

Article XXI.—A REVISION OF THE BUNODONT ARTIODACTYLA OF THE MIDDLE AND LOWER EOCENE OF NORTH AMERICA.

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INTRODUCTION.

The collections of the American Museum of Natural History from the Bighorn and New Mexican Wasatch, the Wind River and the Bridger contain a number of new genera and species of bunodont artiodactyls which it is the purpose of the present article to describe. The writer's acknowledgements are due to Professor Henry F. Osborn for the opportunity to study the collections here reported on, to Dr. W. D. Matthew and Mr. Walter Granger for many helpful suggestions, and to Professors Charles Schuchert and R. S. Lull for permission to examine the Marsh types in the Peabody Museum of Yale University.

With the exception of *Trigonolestes* (= *Diacodexis* Cope) our knowledge of Lower Eocene artiodactyls has hitherto been limited to a few specimens described by Professor Marsh under the names *Eohyus distans*, *Eohyus robustus*, *Parahyus vagus* and *Parahyus aberrans*.¹ Of these, *Eohyus distans* is based on a single third upper molar wholly unlike that of any of the artiodactyls in the American Museum collection and may be regarded for the present as of uncertain systematic position. *Eohyus robustus* is, unquestionably, referable to *Peripitychus*, and both species of *Parahyus* far exceed in size any of the forms here discussed and are probably Achænodonts. The American Museum collections have added three new genera and seven new species to the list besides increasing our knowledge of the skull and skeletal characters in some of the forms already known.

If more or less uncertainty still exists regarding the systematic position and relationships of the new forms here described, it is because of the fragmentary character of the material, mainly parts of jaws unassociated with remains of the skeleton. In but few instances has the typical artio-

¹ The types of both *Eohyus distans* and *E. robustus* are said to be from the Lower Eocene (Wasatch) of New Mexico. Some doubt seems to exist regarding the horizon of the two species of *Parahyus*. Marsh states that they are from the Coryphodon beds of Wyoming. Hay's catalogue locates them in the Bridger, while Matthew's checklist (U. S. G. S. Bulletin 361) gives the locality as Coryphodon zone, Black Buttes, Washakie Basin, Wyoming. Professor R. S. Lull kindly informs me that the type of *P. vagus*, catalogue No. 10972 Yale University Museum, comes from Bitter Creek Station, Wyoming. *P. aberrans*, catalogue No. 10027, was shipped from Fort Bridger, Wyoming, and this is the only record regarding its geographic locality.

dactyl astragalus been found in undoubted association with the tooth-bearing parts of the skull. The reference of these Lower and Middle Eocene bunodonts to the Artiodactyla must, therefore, largely depend on such dental characters as can be worked out from specimens in which the teeth are positively associated with foot-bones of artiodactyl type.

Family DICHOBUNIDÆ.

Wasatchia new genus.

Dentition $\frac{?}{?}, \frac{?}{?}, \frac{4}{4}, \frac{3}{3}$. P^3 trenchant, with small deuterocone and slight posterior cuspule. Anterior cuspule, if present, broken off; p^4 with large deuterocone and broad antero-external cuspule. M^1 and m^2 quadritubercular with small hypocone; m^3 tritubercular with incipient hypocone. Small intermediates apparently present. Cusps bunoid. Cingula on molars continuous except for slight interruption internally on m^1 and m^2 .

Lower premolars, except the first, double-rooted, separated by short diastemata; p_2 simple, trenchant, without accessory cuspules; p with laterally compressed crown,

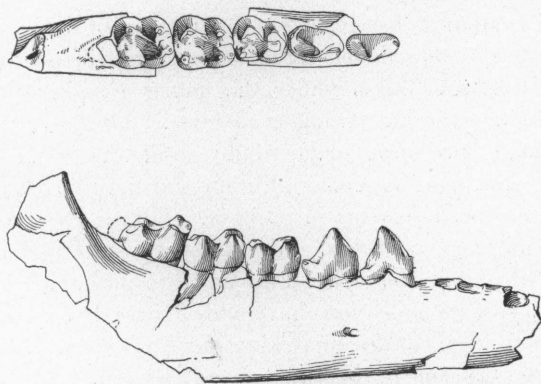


Fig. 1. *Wasatchia grangeri*, lower jaw, superior view of left ramus with p_3 reversed from opposite side, and external view of right ramus with p_4 and m_3 reversed from opposite side, nat. size. Type specimen No. 15516.

small anterior cuspule and narrow, cingulum-like posterior ledge; p_4 less compressed, with anterior cuspule a little stronger than in p_3 and a broader heel-ledge. No deuterocoid.

Paraconid smaller than metaconid but always present on lower molars. Heels of anterior molars wider transversely than trigonids; in m_3 , heel a little narrower transversely than trigonid. Hypoconid of m_3 as large as, or larger, than protoconid; hypoconulid and entoconid subequal.

Mandible not strongly convex inferiorly, not increasing rapidly in depth below m_2 .

Wasatchia grangeri n. sp.

Type. Parts of both rami of the lower jaw (Amer. Mus. Coll. No. 15516). From the Bighorn Wasatch (Gray Bull beds) two miles southwest of St. Joe postoffice (horizon 3 of Sinclair and Granger, Bull. Am. Mus., Vol. XXX, p. 108 and Fig. 2B), Bighorn County, Wyoming. Amer. Mus. Expd. 1910. The species is named in honor of Mr. Walter Granger.

Measurements.

	mm.
p ₂ -m ₃	50
m ₁ -m ₃	25.5
p ₃ , long diam.....	7
p ₄ " ".....	7
m ₁ " ".....	7
m ₂ " ".....	7.5
m ₃ " " approx.....	11
p ₃ , trans. diam.....	3
p ₄ " ".....	4
m ₁ " " across heel.....	5.5
m ₂ " " " ".....	7
m ₃ " " " ".....	6.5
m ₃ " " " trigonid.....	6.8
Depth of mandible below p ₃	12
" " " " m ₂	14

Separable from *Wasatchia dorseyana* n. sp., which approaches it in dimensions, by the slightly larger size of the teeth, the larger hypoconid on m₃, the barely visible anterior basal cuspule on p₃, the limitation of a cingulum to the anterior face of m₁, and by the slightly greater degree of rugosity of the enamel on the outer surface of the tooth crowns, but this may be a feature due to their almost unworn condition.

Wasatchia dorseyana n. sp.

Type. Palate and fragment of right mandibular ramus with m₃ (Amer. Mus. Coll. No. 15673). From the Bighorn Wasatch (Gray Bull beds) at the head of Dorsey



Fig. 2. *Wasatchia dorseyana*, upper jaw and last lower molar (right), nat. size. Type specimen No. 15673.

Creek (horizon 3 of Sinclair and Granger, Bull. Am., Vol. XXX, p. 108 and Fig. 2B), Bighorn County, Wyoming. Amer. Mus. Exp. 1911.

Two other specimens in the collection seem referable to this species:—

No. 15517, including a lower jaw, the distal end of a tibia and an astragalus of the usual artiodactyl pattern from the same horizon as the type of the species, but a different locality, 2 miles south of St. Joe postoffice, Bighorn County, Wyoming.

No. 16295, the right ramus of a lower jaw with p_2 - p_4 , part of m_2 , and m_3 from the upper levels of the so-called New Mexican Wasatch (Largo beds = Lost Cabin, Wind River), about 10 miles west of Laguna Colorado, Rio Arriba County, New Mexico. American Museum Expedition, 1912.

Measurements.

	No. 15673	No. 16295
	mm.	mm.
p^3 - m^3 , length.....	33.3	
p^3 long diam.....	6	
p^4 " ".....	6	
m^1 " ".....	6.5	
m^2 " ".....	7	
m^3 " ".....	7	
p^3 trans. diam.....	4	
p^4 " ".....	7.3	
m^1 " ".....	8.3	
m^2 " ".....	9	
m^3 " " at widest part.....	8.5	
p_2 - m_3 , length.....		43
p_2 long diam.....		4.6
p_3 " ".....		7.2
p_4 " " (approx.).....		7
m_3 " ".....	9	8.5
m_3 trans. diam. of trigonid.....	6.2	5.3
" " " " heel.....	5.2	5

Assuming that Nos. 15517 and 16295 are correctly referred here, the characters of this species may be summed up as follows:—

Readily separable from *Wasatchia grangeri* by its smaller size, large anterior cuspule on p^3 and the development of a slight external cingulum on the molars, so far as preserved, though, with respect to this last mentioned character, some variation may occur, as in a specimen from the same horizon in the Bighorn Wasatch as the type, but from a different locality (Amer. Mus. Coll. No. 15,517, Fig. 3), the cingulum is absent.

The upper dentition has already been characterized in defining the genus. Except for their smaller size, the teeth closely resemble those of *Helohyus*, a Bridger bunodont artiodactyl, undoubtedly related to *Wasatchia*. In both, the tooth cusps are bunoid, the third premolar is trenchant with a

slight deutercone, the fourth has a large, conical deutercone and prominent anterior basal cuspule, the first two molars are quadritubercular, with a small hypocone rising from the cingulum while the third is tritubercular, with the hypocone faintly indicated. In both, the cingulum is more or less complete, except internally. Intermediate cuspules seem to have been present in *Wasatchia* but their character is obscured by the wear to which the tooth-crowns have been subjected.

The characters of m_3 are the same as in the genotype with the addition of anterior and external cingula. As already noted, these appear to vary. P_{2-4} , preserved in No. 16295 from New Mexico, are laterally compressed blades without accessory basal cuspules in p_2 , but with these well developed in p_3 . P_4 has the characteristic cingulum-like heel, but the anterior cuspule is broken off.

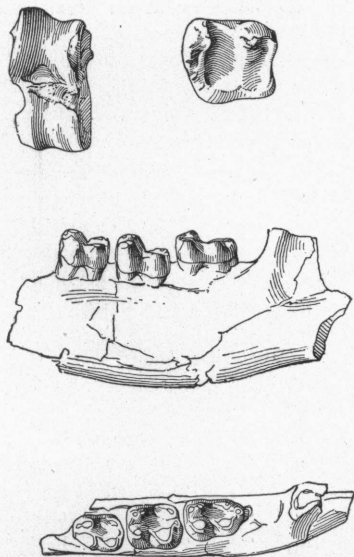


Fig. 3. Artiodactyl referred to *Wasatchia dorseyana*. Astragalus, distal end of tibia, outer and superior views of lower jaw, nat. size. No. 15517. Gray Bull beds, Big-horn Wasatch, Wyoming.

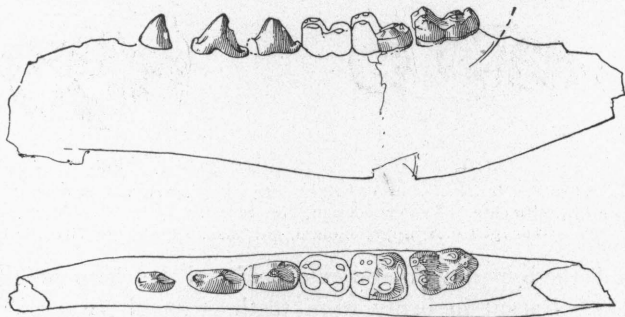


Fig. 4. Artiodactyl inseparable from *Wasatchia dorseyana*. Lower jaws, external and superior views, nat. size. No. 16295. Largo beds (= Lost Cabin, Wind River), New Mexico.

Wasatchia lysitensis n. sp.

Type. Fragments of right and left mandibular rami with m_{1-3} (Amer. Mus. Coll. No. 15660). From the Lysite formation (Wind River group) on Fifteen-mile Creek otherwise known as Dry Cottonwood Creek, Buffalo Basin, Wyoming. Amer. Mus. Exp. 1911.

Paratype. Fragment of the right maxilla with m^1 , m^2 and part m^3 , lower m_2

and parts of m_1 and m_3 and a small incisor, probably a lower (Amer. Mus. Coll. No. 14936). From the Lysite formation (Wind River group), upper part of the section, Cottonwood Draw, Wind River Basin, Wyoming. Amer. Mus. Exp. 1909.

Measurements.

	Paratype, No. 14936.	Type, No. 15660.
	mm.	mm.
m^1 - m^3	23.7	
m^1 ant.-post. diam. externally.....	7.1	
“ “ “ through center.....	6.4	
m_2 “ “ externally.....	8.7	
“ “ “ through center.....	7.3	
m^3 “ “ externally.....	7.5	
m^1 greatest trans. diam.....	9.1	
m^2 “ “ “	11.1	
m_1 ant.-post. diam.....		8.2
m_2 “ “	9.1	8.7
m_3 “ “		10.4
m_1 trans. diam. through heel.....	6.3	6.7
“ “ “ “ trigonid.....	—	5.8
m_2 “ “ “ heel.....	7.5	7.9
“ “ “ “ trigonid.....	6.8	7.2
m_3 “ “ “ heel.....	5.7	6
m_3 “ “ “ trigonid.....	—	6.7, 7

Closely approaching *Helohyus plicodon* in size, but undoubtedly referable to *Wasatchia* (of which it is the largest known species) from the character of the heel of the last lower molar which differs from that of *Helohyus* in the



Fig. 5.

Fig. 5. *Wasatchia lysitensis*, m_1 - m_3 of right side, superior view, nat. size. Second molar reversed from opposite side. Type specimen, No. 15660.

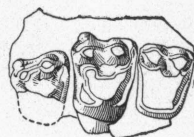


Fig. 6.

Fig. 6. *Wasatchia lysitensis*, upper molars, nat. size. Paratype, No. 14936.

reduction of the hypoconulid and entoconid and the closer juxtaposition of these cusps. Except in badly worn teeth, a small paraconid is always present. Traces of anterior and external cingula appear on the lower molars. The enamel is almost smooth.

No. 14936 is associated as paratype from the shape of the heel of m_3 , which, although somewhat more worn, is indistinguishable from that of the type. The upper molars are suggestively like those of *Helohyus*, differing in having the greatest anteroposterior diameter through the outer cusps while those of *Helohyus* are squarer, their anteroposterior diameters at the center being the same as at the outer margin. M^1 and m^2 are quadrituber-

cular with hypocones as large as in *Helohyus*. M^3 seems to have been tri-tubercular, but the posterior portion of the crown is broken off. Prominent tubercles rise from the external cingulum at the base of the metacone in m^2 and m^3 . A similarly situated tubercle has been observed in m^2 of *Helohyus* and perhaps may be found to occur occasionally on some of the other molars. Cingula probably complete except, perhaps, internally. Small tubercle on anterior cingulum opposite notch between protocone and protoconule absent. The presence of this tubercle is a specific character in *Helohyus plicodon*. It is not found in *H. milleri* and will serve to separate the teeth of *H. plicodon* from those of *Wasatchia lysitensis* which approach them so closely in size. Enamel almost smooth.

The incisor is a small spatulate tooth, probably referable to the lower series.

Bunophorus new genus.

Dentition $\frac{?}{?}, \frac{?}{?}, \frac{?}{4}, \frac{?}{3}$. Upper teeth unknown. Lower premolars, except probably the first, double-rooted, not separated by diastemata; premolars not much compressed laterally, anterior basal tubercles small or absent, heels ingulum-like ledges broader in p_4 than in p_3 ; no deuterocoid on lower premolars.

Molar cusps bunoid; paraconid vestigial or absent; heels of anterior molars as wide as or a little wider than trigonids; in m_3 heel much narrower than trigonid, with hypoconid smaller than protoconid and hypoconulid exceeding in size the entoconid.

Mandible strongly convex inferiorly, rapidly increasing in depth below m_2 .

Bunophorus etsagicus (Cope).

Type. *Trigonolestes etsagicus* Cope, right and left halves of the mandible (Amer. Mus. Coll. No. 4698). From the Bighorn Wasatch, Bighorn Basin, Wyoming. J. L. Wortman collector, 1881.

Measurements.

	mm.
p_3-m_3	38
m_1-m_3	23.5
p_3 , long diam.....	7.5
p_4 " ".....	7.5
m_1 " ".....	6.5
m_2 " ".....	7.5
m_3 ".....	9
p_3 trans. diam.....	3.8
p_4 " ".....	4.8
m_1 " " across heel.....	5.8
" " " " trigonid.....	5.3
m_2 " " " heel.....	6.8
" " " " trigonid.....	6.8, 7
m_3 " " " heel.....	5.3
" " " " trigonid.....	7
Depth of mandible below p_3	10
" " " " m_2	15.3

Cope's original description is, in part, as follows:—

"The heel of the third premolar is obsolete, and that of the fourth is a wide cingulum. Neither exhibit an anterior basal tubercle, and in both the principal cusp is stout. The true molars widen posteriorly to the anterior part of the last molar. The latter contracts rapidly to a narrow heel. The tubercles are all subconic, and the median ones of the last molar are small. There are no cingula and the enamel is smooth.

"The ramus is not robust, and is of moderate depth. Its inferior border rises below the middle of the last molar tooth, and posteriorly. There is a 'mental' foramen below the contact of the fourth premolar and first true molar."

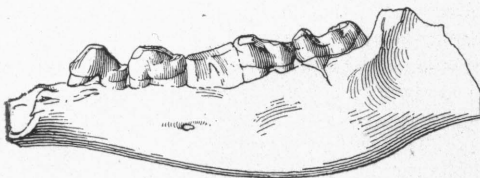
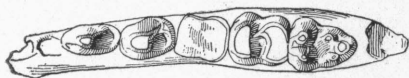


Fig. 7. *Bunophorus etsagicus*, outer side of left ramus with p_4 reversed from opposite side and superior view of right ramus, nat. size. Type specimen No. 4698.

The generic distinctness of *B. etsagicus* was recognized by Wortman in 1898. Referring to *Pantolestes* (i. e. *Trigonolestes*) he writes: "From this genus I exclude the type of *Pantolestes etsagicus* Cope as belonging to a distinct genus ancestral to and leading directly up to the bunodont Artiodactyla. It is very probably synonymous with *Eohyus*

distans Marsh, who properly placed it among the Bunodonts."

But little need be added to Cope's description. In his figure (Tertiary Vertebrata, pl. xxve, fig. 24a) only one alveolus for p_2 is shown whereas the specimen shows a second alveolus for the anterior root of this tooth. The advanced state of wear of the anterior molars has destroyed all trace of the paraconid if this cusp was ever present in a vestigial condition as seems possible from what has been observed in the other species of *Bunophorus*. Not the slightest trace of paraconid is seen in the almost unworn third molar. Cingula, though feebly developed, are not entirely wanting. A faint anterior cingulum occurs on m_2 and may have been present on m_1 . Faint traces of discontinuous external cingula may be seen on all the molars. Enamel practically smooth.

Bunophorus macropternus (Cope).

Type. *Phenacodus macropternus* Cope, a fragment of a right mandibular ramus with m_{1-3} (Amer. Mus. Coll. No. 4395). From the Bighorn Valley, Wyoming. It is not certain to what horizon the specimen belongs (i. e. whether Wasatch, Lysite or Lost Cabin). J. L. Wortman collector, 1881.

Measurements.

	mm.
m_1 , long diam.....	6.1
m_2 " "	6.5
m_3 " "	9.2
m_1 trans. diam. across heel.....	5.1
" " " " trigonid.....	4.8
m_2 " " " heel.....	6.2
" " " " trigonid.....	6
m_3 " " " heel (approx.).....	4.3
" " " " trigonid.....	6

Original description.—"This species is apparently rare, being represented by only one mandibular ramus, which supports the posterior three molars, and a possible second ramus with molars IV and V. The first and second true molars are much like those of *P. vortmani*, but the third is relatively larger, and has an especially elongate heel. In *P. vortmani* the last molar is constricted, and narrower than the penultimate. In *P. macropternus* there is a weak external and no internal cingulum. The tubercles of the last two molars are quite regularly conical, while the external pair of the first molar wear into crescents. Smaller than *P. vortmani*."



Fig. 8. *Bunophorus macropternus*, part of right mandibular ramus, superior view, nat. size. Type specimen No. 4395.

Readily separable from *Phenacodus*, to which it has been erroneously referred, by the increase in size posteriorly of the molars (instead of decreasing in size as in *Phenacodus*), by the bunoid outer molar cusps in contrast with their bunocrescentic character in *Phenacodus*, and, finally, in the greater posterior extension of the hypoconulid in m_3 and its greater degree of isolation from the remaining cusps of the heel than in *Phenacodus*.

Owing to the incompleteness of m_3 in the type of *B. macropternus*, comparison with *B. etsagicus* cannot be made as closely as might be desired, but in all respects in which the specimens can be compared there is not sufficient difference to warrant more than a specific separation. The teeth of *B. macropternus* are somewhat smaller than those of *B. etsagicus*. A minute paraconid seems to have been present in m_1 of the type, but this cusp is

entirely wanting in m_2 . A vestige of it is found in m_3 . In the smaller species of *Wasatchia*, which approach *B. macropternus* in size, the paraconid, though small, is present in all the molars. Cingula are more strongly developed than in *B. etsagicus*, both anteriorly and externally, but are lacking internally. A continuous external cingulum is present about the outer cusps of m_3 , while in m_1 and m_2 it is interrupted about the base of the hypoconid. The enamel is slightly rugose.

Cope's second specimen (No. 4394 Am. Mus.), a fragment of the right mandibular ramus with the first and second molars, has the teeth badly worn and lacks the diagnostic third molar. As m_2 shows a well marked trace of the paraconid, a cusp which is absent or at best but slightly indicated in the molars of *Bunophorus*, we may be justified in referring the specimen in question to *Wasatchia*.

Lophiohyus new genus.

Dentition $\frac{3}{2 \text{ or } 3}, \frac{1}{1}, \frac{\text{probably } 4}{4}, \frac{\text{probably } 3}{3}$. Upper dentition almost unknown. Incisors spaced, crowns small, second conical, recurved. Canine large, long, perhaps laterally flattened (only a fragment, split longitudinally, is preserved). Anterior premolars double-rooted, widely spaced and trenchant. Molars known only from a fragment or two, not unlike *Helohyus*.

In the lower series, the tips of the alveoles of two incisors and the alveolus of a small canine are preserved. P_1 single-rooted, p_{2-4} double-rooted. Wide diastemata behind c , p_1 and p_2 . No anterior basal cuspule on p_3 , posterior cuspules cingulum-like, broader in p_4 than in p_3 . Crowns moderately compressed laterally. No deuterocoonid.

Lower molars with very small paraconid. Heels of anterior molars wider than trigonids, that of m_3 with large hypoconulid supporting several minor tubercles. External, anterior and posterior cingula present on the molars. Enamel finely rugose.

Mandible decreases slightly in depth anterior to p_3 , but otherwise is of about the same depth throughout. Skull with high, thin sagittal crest, rapidly sloping downward and forward to its point of divarication back of the postorbital processes, between which the inclosed frontal tract is smooth.

Lophiohyus alticeps n. sp.

Type. An incomplete crushed skull, lower jaws and fragments of cervical vertebrae (Amer. Mus. Coll. No. 1518). From the Bridger formation, Twin Buttes, Sweetwater County, Wyoming. Amer. Mus. Exp. 1893.

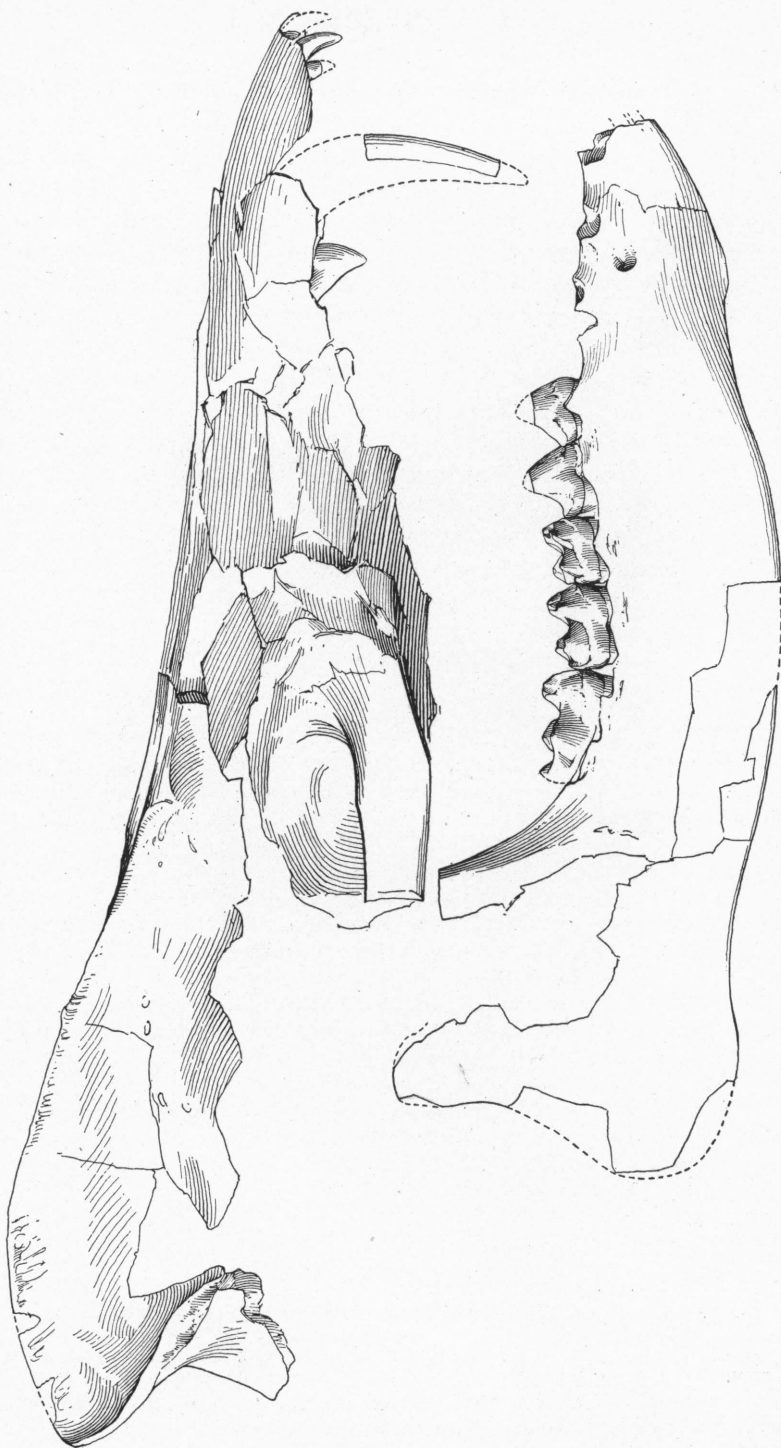


Fig. 9. *Lophiohyus alticeps*, side view of skull and lower jaw, nat. size. Type specimen, No. 1518.

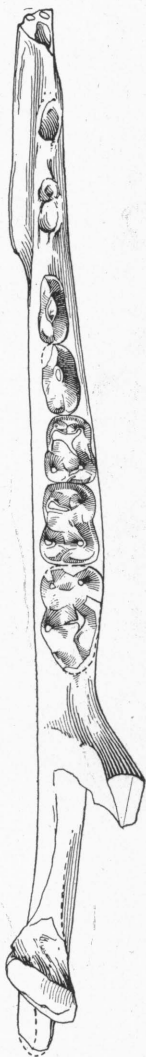


Fig. 10.

Fig. 10. *Lophiohyus alticeps*, superior view of right ramus of lower jaw, nat. size. Incisor alveoli inserted from opposite side. Type specimen, No. 1518.

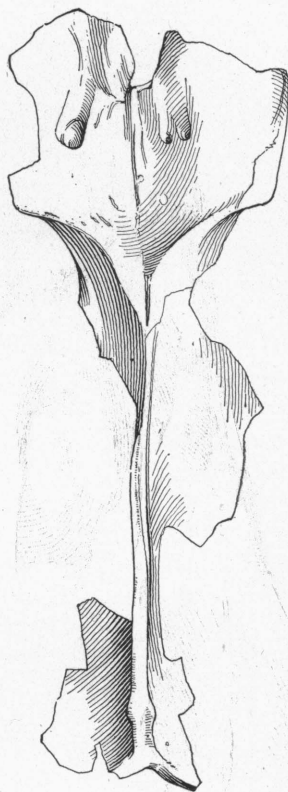


Fig. 11.

Fig. 11. *Lophiohyus alticeps*, dorsal view of part of skull, nat. size. Type specimen, No. 1518.

Measurements.

	mm.
Length, lower jaw, incisors to condyles (partly estimated).....	133
“ lower dentition (p ₁ -m ₃).....	73.5
“ premolar series including diastemata.....	41-43
“ true molar series.....	33
“ Alveolus of p ₁ 4.5; Alveolus of p ₂ 7; p ₃ 9; p ₄	9
“ postcanine diastema 6; 2nd diastema 5; 3d diastema.....	5.5
“ m ₁ 9; m ₂ 10; m ₃ (estimated partly).....	14
Depth of jaw at back of symphysis bet. p ₂ and p ₃	18
“ “ “ “ m ₂	22
Greatest width of p ₃ , 3.5; p ₄ , 4; m ₁ , 6.5; m ₂	7.5

As but one specimen of a single species is known, the generic and specific characters cannot be separated at present. Apparently, we have in *Lophiohyus* a form closely related to *Helohyus*, but differing, so far as comparison can be made, chiefly in the greater spacing of the anterior lower premolars, the less strongly developed paraconid and the presence of strong external cingula on the lower molars. Probably other differences would appear if both forms were known from more complete material.

The conical, widely-spaced incisors of *Lophiohyus* resemble in a way those of the type of the problematic Bridger genus *Ithygrammodon cameloides* (No. 10125 Princeton University Museum, Fig. 12), which is possibly

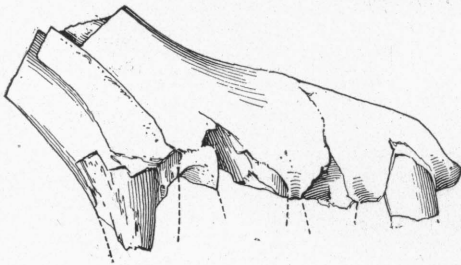


Fig. 12.

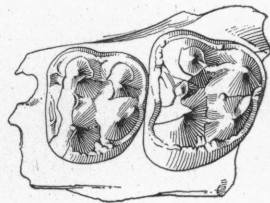


Fig. 13.

Fig. 12. *Ithygrammodon cameloides*, side view of right premaxilla, nat. size. Type specimen, No. 10125, Princeton University Museum.

Fig. 13. Two upper molars of an artiodactyl from the Bridger Eocene, nat. size. No. 10084, Princeton University Museum.

an artiodactyl resembling *Helohyus* or *Lophiohyus*. Two upper molars from the Bridger (No. 10084 Princeton University Museum, Fig. 13) may belong either to *Ithygrammodon* or to Marsh's *Helohyus lentus*, or, possibly, to an undescribed genus.

Helohyus Marsh.

Dentition ? ? , probably $\frac{4}{4}$, $\frac{3}{3}$. Upper incisors, canine and anterior premolars unknown; p³ trenchant, with small deuterocone; p⁴ with large, conical deuterocone,

slightly trenchant protocone, small, but distinct, prostyle and strong cingulum, incomplete only about inner side of deutocone.

Molars 1 and 2 quadritubercular with well-developed intermediates; hypocone a small cusp rising from the cingulum, smaller than the posterior intermediate. Hypocone in m^3 incipient and tooth-crown practically tritubercular. Cingula strong and continuous, except for a slight interruption internally. Enamel finely rugose. Cusps bunoid.

In the lower series, p_1 is probably single-rooted, the remaining premolars double-rooted, trenchant, with cingulum-like heels in p_3 and p_4 and a minute anterior cusplet on p_4 . Short diastemata back of p_1 and p_2 . No deutoconid.

Lower molars with paraconid always present. Heels wider than trigonids in m_1 and m_2 , a little narrower in m_3 . Hypoconulid in m_3 large, often bearing accessory tubercles. Slight anterior and discontinuous external cingula. Enamel finely rugose.

***Helohyus milleri* n. sp.**

Type. Left maxilla with p^2 - m^3 , and anterior half of left mandible with p_3 - m_2 . (Amer. Mus. Coll. No. 12151). From the Bridger formation (C5, Lone Tree white layer), Burnt Fork postoffice, Henry's Fork of Green River, Sweetwater County, Wyoming. Amer. Mus. Expd. 1904. The species is named in honor of its collector, Mr. Paul Miller.

Measurements.

	mm.
m^1 - m^3	30
p^4 long diam.....	7.5
m^1 " "	9.75
m^2 " "	10
m^3 " "	10
p^4 trans. diam.....	9
m^1 " " at widest point (approx.).....	11
m^2 " " " " "	13.5
m^3 " " " " "	14.5
p_3 - m_2	39.5
p_3 long diam.....	10
p_4 " "	9.5
m_1 " "	10
m_2 " "	11
p_3 trans. diam.....	4
p_4 " "	5
m_1 " " at widest point across heel.....	7.5
m_2 " " " " " " "	8.5

Somewhat larger than *Helohyus plicodon* from which it differs in the stronger development of an accessory tubercle on the low crescentic ridge

sweeping forward and outward from the anterior margin of the deuterocone in p^4 , in the proportionately less strongly developed hypocone in m^1 and m^2 , in the greater degree of enlargement of the metaconule in m^3 , which gives the posterior margin of this tooth a greater degree of convexity than in *H. plicodon*, and, finally, in the greater projection externally of the antero-external margin of m^2 and m^3 than occurs in the species just mentioned.

Except for larger size, the characters of the lower dentition are as in *H. plicodon*. As m_3 is not preserved, comparison cannot be made with Marsh's *H. validus* and *H. lentus* which are known only from this tooth. Apparently the new species is somewhat larger than *Helohyus validus*.

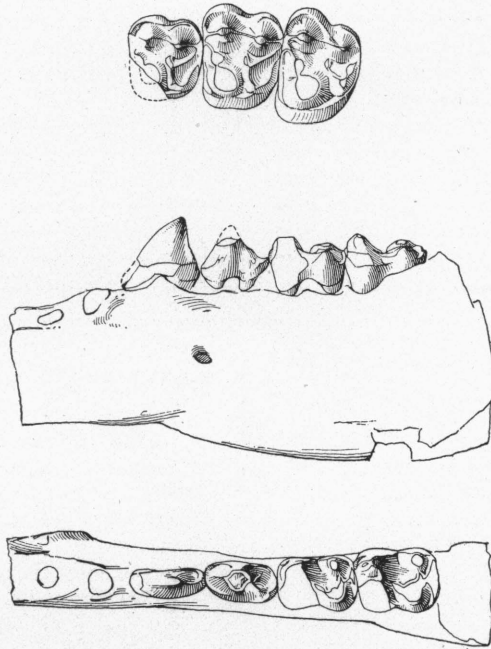


Fig. 14. *Helohyus milleri*, m^1 - m^3 of left side and outer and superior views of left mandibular ramus, nat. size. Type specimen, No. 12151.

Helohyus plicodon Marsh.

Measurements.

	12147 Am. Mus.
	mm.
Length, p^4 - m^3	31.5
“ p^4	7
“ m^1	7.5
“ m^2	8.5
“ m^3	8.5
Greatest width, p^4	7.5
“ “ m^1	9
“ “ m^2	11
“ “ m^3	11
	12149 Am. Mus.
	mm.
Length, p_2 - m_2	43
“ p_3	8

	12149 Am. Mus.		12148 Am. Mus.
	mm.		mm.
Length, p ⁴	8.5		
" m ₁	8.75		
" m ₂	9.5		9
" m ₃			11.5
Greatest width, p ₃	3.5		
" " p ₄	4		
" " m ₁	6		6
" " m ₂	7		7.5
" " m ₃			7

The additional material of this species of *Helohyus* now available has made it possible to separate generic and specific characters to better advantage. The generic characters have already been listed and need not

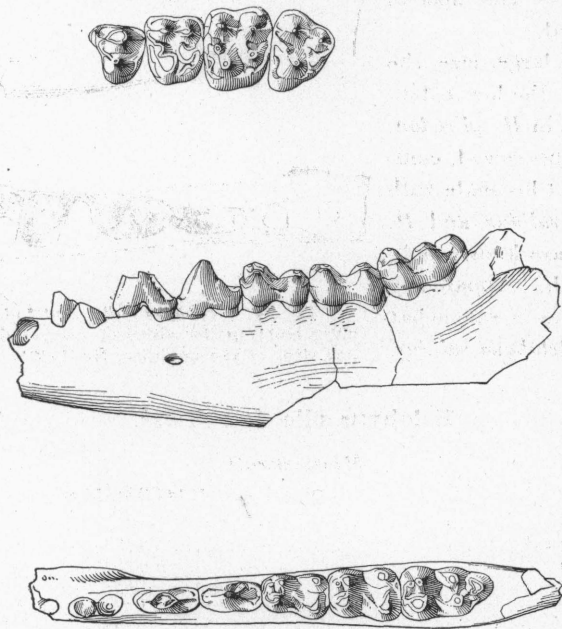


Fig. 15. *Helohyus plicodon*, upper p⁴-m³, nat. size, No. 12147. Side and superior views of left half of lower jaw, nat. size. No. 12149. Last molar and a small fragment of the jaw supplied from No. 12148.

be repeated. *Helohyus plicodon* is distinguishable from *H. milleri* by its smaller size, proportionately stronger development of the hypocone in m¹ and m², the straighter posterior border of m³ owing to the smaller posterior intermediate, and by the approximately equal projection of the external

cusps in m^2 and m^3 while in *H. milleri* the antero-external projects farther outward than the postero-external. From *H. validus* it may readily be separated by the very much smaller hypoconulid on m_3 (see Fig. 16). *H. lentus* (Fig. 17) if correctly referred to the genus *Helohyus*, is a very much larger form. A small tubercle occurring on the anterior cingulum of the upper molars opposite the notch between the protocone and protoconule is present in *Helohyus plicodon*, but absent in *H. milleri*.



Fig. 16.



Fig. 17.

Fig. 16. *Helohyus validus*, last, right, lower molar, nat. size. No. 12694.

Fig. 17. *Helohyus lentus*, last, right, lower molar, nat. size. No. 12150.

***Helohyus validus* and *Helohyus lentus*.**

Each of these species is represented in the American Museum collections by a single tooth. That referred to *Helohyus lentus* (No. 12150, Amer. Mus. Coll., Fig. 17) is from the Bridger formation (D3), Henry's Fork Hill, Sweetwater County, Wyoming. A fragment of the right mandibular ramus with the last molar in place (Amer. Mus. Coll. No. 12694, Fig. 16) from the Bridger formation (B3), on the middle portion of Cottonwood Creek, Bridger Basin, Sweetwater County, Wyoming, apparently pertains to *H. validus*.

THE SKULL OF HELOHYUS (?).

The posterior half of a skull (Amer. Mus. Coll., No. 13079) associated with an upper p^3 from the Bridger formation (B5, mouth of Summers' Dry Creek, Sweetwater County, Wyoming, Amer. Mus. Exp., 1906) is probably referable, from its size, either to *Helohyus* or *Lophiohyus*.

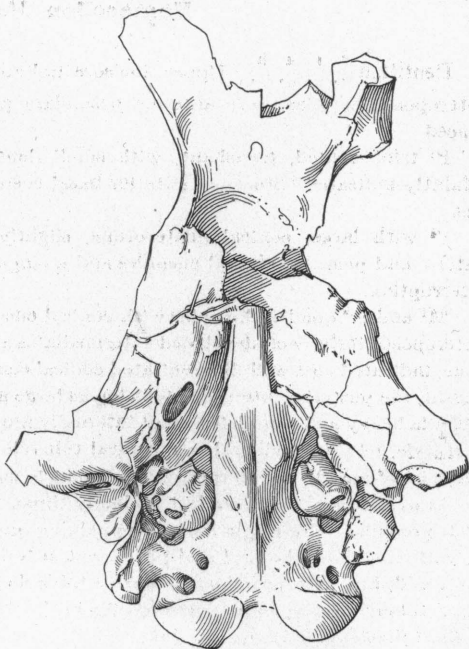


Fig. 18. *Helohyus* (?), basicranial surface of skull, nat. size. No. 13079.

In the basicranial region (Fig. 18) many striking resemblances are found to the structure of the same tract in *Dichobune leporina*, as figured by Stehlin. The most noticeable of these resemblances appears in the absence of an ossified bulla and auditory meatus. What seems to be the bulla is really the petrous as shown by an orifice (the fenestra rotunda) on its lower surface, posteriorly. As Stehlin observes, this structure may have been, originally, common to all the Artiodactyla. It is perhaps, therefore, not to be regarded as peculiarly dichobunid though certainly retained in this family. As will be seen, later, it occurs also in *Homacodon*. The large postglenoid foramen, the long, broad paramastoid processes and the overlapping of the mastoid process by a lamella of the squamosal are found in *Dichobune*, *Helohyus* (?) and *Homacodon*. The remaining features of the basicranial region can be ascertained to better advantage from the drawing (Fig. 18) and need not be described in detail. On the dorsal surface of the skull fragment, the temporal ridges resemble those of *Lophiohyus*. The sagittal crest is considerably lower and the skull seems to have been somewhat shorter proportionately than in that genus.

Homacodon Marsh.

Dentition $\frac{?}{?}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3}$. Upper incisors unknown; canine about equal to p^1 in anteroposterior diameter; anterior premolars probably trenchant and but little spaced.

P^3 triple-rooted, trenchant, with small deutocone and, in some specimens, a faintly-indicated triticone; anterior basal cuspule very small; cingulum continuous.

P^4 with large, conical deutocone, slightly trenchant protocone, prominent antero- and postero-external cuspules and a cingulum continuous except for internal interruption.

M^1 and m^2 quadritubercular with conical cusps, the outer pair slightly trenchant anteroposteriorly, well-developed intermediates and prominent, though small, hypocone, indicated as a well-differentiated conical cusp. In m^3 , the hypocone is entirely absent, the posterior intermediate being as large as the protocone in some specimens. Cingula heavy and complete except internally around base of protocone. Prominent parastyle, no mesostyle unless a conical tubercle sometimes seen between the outer cusps in m^3 may be so interpreted; incipient to small metastyle.

Lower incisors unknown but probably three. Canine as large in cross-section as first premolar. P_1 single-rooted, remaining premolars double-rooted, trenchant. P_2 with cingulum-like heel and prominent anterior tubercle; p_4 without deutoconid, but with prominent anterior tubercle and almost as prominent posterior basal tubercle rising from cingulum-like heel. Premolars practically in close series. A short diastema between c and p_1 .

Lower molar cusps bunoid internally, slightly bunio-selenodont externally, paraconid absent on anterior molars and but feebly developed in m_3 ; heels wider than

trigonids in m_1 and m_2 and of about the same width in m_3 . Hypoconid the largest cusp in the heel; in m_3 hypoconulid slightly smaller than entoconid and all the cusps of the heel high and conical. No internal cingula; slight, discontinuous anterior, external and posterior cingula. Enamel smooth.

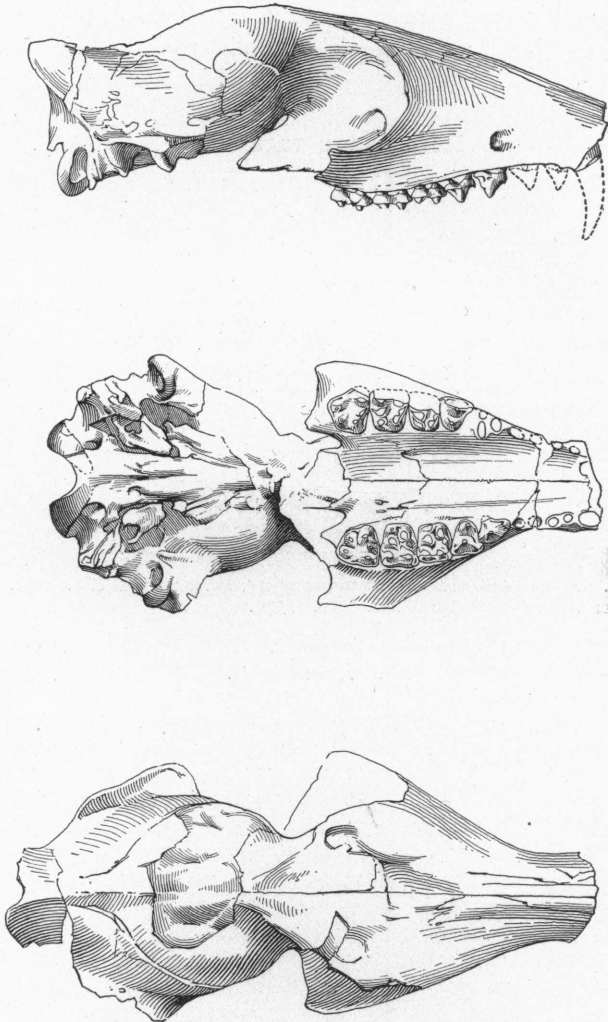


Fig. 19. *Homacodon vagans*, skull, nat. size, side, lower and superior views. No. 12695.

Skull. The skull of *Homacodon*, here figured for the first time, though somewhat damaged, is quite uncrushed. Its salient features may be summarized as follows:—

Basifacial and basicranial axes inclined to each other at a broadly obtuse angle; orbits large, without postorbital processes; temporal ridges low and straight; sagittal crest broken off; brain case depressed posteriorly especially along junction of parietal and squamosal; ossified bulla and auditory meatus absent as in *Dichobune* and *Helohyus* (?) the exposed petrous occupying its place; structure of basicranial region much the same as in *Helohyus* (?)

***Homacodon vagans* Marsh.**

Plesiotype. Skull (Amer. Mus. Coll. No. 12695) from the Bridger formation on Henry's Fork opposite the mouth of Burnt Fork, Sweetwater County, Wyoming. Amer. Mus. Expd. 1905.

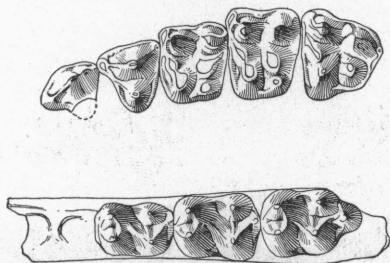


Fig. 20. *Homacodon vagans*, left upper p^4 - m^3 , twice natural size. No. 12695. Lower m^1 -s, superior view, twice natural size. No. 12139.

Measurements.

	mm.
Skull, length from anterior border of canine to condyle.....	71
“ width between orbits.....	24
“ “ at postorbital constriction.....	14
“ height above m^3	22
c - m^3 , length.....	35
p^3 , length.....	4.5
p^4 “.....	4.2
m^1 “.....	4.4
m^2 “.....	4.9
m^3 “.....	5.5
p^3 width.....	3
p^4 “.....	4.5
m^1 “.....	5
m^2 “.....	6
m^3 “ anteriorly.....	6

Generic and specific characters not separable at present.

Nanomeryx Marsh.

Original description.—"This genus appears to be nearly related to *Homacodon*, with which it agrees in several respects, but may be distinguished from it by the fact that the fibula is reduced, and coössified distally with the tibia. The lower jaws are more slender and compressed than in *Homacodon*, and there is a short diastema between the canine and the first lower premolar. The bones of the skeleton, even the vertebræ, are very hollow.

The humerus is perforated above the lower condyle, and the inner condylar margin is without the process characteristic of *Homacodon*. The radius and ulna are separate, but the latter bone is quite slender. The fibula is incomplete. The lower part has coalesced entirely with the tibia, but the suture remains distinct, except in very old individuals . . . The present species is only about half as large as *Homacodon vagans*, and is thus one of the smallest Eocene Artiodactyles known."

A fragmentary specimen in the American Museum collection (No. 12375, Bridger C1, Twin Buttes, Sweetwater Co., Wyoming, Exp. 1904) agreeing in size with *Homacodon*, has the tibia and fibula fused distally. Another specimen of *Homacodon* has the humerus perforated by a supra-condylar foramen. Until better material is available, *Nanomeryx* may be regarded as rather doubtfully separable from *Homacodon*.

Sarcolemur Cope.

It seems probable that this genus, formerly regarded as a primate, should be included among the Artiodactyla and, possibly, referred to the Dichobunidae, although the artiodactyl type of astragalus has not yet been found in association with the teeth. It may be readily recognized by the development of a prominent deutoconid on p_4 , by the retention of a well-marked paraconid on all the lower molars and by the more strongly marked bunosele-nodont character of the outer molar cusps than is found in *Homacodon*.

A maxillary fragment with p^4-m^3 (Amer. Mus. Coll., No. 12043) from the Bridger formation, C3 on Henry's Fork at Burnt Fork postoffice, Sweetwater County, Wyoming is probably referable to *Sarcolemur* (Fig. 21). P^4 resembles that of *Homacodon*, but the deutocone is higher. M^1 and m^2



Fig. 21. *Sarcolemur pygmaeus*, right, upper p^4-m^3 , twice natural size. No. 12043.

are quadritubercular with a small conical hypocone and a prominent style on the anterior cingulum opposite the notch between protocone and protoconule. A smaller style is found on the outer cingulum of m^1 between the paracone and metacone. This portion of the crown is broken off in the remaining teeth. In m^3 the crown is tritubercular, the metaconule is no larger than the protoconule and the hypocone is absent, unless a very slight elevation of the posterior cingulum is to be interpreted as an incipient (or should it be vanishing?) hypocone.

Measurements.

	No. 12043
	mm.
p^4 - m^3 , length.....	17.5
p^4 , length (approx.).....	4.4
m^1 " ".....	4.9
m^2 " ".....	5
m^3 " ".....	4.8
p^4 , width.....	5.3
m^1 " ".....	5.3
m^2 " ".....	6
m^3 " anteriorly.....	6

Microsus *Leidy*.

Two mandibular fragments from the Bridger are, apparently, referable to this little known genus. One of them with m_2 and m_3 (Amer. Mus. Coll.,

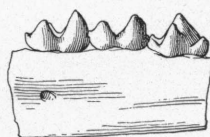
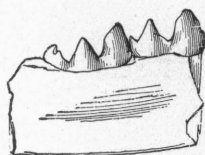


Fig. 22.

Fig. 23.

Fig. 22. *Microsus cuspidatus*, left m_2 and m_3 , superior and inner views, twice natural size. No. 12143.

Fig. 23. *Microsus* sp., p_4 - m_2 , superior and inner views, twice natural size. No. 12144.

No. 12143, Fig. 22) from Bridger D4, on Henry's Fork at Burnt Fork post-office agrees in size with *M. cuspidatus* while the other one (Amer.

Mus. Coll., No. 12144) from Bridger D4 on Henry's Fork Hill, is smaller. *Microsus* resembles *Sarcolemur* in retaining a large deuterocoenid on p_4 but has lost the paraconid on the posterior molars, retaining but a trace of it on m_1 (Fig. 23).

Measurements.

	No. 12143.	No. 12144.
	mm.	mm.
p_4 , length.....		4
m_1 "		3.8
m_2 "	4.9	4.1
m_3 "	5.1	
p_4 , width.....		2
m_1 " across trigonid.....		2.5
" " " heel.....		2.9
m_2 " " trigonid.....	3	2.8
" " " heel.....	3.5	3
m_3 " " trigonid.....	3.2	
" " " heel.....	3.2	

Microsus ? sp.

A fragment of a right half of a mandible with m_{1-3} , from Bridger C5 on Henry's Fork Hill (No. 12145, Am. Mus. Collection) is perhaps referable to *Microsus*. It has a fairly strong paraconid on the first molar, with faint indications of this cusp on the remaining teeth. As the range of cusp variation in this genus is not yet known, the specimen is, for the present, referred doubtfully as above.



Fig. 24. *Microsus* ? sp., fragment of right mandible with m_{1-3} , superior view, twice natural size, No. 12145.

Measurements.

	mm.
m_1 , length.....	4
m_2 "	4
m_3 "	4.5
m_1 , width across trigonid.....	2.4
" " " heel.....	2.8
m_2 , " " trigonid.....	2.8
" " " heel.....	3
m_3 , " " trigonid.....	2.7
" " " heel.....	2.7

Diacodexis Cope.

Dentition $\frac{?}{?}, \frac{?}{?}, \frac{?}{4}, \frac{3}{3}$. Of the upper premolars only the third and fourth are known. P^3 crescentic-trenchant, with small deuterocone and antero-external style; p^4 with large deuterocone and medium sized antero-external style; outer cusp crepcentic-trenchant, inner cusp bunodent; cingulum continuous.

Upper molars tritubercular; hypocone not yet differentiated from cingulum; internal cusp buno-selenodont, external cusps bunoid with trenchant edges. Intermediates well developed. Cingulum interrupted internally on m^1 and m^2 , continuous on m^3 .

Lower molar cusps bunoid with slight suggestion of buno-selenodont pattern externally. Paraconid usually well developed and present on all the molars (exceptionally absent.)¹ Heels of anterior molars wider than trigonids; in m_3 , heel a little narrower than trigonid, hypoconid as large as protoconid, hypoconulid either larger than, or equal to, entoconid.

Mandible with medium inferior convexity, gradually increasing in depth posteriorly.

The type specimen of the genus *Diacodexis* is a composite, originally described as *Phenacodus laticuneus*, and combines upper premolars of *Eohippus*, upper molars of *Hyopsodus* and the last lower molar of an artiodactyl. The lower molar was used by Cope in defining his *P. laticuneus*. Later (1882), the reference of this species to *Phenacodus* was dropped and the new genus *Diacodexis* substituted. As indicated above, the only portion of the type specimen to which this name is applicable is the last lower molar which does not seem to be generically distinct from that of *Trigonolestes*. As the latter genus was not proposed until 1894, *Diacodexis* has priority. Whether *D. laticuneus* is determinable specifically may be open to question, though its generic position is clear. It is of about the same size as *D. (Trigonolestes) chacensis* and, eventually, may prove to be identical with it.

Diacodexis chacensis Cope.

I am wholly unable to separate this species from *D. metsiacus* and *D. brachystomus* on the basis of size nor have I found a single morphologic character whereby they can be differentiated. When taken by themselves,



Fig. 25. *Diacodexis chacensis*, right upper p^2 - m^3 , twice natural size. No. 15671.

the types seem to differ specifically, but the large series of specimens at my disposal has made it possible to connect them by transitional forms. Eighteen specimens, in addition to the types, were subjected to careful measurement and the results are tabulated below.

Completeness of preservation was the sole basis of selection. The series is arranged in the order of increasing length of the tooth row (p_4 - m_3) and the value of each dimension given both in millimeters and as a percentage of the length of the tooth row (p_4 - m_3), taking the latter as 100.

¹ As on m_2 in the type specimen of *D. (Trigonolestes) secans*, where it is hardly visible.

Variation table for *Diacoderis (Trigonolestes) chaensis* from the Wasatch and Wind River groups of the Bighorn and Wind River Basins, Wyoming.

Am. Mus. No.	Length, pr-ms		Length, m-ms		Long diam., pr		Long diam., ms		Depth of jaw at pr		Depth of jaw at ms		Horizon
	mm.	%	mm.	%	mm.	%	mm.	%	mm.	%	mm.	%	
15533	17.9	(100)	13.4	(74.8)	4.4	(24.5)	5.4	(30.1)	7	(39.1)	8.3	(46.3)	Wasatch (horizon 2) ⁴
15669	18.4	"	13.4	(72.8)	4.9	(26.6)	5.4	(29.3)	6.9	(37.9)	7.5	(40.7)	" (horizon 3)
15666	18.5	"	13.4	(72.4)	5	(27.0)	5.3	(28.6)	7.2	(38.9)	8.1	(43.7)	"
1535	18.5	"	13.5	(72.9)	5	(27.0)	5.1	(27.5)	6.5	(35.1)	8	(43.2)	Lower Gray Bull Valley
15522	18.5	"	13.7	(74.0)	4.9	(26.4)	5.4	(29.1)	6.5	(35.1)	7.7	(41.6)	" (horizon 3)
15668	18.8	"	13.3	(70.7)	5.3	(28.0)	5	(26.5)	6.6	(35.1)	—	—	"
15671	18.8	"	13.8	(73.4)	5.1	(27.1)	5.8	(30.8)	6.7	(35.6)	8.6	(45.7)	Shoshone R.
4696 ¹	19	"	14.2	(74.7)	4.8	(25.2)	5	(26.3)	6	(31.5)	7	(36.8)	Bighorn Valley
15527	19	"	14.5	(76.3)	4.5	(23.6)	6.1	(32.1)	7	(36.8)	—	—	" (horizon 1)
4700 ²	19	"	14.4	(75.7)	4.2	(22.1)	5.4	(28.4)	8.2	(43.1)	9.3	(48.9)	Bighorn Valley
15523	19	"	14.3	(75.2)	4.7	(24.7)	5.7	(30.0)	7.4	(38.9)	9.3	(48.9)	" (horizon 1)
15521	19.1	"	14.6	(76.4)	4.5	(23.5)	5.1	(26.7)	6.4	(33.5)	—	—	" (horizon 2)
15524	19.2	"	14.6	(76.0)	4.5	(23.4)	6	(31.2)	7.2	(37.5)	8.2	(42.7)	" (horizon 1)
15672	19.2	"	14.8	(77.0)	5.5	(28.6)	6	(31.2)	7.1	(36.9)	8	(41.6)	Shoshone R.
15662	20	"	15	(75.0)	5	(25.0)	5.7	(28.5)	8.1	(40.5)	9.2	(46.0)	Lysite, Buffalo Basin
15531	20.2	"	15.2	(75.2)	5	(24.7)	5.7	(28.2)	6.1	(30.1)	7.2+	—	Wasatch (horizon 1)
15661	20.4	"	15	(73.5)	4.8	(23.5)	5.8	(28.4)	6.9	(33.8)	8.4	(41.1)	Lysite, Buffalo Basin
1559	20.5	"	15.4	(75.1)	4.8	(23.4)	—	—	8.4	(40.9)	9.4	(45.8)	"
4691 ³	20.6	"	15.4	(74.7)	4.8	(23.3)	5.7	(27.6)	—	—	8.3	(40.2)	Wasatch, Bighorn Valley
297	20.7	"	15.1	(72.9)	5.3	(25.6)	5.9	(28.5)	7.4	(35.7)	8.3	(40.2)	"
15520	22.5	"	17.3	(76.8)	5.2	(23.1)	6.5	(28.8)	8.2	(36.4)	—	—	" (horizon 3)

¹ Cotype of *T. metistacus*.² Type of *T. brachystomus*.³ Paratype of *T. chaensis*.⁴ Wasatch (horizon 1, 2 etc.) refers to the three horizons in the Bighorn Wasatch (Gray Bull beds) shown in Fig. 2B. Bull. Am. Mus. XXX, Article VII. Horizon 1 is the oldest.

An examination of the table will show that it is quite impossible to draw even arbitrary lines separating the three species recognized by Cope. Nor does the series seem to be varying in any particular direction. Large forms occur both in the Lysite and in horizons 1 and 3 of the Wasatch. Small forms are found in all the Wasatch horizons and in the Lysite also, but the small specimens from the Lysite have been omitted from the table because they were not complete enough to give a full set of measurements.

Diacodexis (*Trigonolestes*) *chacensis*, *metziacus* and *brachystomus* may be regarded as variants of a single type illustrating the artificial character of most specific distinctions, which blend as soon as a sufficiently large series of forms is examined. *T. chacensis* was first described, *T. metziacus* next and, finally, *T. brachystomus* which was later designated as type of the genus. Under these circumstances there may well be some question as to which name should be retained. For the present, *Diacodexis* (*Trigonolestes*) *chacensis* may be used, and *D. metziacus* and *D. brachystomus* included as synonyms.

***Diacodexis olseni* n. sp.**

Type. A fragment of the right mandibular ramus with p_4 - m_2 and half of m_3 (Amer. Mus. Coll. No. 14937).



Fig. 26. *Diacodexis olseni*, lower p_4 - m_3 , superior view, twice natural size. Type specimen. No. 14937.

From the Lost Cabin formation (Wind River group), Davis ranch, Alkali Creek, Wind River Basin, Wyoming. Amer. Mus. Exp. 1909. The species is named in honor of its collector, Mr. George Olsen.

Measurements.

	mm.
p_4 , long diam.....	5.6
m_1 " "	4.6
m_2 " "	4.8
p_4 greatest trans. diam.....	3
m_1 " " " across heel.....	4
" " " " " trigonid.....	3.7
m_2 " " " " " heel.....	4.9
" " " " " trigonid.....	4.5
m_3 " " " " " trigonid.....	4.7

Additional material may show that this species is connected by intermediate gradations with the larger members of the *D. chacensis* series, but, at present, it is well characterized by the fact that the molars, though of much the same length as in *D. secans* and some of the larger specimens in

the *chacensis* series, are considerably wider transversely than even the largest of these, giving the tooth crown a square outline. The paraconid shows a tendency toward reduction, for it is quite small in m_2 , but this may be an individual peculiarity (see note, p. 290). The slight spacing of the molars seen in the figure (Fig. 26) is the result of calcite infiltration into cracks which have spread apart the fractured sections. Readily separable from *Pelycodus*, which it resembles in the square-shaped molars, by the absence of deuterocoid on p_4 .

Diacodexis robustus n. sp.

Type. A fragment of the left mandibular ramus with m_2 , m_3 (Amer. Mus. Coll. No. 15514). From the Bighorn Wasatch (Gray Bull beds) Lower Gray Bull Valley, Wyoming. Amer. Mus. Exp. 1910.

Additional referred specimens. No. 15510 Am. Mus., maxillary fragment with m^2 , m^3 , Gray Bull beds, Wasatch (horizon 2) 5 miles south of Otto, Bighorn Co., Wyo.; No. 15511 Am. Mus., part of right mandibular ramus with m_2 , m_3 , Gray Bull beds, Wasatch (horizon 3), near St. Joe postoffice, Bighorn Co., Wyo.; No. 15512 Am. Mus., mandibular fragment with p_4 , m_1 , and No. 15513, also a fragment of the mandible with m_1 and m_2 , both from the Gray Bull beds, Wasatch, lower Gray Bull Valley, Wyoming.

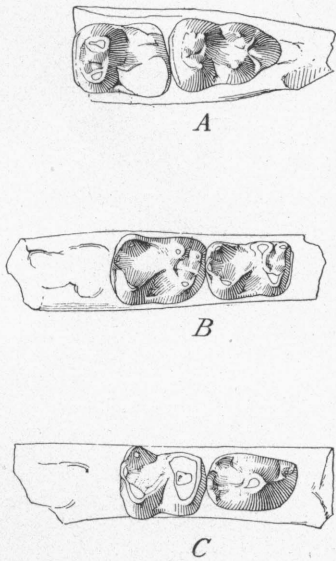


Fig. 27. A. *Diacodexis robustus*, left m_2 , m_3 , twice natural size. Type specimen, No. 15514. B. Right m_1 , m_2 , twice natural size. Paratype, No. 15513. C. Right p_4 , m_1 , twice natural size. Paratype, No. 15512.

Measurements.

	No. 15512 Amer. Mus.	No. 15513 Amer. Mus.	No. 15514 Amer. Mus. Type.
	mm.	mm.	mm.
p_4 , long diam.....	5.9		
m_1 " "	5.3	5.5	
m_2 " "		6	6.3
m_3 " "			7
p_4 trans. diam.....	3.7		
m_1 , " " across heel.....	4.4	3.9	
" " " trigonid.....	3.9	3.5	
m_2 " " " heel.....		4.3	4.9
" " " " trigonid.....		4	4.4
m_3 " " " heel.....			3.8
" " " " trigonid.....			4.7

No. 15510
Amer. Mus.

mm.

m ² long diam. externally.....	6
m ³ " " "	5.5
m ² greatest trans. diam.....	7.5
m ³ " " "	6.2



Fig. 28. *Diacodexis robustus*, right upper m², m³, twice natural size. Paratype, No. 15510.

A species of *Diacodexis* larger than any previously described Wasatch form is indicated by various fragmentary specimens collected by the American Museum Expedition of 1910. The teeth are wider both anteroposteriorly and transversely and the jaw heavier than in the largest member of the *chacensis* series. From *D. olseni* it is readily distinguished by the greater anteroposterior diameter of the molars in proportion to their width.

The two upper molars referred to *D. robustus* (No. 15510, Fig. 28) do not differ, except in size, from the corresponding teeth in the other species of *Diacodexis* in which the upper dentition is known.

RELATIONSHIPS OF THE AMERICAN DICHOBUNIDS.

The resemblance in tooth pattern of the American genera here described to the European dichobunids and, especially, the close agreement in basi-cranial structure of *Dichobune*, *Helohyus* (?) and *Homacodon*, renders it highly probable that the closely allied American genera *Wasatchia*, *Bunophorus*, *Helohyus*, *Lophiohyus* and *Homacodon* should be referred to the Dichobunidae. *Diacodexis* should also, probably, be included in this family. Though somewhat larger than *Protodichobune*, *Wasatchia* shows a considerable degree of resemblance to a specimen figured by Stehlin¹ from the Upper Ypresien of Monthelon near Epernay and provisionally determined as *Protodichobune*. Less certainty exists regarding the systematic position of *Sarcolemur* and *Microsus* which are referred to the Artiodactyla on dental characters only and may, for the present, be classed as dichobunids. Owing to the fragmentary character of the available material, it is unsafe to dogmatize on matters of phylogeny, but several divergent lines of evolution appear to be indicated. A close relationship seems to exist between the Lower Eocene genus *Wasatchia* and the Middle Eocene *Helo-*

¹ Stehlin. Die Säugetiere des schweizerischen Eocaens, Vierter Teil, Abhandlungen der Sch. Pal. Gesellschaft, XXXIII, fig. xciii, p. 668, 1906.

hyus and *Lophiohyus*, perhaps sufficiently close to warrant the inference that the latter are derived from the former. *Bunophorus*, a contemporary of *Wasatchia*, has diverged from the *Wasatchia-Helohyus* line in the loss of the paraconid in the lower molars. Unfortunately, the upper dentition of this form is unknown so we cannot be sure of its relationship to *Homacodon* which has also lost the paraconid in the lower molars, or almost so. *Homacodon* departs from the structure of the last upper molar found in *Wasatchia* and *Helohyus* in the enlargement of the metaconule, thereby developing a quadritubercular crown in which the undeveloped or lost hypocone takes no part. It may, perhaps, represent still another divergent evolutionary line, though from the fact that its Lower Eocene predecessors are unknown, this is uncertain. *Diacodexis* (*Trigonolestes*) differs from all its contemporary artiodactyls, so far as known, in the trigonodont character of the upper molar crowns. I am not prepared to add anything to Stehlin's suggestion that it could, possibly, represent the stem-group of the dichobunids, with nearer relationships to *Protodichobune*. Finally, in *Sarcolemur* and the allied *Microsus* still other variations appear in the development of a large deuterconid in p_4 coupled either with the presence or the absence of a paraconid in the lower molars. It is, perhaps, among the members of this last group, rather than in *Homacodon*, that the ancestor of the Urita selenodonts is to be found.

