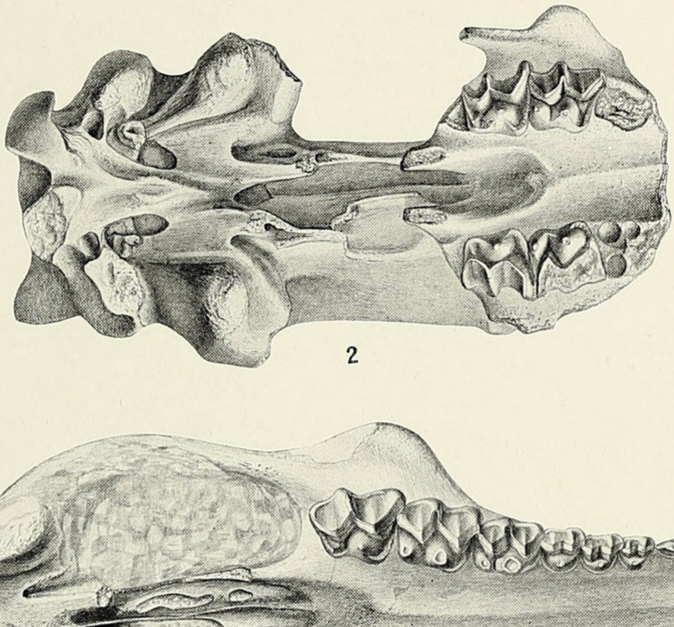

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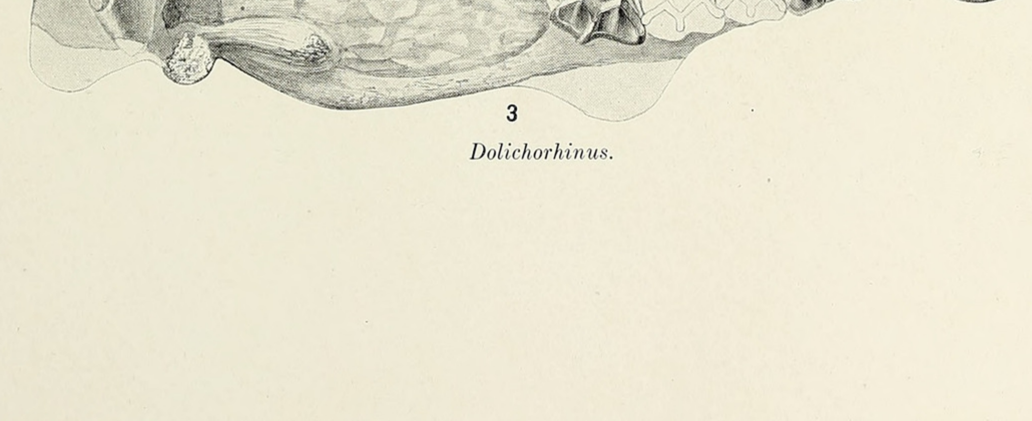


3

Dolichorhinus.

EXPLANATION OF PLATE XLVI.

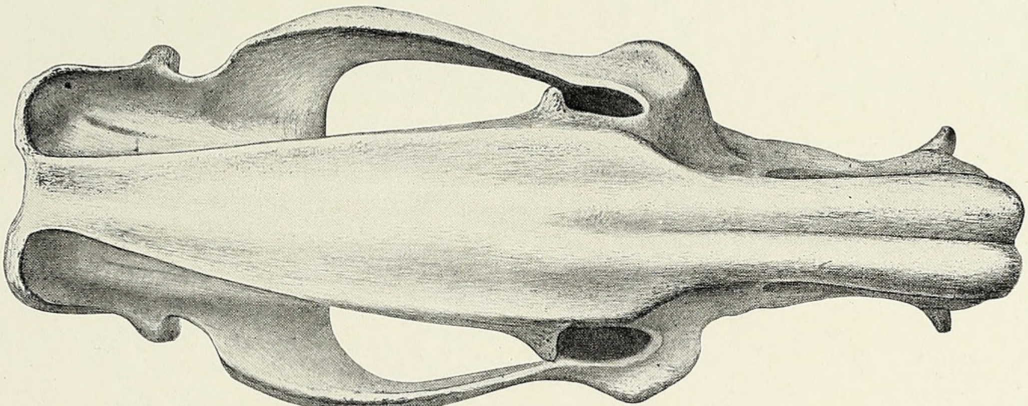
Dolichorhinus longiceps Douglass, C. M. Cat. Vert. Foss., No. 11,081.

FIG. 1. Top view of skull.

FIG. 2. Palatal view of skull, showing at *a* the primary position of the posterior nares; at *b* the second depression, or the anterior portion of the choanæ, and at *c* the location of the posterior nares.

FIG. 3. Side view of skull.

(All figures one-fourth natural size)



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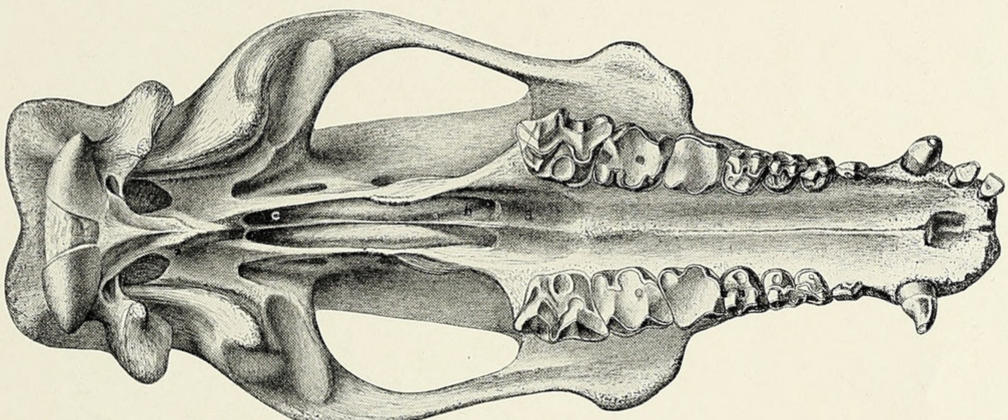

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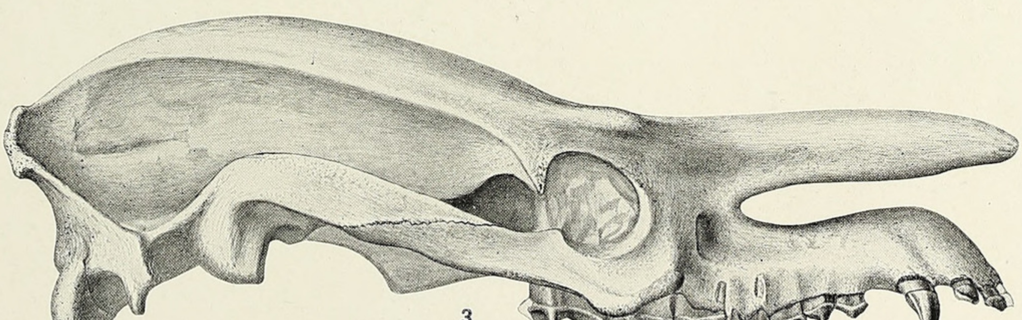


3

Dolichorhinus.

EXPLANATION OF PLATE XLVII.

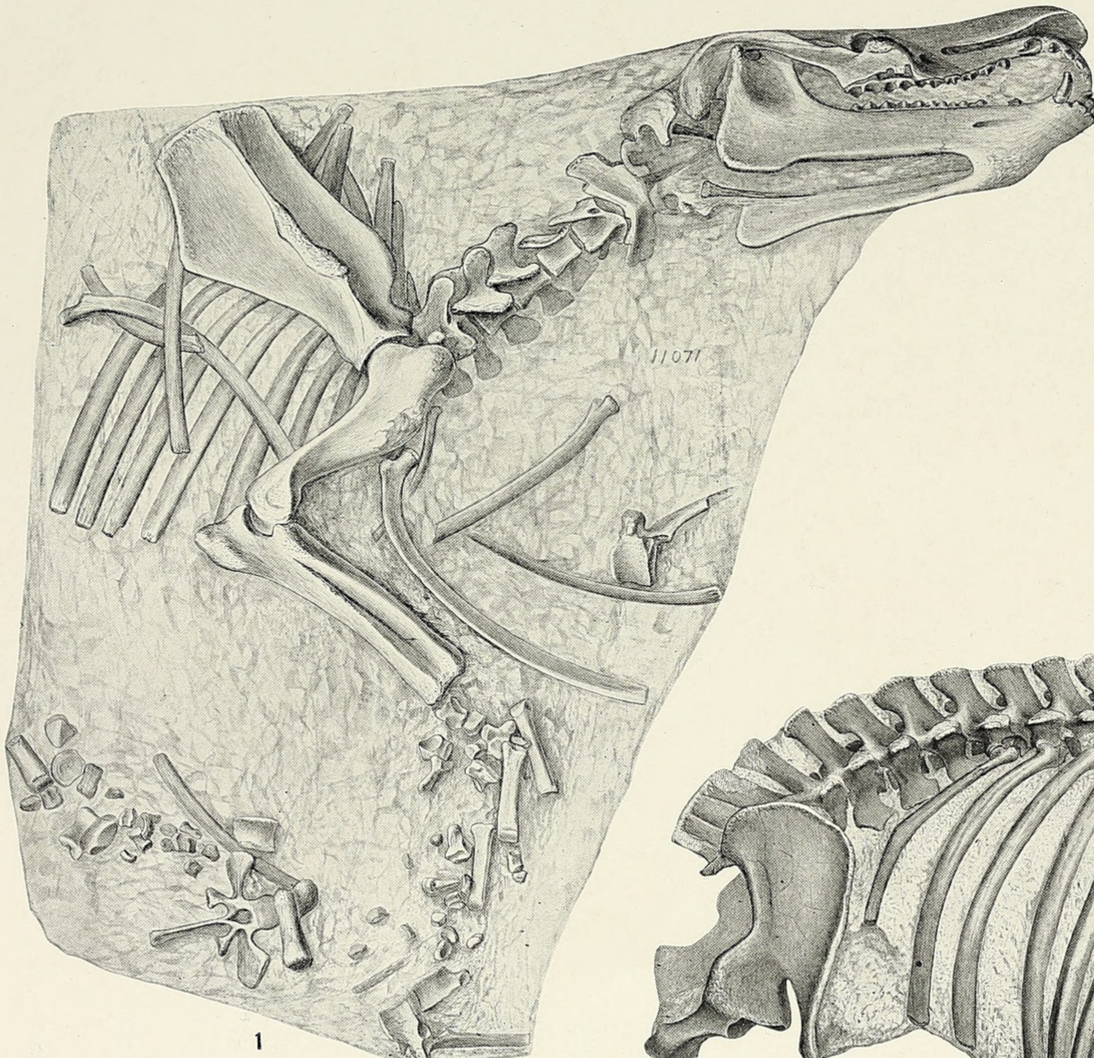
Dolichorhinus longiceps Douglass, C. M. Cat. Vert. Foss., No. 11,071.

Fig. 1. Portion of skeleton as found in the quarry.

Dolichorhinus longiceps Douglass, C. M. Cat. Vert. Foss., No. 11,072.

Fig. 2. Portion of skeleton as found in the quarry. The forelimb of No. 11,072 was removed before the drawing was made in order to show the anterior part of the thorax. The two skeletons are represented on the plate in very nearly their relative positions in the quarry.

(Figures one-ninth natural size)



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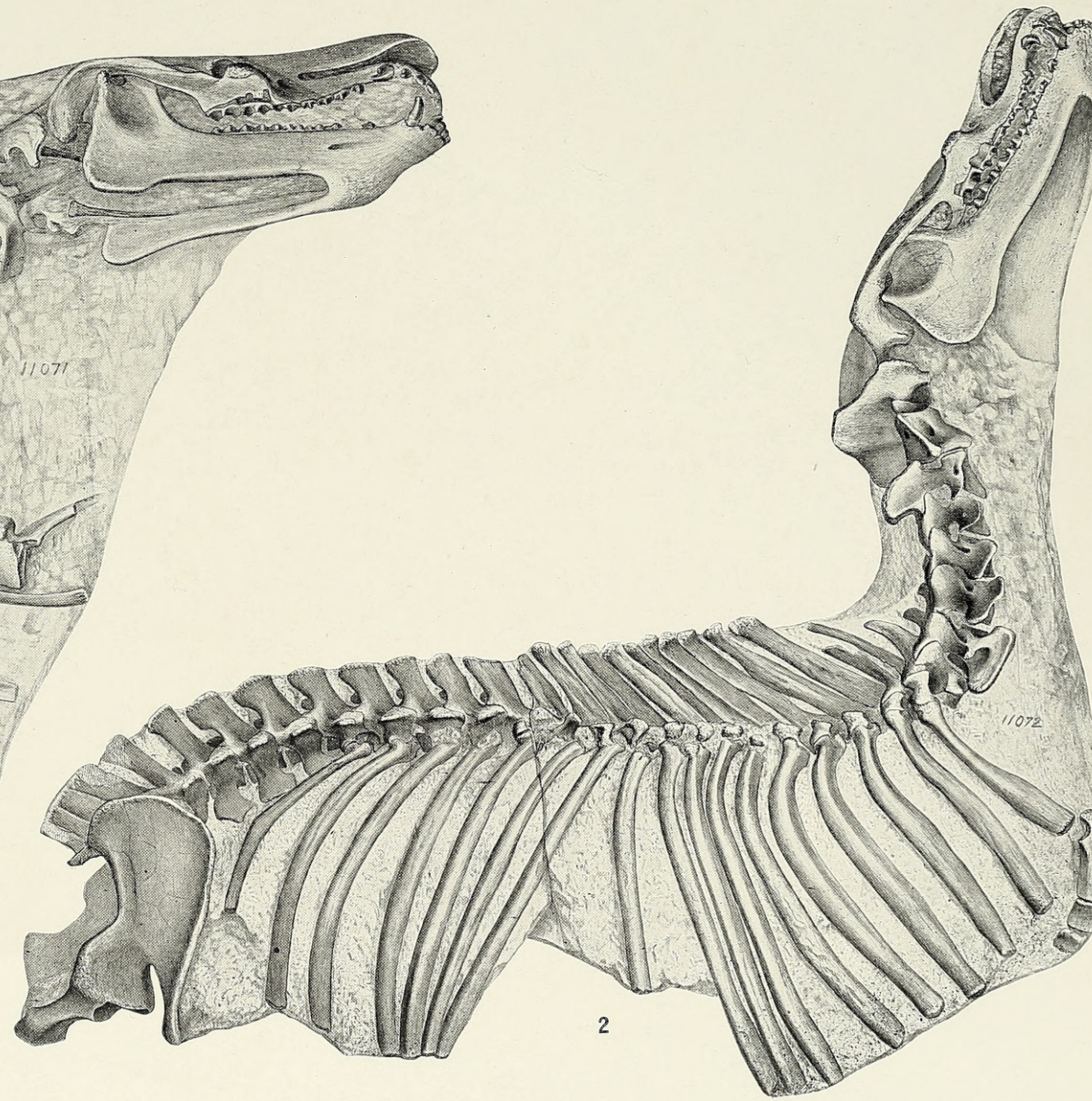


2

Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE XLVIII.

Dolichorhinus longiceps Douglass, C. M. Cat. Vert. Foss., No. 11,071.

FIG. 1. Ulnar view of coössified radius and ulna.

FIG. 2. External view of scapula.

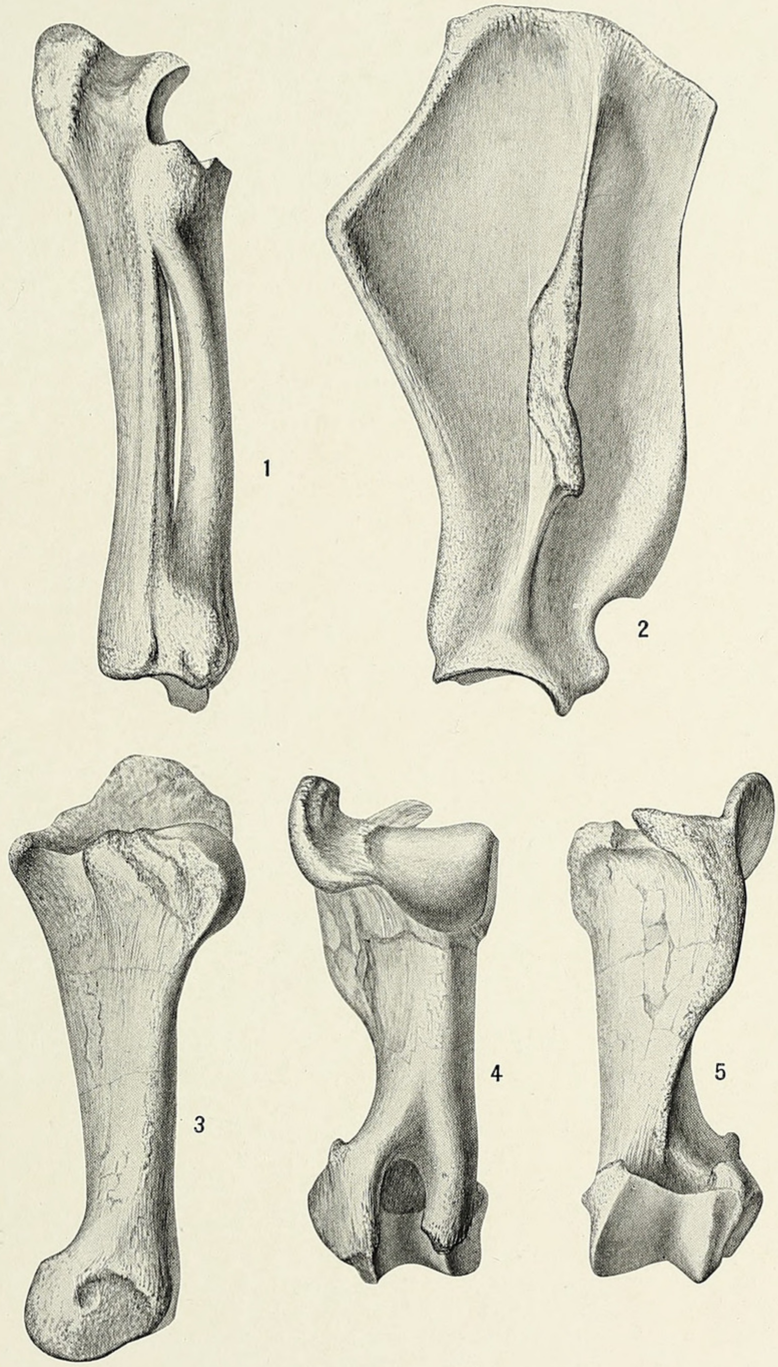
FIG. 3. Radial view of humerus.

Dolichorhinus longiceps Douglass, C. M. Cat. Vert. Foss., No. 11,072.

FIG. 4. Posterior view of humerus. Near the head is a line across the shaft, which indicates a line of breakage and distortion in the vertical direction.

FIG. 5. Anterior view of the same humerus. Shaft shortened by distortion.

(All figures one-fourth natural size)



Dolichorhinus.

EXPLANATION OF PLATE XLIX.

Dolichorhinus longiceps Douglass, C. M. Cat. Vert., Foss. No. 11,071.

FIG. 1. Anterior view of scaphoid.
FIG. 2. Posterior view of scaphoid.
FIG. 3. Proximal view of scaphoid.
FIG. 4. Distal view of scaphoid.
FIG. 5. Proximal view of unciform.
FIG. 6. Radial view of unciform.
FIG. 7. Anterior view of unciform.
FIG. 8. Proximal view of unciform.
FIG. 9. Anterior view of lunar.
FIG. 10. Proximal view of lunar.
FIG. 11. Posterior view of lunar.
FIG. 12. Radial view of lunar.
FIG. 13. Ulnar view of lunar.
FIG. 14. Distal view of trapezoid.
FIG. 15. Proximal view of trapezoid.
FIG. 16. Anterior view of trapezoid.
FIG. 17. Ulnar view of trapezoid.
FIG. 18. Ulnar view of trapezium.
FIG. 19. Radial view of trapezium.
FIG. 20. Oblique radial view of trapezium.
FIG. 21. Anterior view of cuneiform.
FIG. 22. Proximal view of cuneiform.
FIG. 23. Distal view of cuneiform.
FIG. 24. Radial view of cuneiform.
FIG. 25. Ulnar view of pisiform.
FIG. 26. Proximal end of pisiform, showing articulations for cuneiform and ulna.
FIG. 27. Anterior view of metacarpal V.
FIG. 28. Radial view of metacarpal V.
FIG. 29. Anterior view of magnum. M*
FIG. 30. Radial view of magnum. M*
FIG. 31. Ulnar view of magnum. M*
FIG. 32. Distal view of magnum. M*
FIG. 33. Anterior view of metacarpal IV.
FIG. 34. Anterior view of metacarpal III.
FIG. 35. Anterior view of metacarpal II.
FIG. 36. Ulnar view of metacarpal II.
FIG. 37. Ulnar view of metacarpal III.
FIG. 38. Radial view of metacarpal III.
FIG. 39. Radial view of metacarpal IV.
FIG. 40. Ulnar view of metacarpal IV.
FIG. 41. Dorsal view of phalanges, digit III.
FIG. 42. Dorsal view of phalanges, digit IV.
FIG. 43. Dorsal view of phalanges, digit II.
FIG. 44. Dorsal view of phalanges, digit V.
FIG. 45. Lateral view of phalanges, digit V.
FIG. 46. Lateral view of phalanges, digit IV.
FIG. 47. Lateral view of phalanges, digit II.
FIG. 48. Lateral view of phalanges, digit III.

(All figures one-half natural size)

* Some characters represented in the illustrations of this bone are taken from the magnum of C. M. Cat. Vert. Loss., No. 2865.

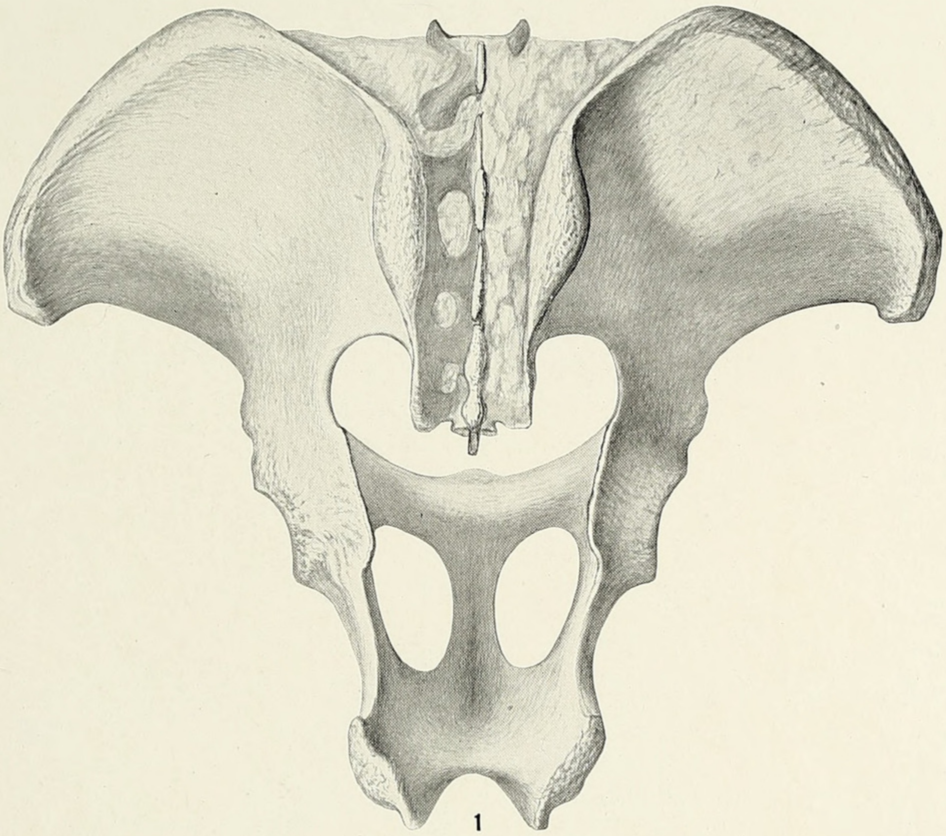
Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE L.

Fig. 1. *Dolichorhinus longiceps* Douglass. C. M. Cat. Vert. Foss., No. 3,840. Dorsal view of pelvis and sacrum. The sacrum is partly covered by matrix in the specimen, and this is indicated in the illustration.

Fig. 2. Do. Side view of pelvis and sacrum.

(Figures are one-fourth natural size)



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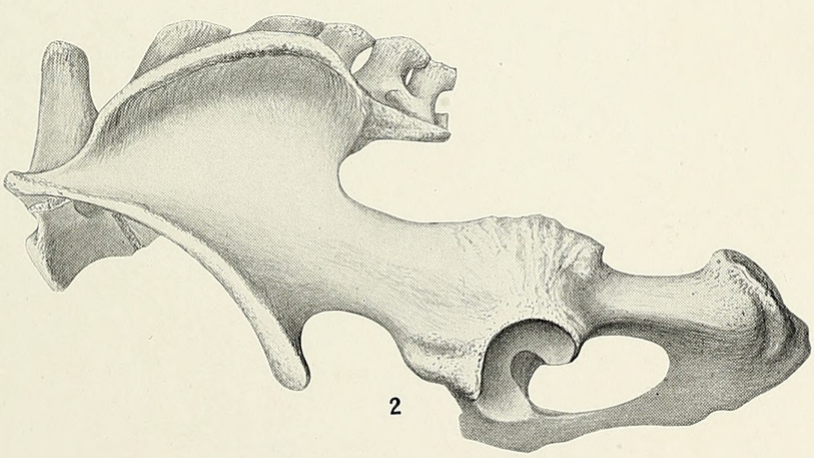

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Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE LI.

FIG. 1. *Dolichorhinus longiceps* Douglass, C. M. Cat. Vert. Foss., No. 3,840. Ventral view of pelvis and sacrum.

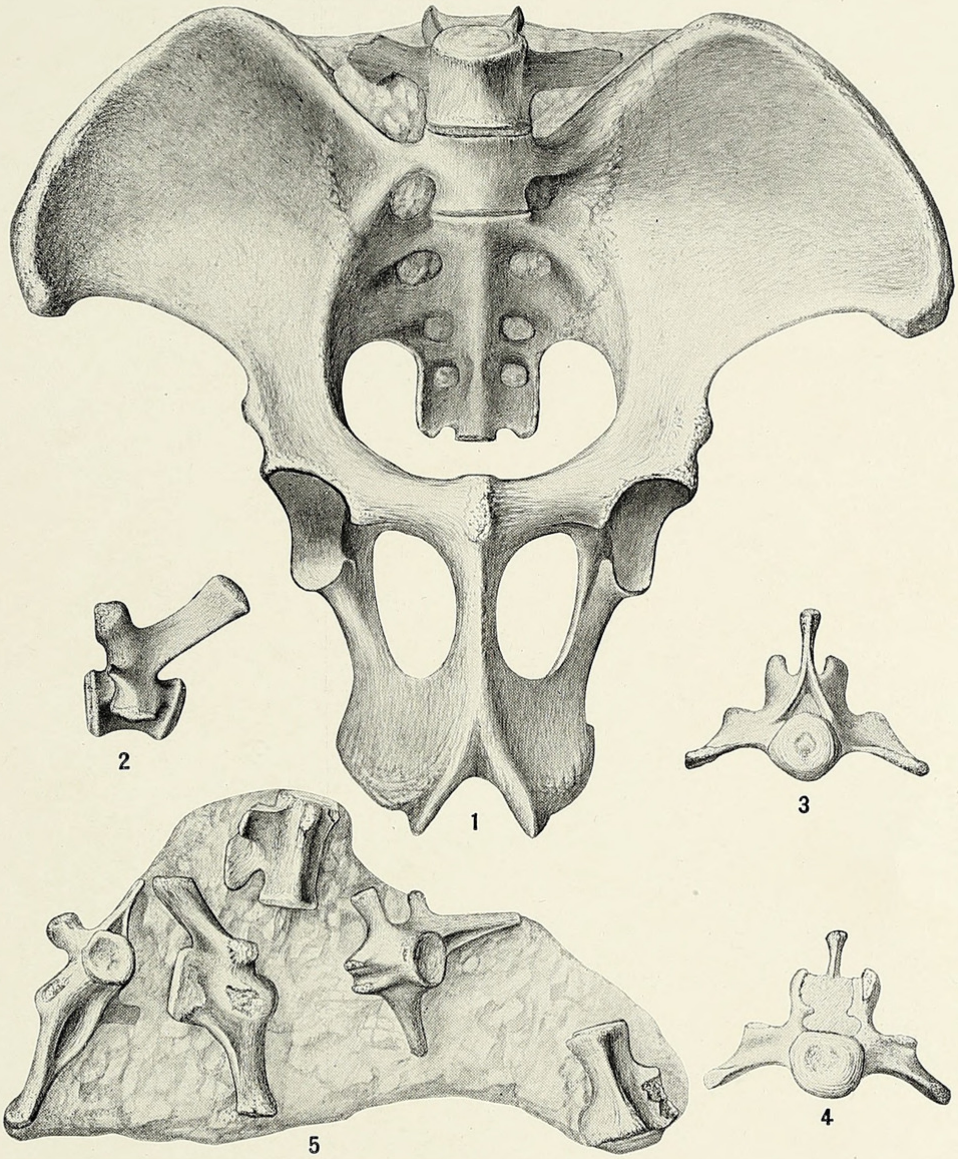
FIG. 2. *Dolichorhinus longiceps* Douglass, C. M. Cat. Vert. Foss., No. 11,072. Lateral view of first caudal.

FIG. 3. Do. Posterior view of first caudal.

FIG. 4. Do. Anterior view of first caudal.

FIG. 5. Do. Views of anterior caudals as found in the quarry.

(Fig. 1 is one-fourth natural size. All the other figures are one-half natural size.)



Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE LII.

FIG. 1. *Dolichorhinus longiceps* Douglass, C. M. Cat. Vert. Foss., No. 11,071. Anterior view of femur.

FIG. 2. Do. Posterior view of femur.

FIG. 3. *Dolichorhinus longiceps* Douglass, C. M. Cat. Vert. Foss., No. 11,072. Anterior view of femur.

FIG. 4. *Dolichorhinus longiceps* Douglass, C. M. Cat. Vert. Foss., No. 11,071. Anterior view of patella.

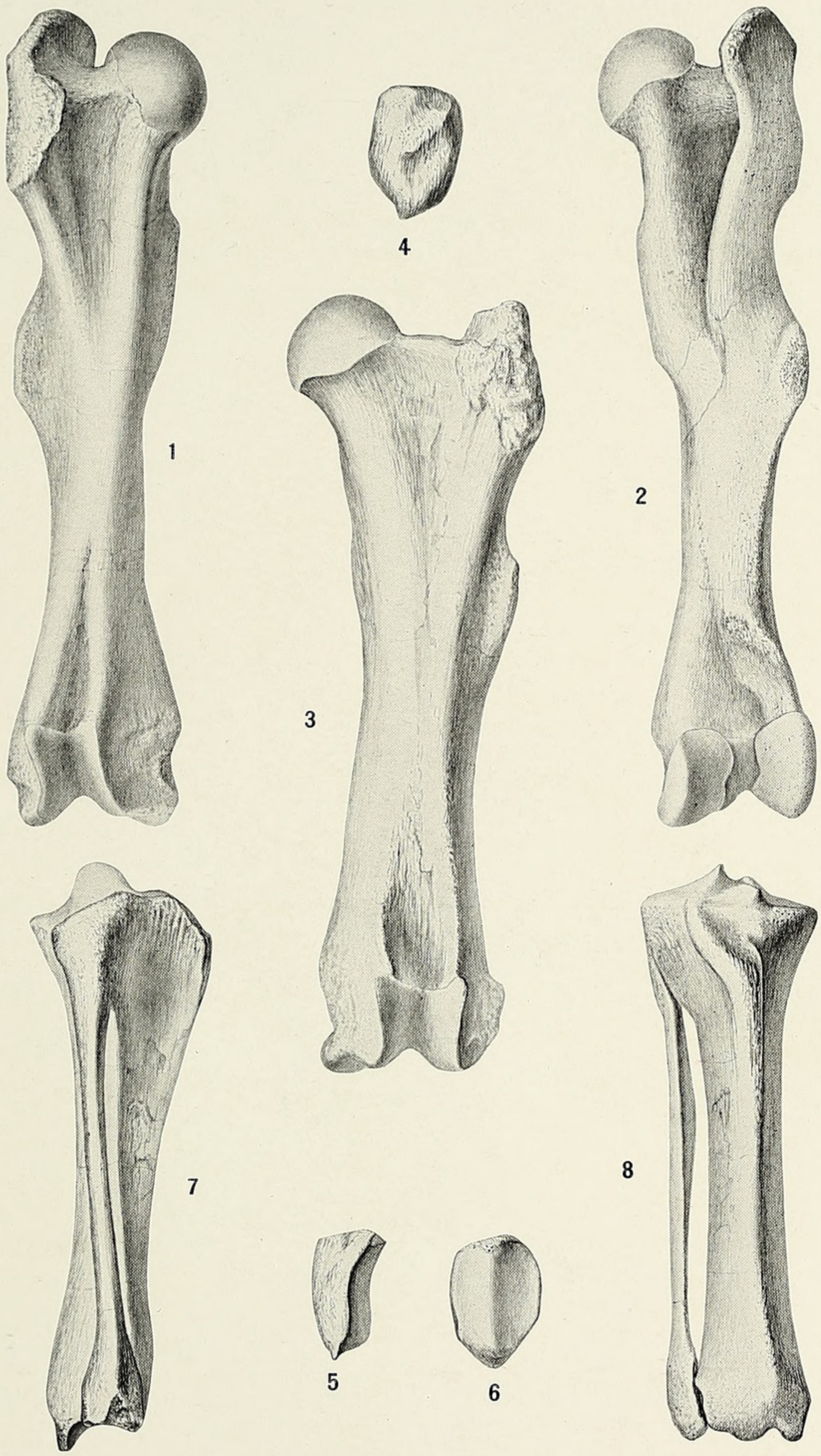
FIG. 5. Do. Lateral view of patella.

FIG. 6. Do. Posterior view of patella.

FIG. 7. Do. Fibular view of tibia and fibula.

FIG. 8. Do. Anterior view of tibia and fibula.

(All figures one-fourth natural size)

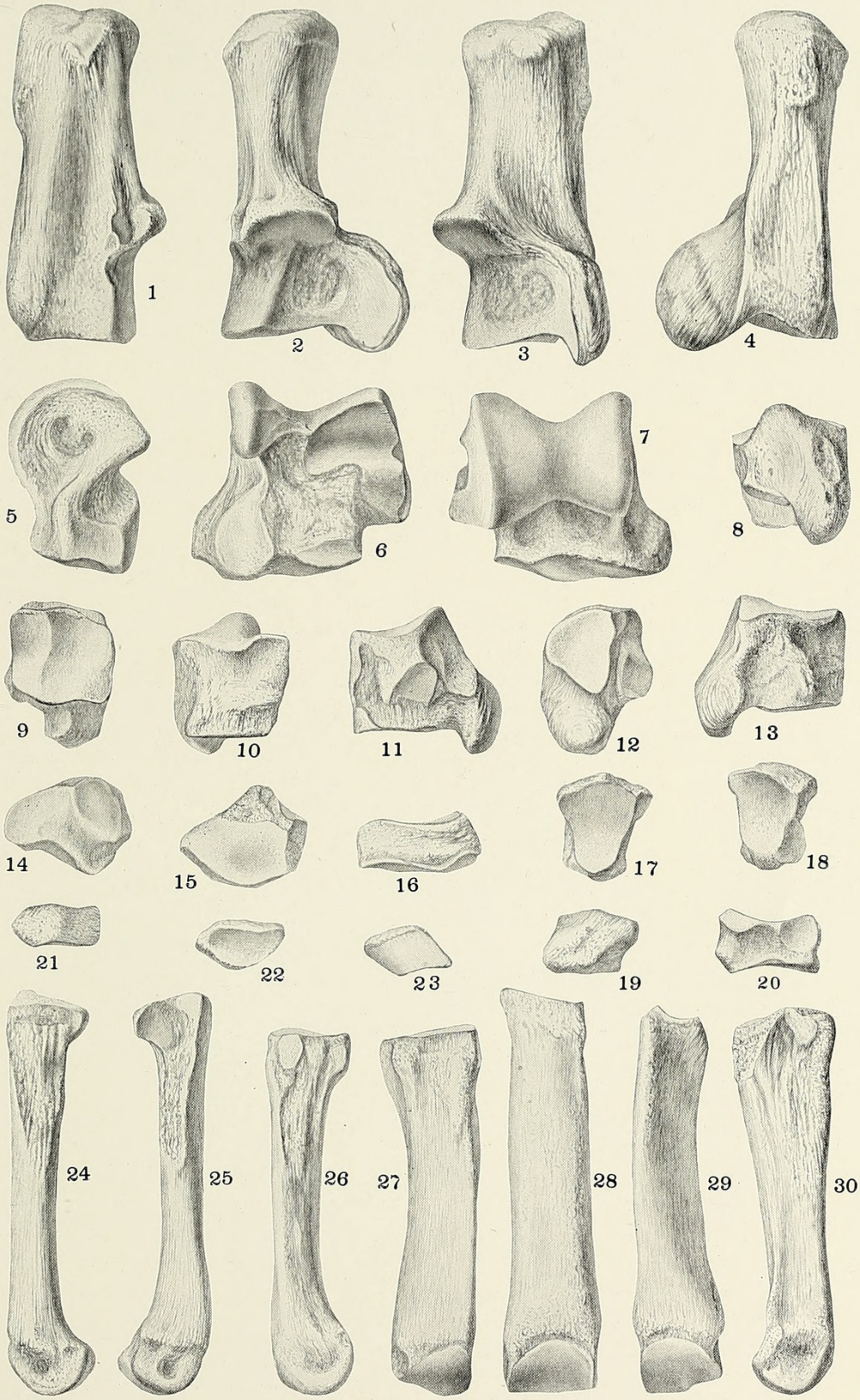


Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE LIII.

Fig. 1. *Dolichorhinus longiceps* Douglass, C. M. Cat. Vert. Foss., No. 11,071. Fibular view of calcaneum.
Fig. 2. Do. Dorsal view of calcaneum.
Fig. 3. Do. Tibial view of calcaneum.
Fig. 4. Do. Plantar view of calcaneum.
Fig. 5. Do. Tibial view of astragalus.
Fig. 6. Do. Plantar view of astragalus.
Fig. 7. Do. Dorsal view of astragalus.
Fig. 8. Do. Plantar view of cuboid.
Fig. 9. Do. Proximal view of cuboid.
Fig. 10. Do. Dorsal view of cuboid.
Fig. 11. Do. Tibial view of cuboid.
Fig. 12. Do. Distal view of cuboid.
Fig. 13. Do. Fibular view of cuboid.
Fig. 14. Do. Distal view of navicular.
Fig. 15. Do. Proximal view of navicular.
Fig. 16. Do. Dorsal view of navicular.
Fig. 17. Do. Distal view of ectocuneiform.
Fig. 18. Do. Proximal view of ectocuneiform.
Fig. 19. Do. Dorsal view of ectocuneiform.
Fig. 20. Do. Tibial view of ectocuneiform.
Fig. 21. Do. Tibial view of entocuneiform.
Fig. 22. Do. Proximal view of entocuneiform.
Fig. 23. Do. Distal view of entocuneiform.
Fig. 24. Do. Tibial view of metatarsal III.
Fig. 25. Do. Fibular view of metatarsal III.
Fig. 26. Do. Tibial view of metatarsal IV.
Fig. 27. Do. Dorsal view of metatarsal IV.
Fig. 28. Do. Dorsal view of metatarsal III.
Fig. 29. Do. Dorsal view of metatarsal II.
Fig. 30. Do. Fibular view of metatarsal II.

(All figures one-half natural size)



Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE LIV.

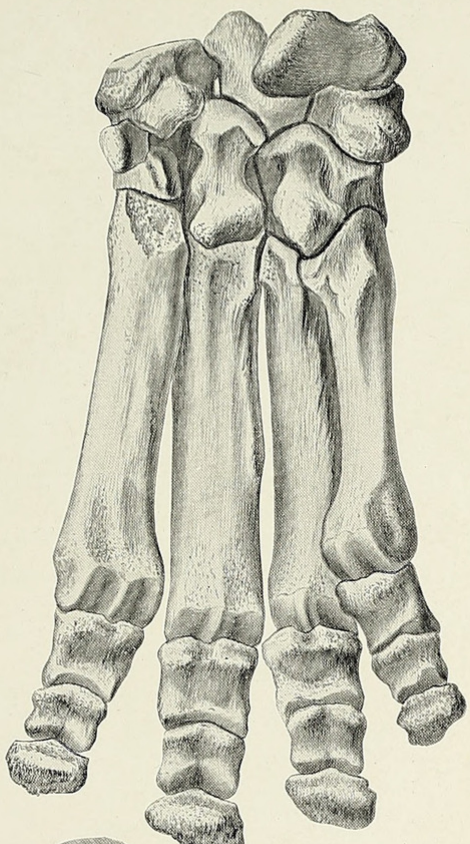
Fig. 1. *Dolichorhinus longiceps* Douglass, C. M. Cat. Vert. Foss., No. 11,071. Palmar view of manus.

Fig. 2. Do. Dorsal view of manus.

Fig. 3. Do. Dorsal view of pes.

Fig. 4. Do. Plantar view of pes.

(All figures one-half natural size)



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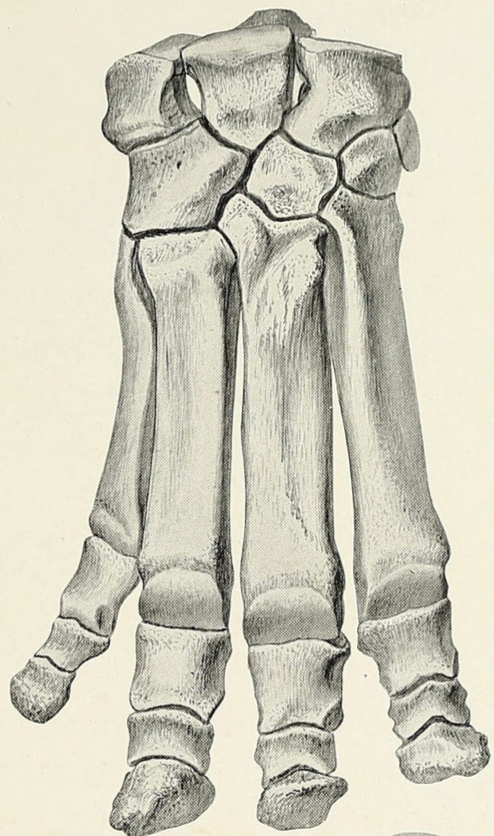
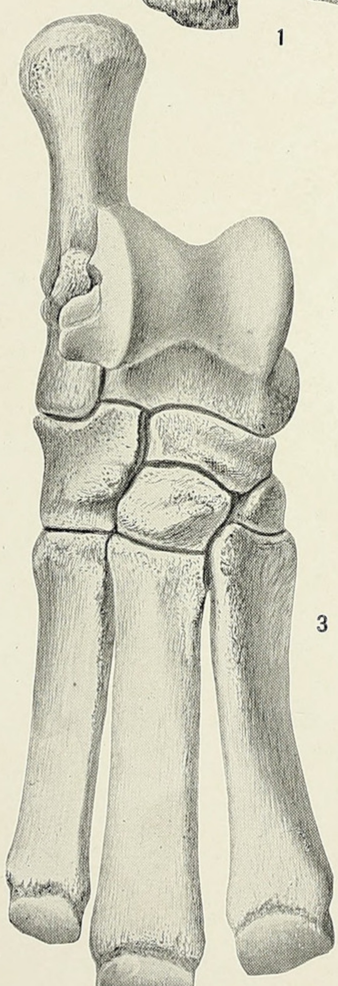


2



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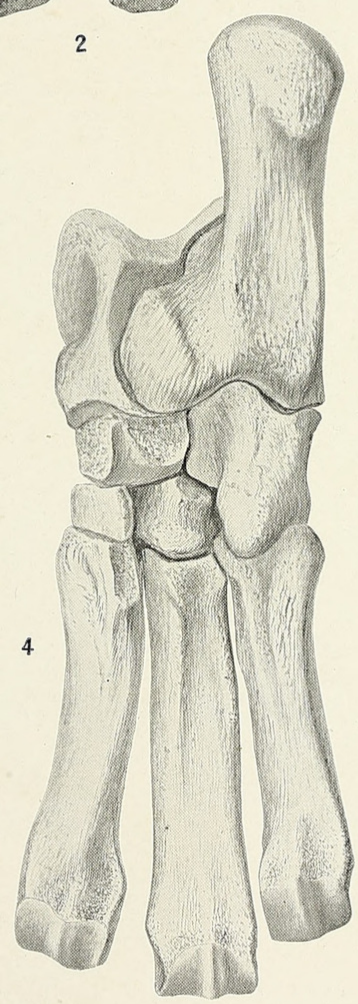


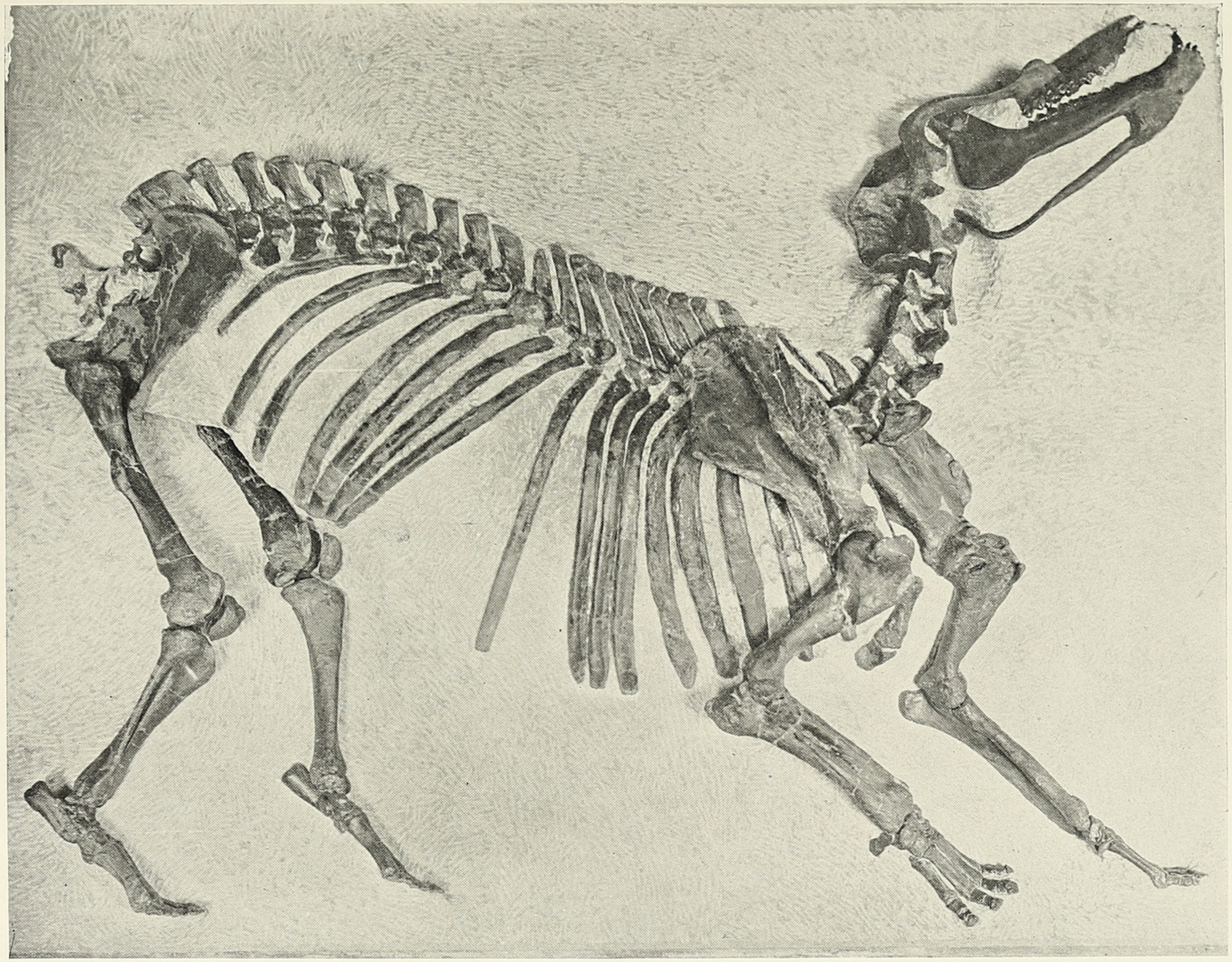
4

Dolichorhinus longiceps Douglass.

EXPLANATION OF PLATE LV.

Articulated skeleton of *Dolichorhinus longiceps* Douglass. Combination of two skeletons Nos. 11,071, and 11,072, C. M. Cat. Vert. Foss. On exhibition in gallery of Fossil Mammals.

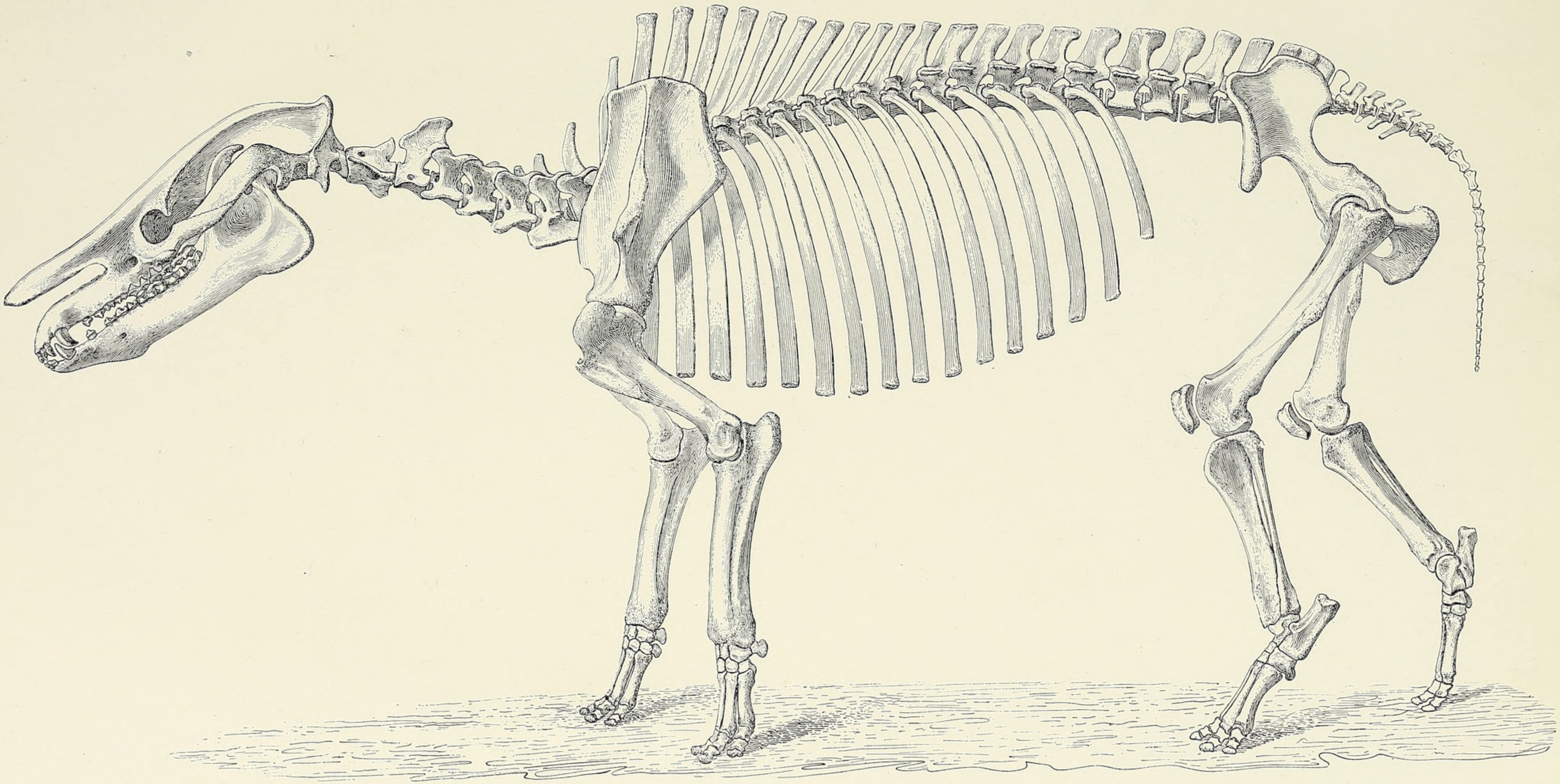
(One-ninth natural size)



Articulated skeleton of *Dolichorhinus longiceps* Douglass.

PLATE LVI.

Dolichorhinus longiceps Douglass.
Restoration of Skeleton.
(One-ninth natural size)



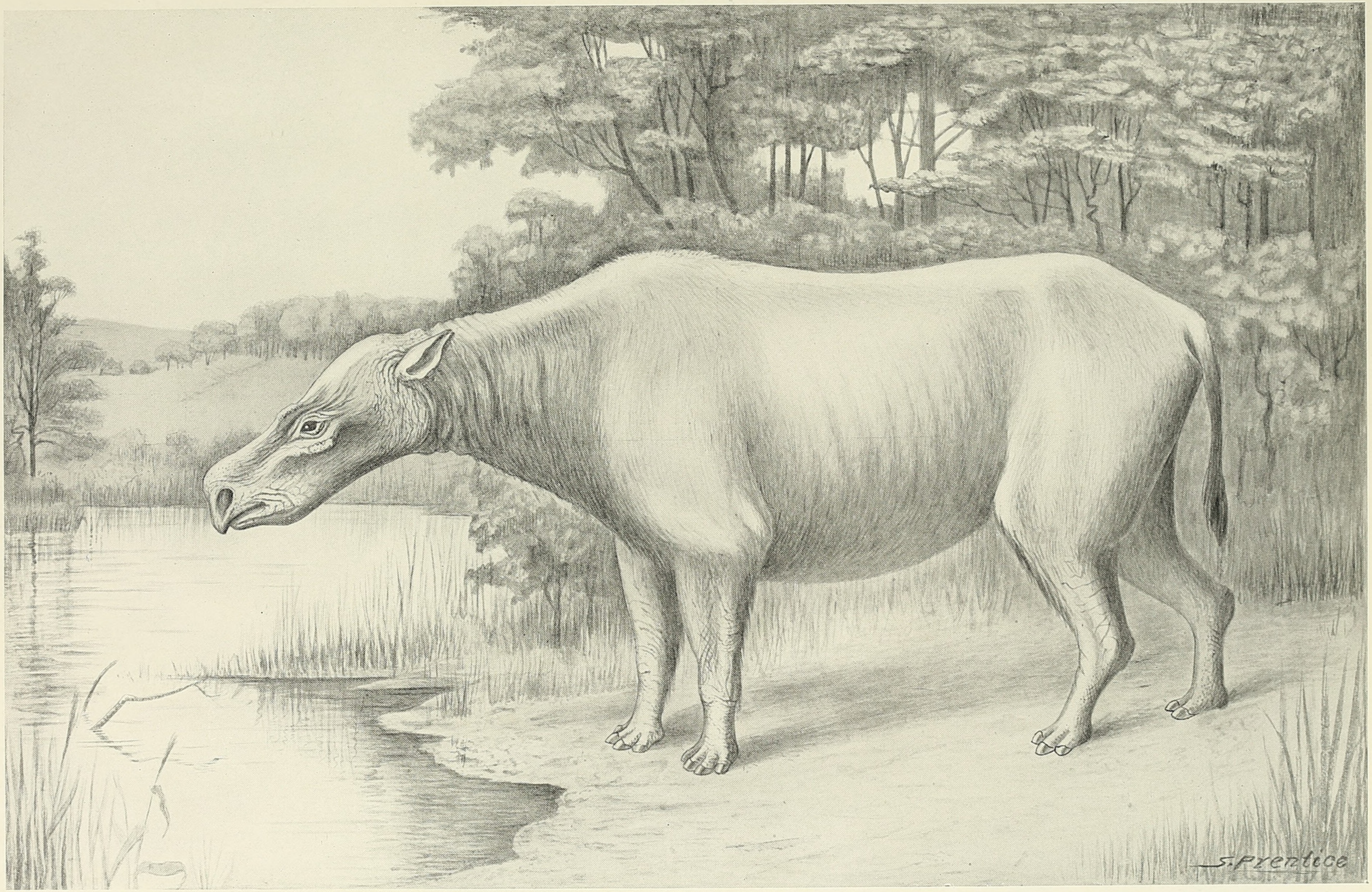
Restored Skeleton of *Dolichorhinus longiceps* Douglass.

PLATE LVII.

Dolichorhinus longiceps Douglass.

Restoration by Sidney Prentice, showing possible appearance in life.

(Greatly reduced)



Restoration of *Dolichorhinus longiceps* Douglass.