

Article XV.— A REVISION OF THE AMERICAN EOCENE
HORSES.

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PLATES XV–XVIII.

This paper forms one of a series of several, published in this Bulletin, on the various groups of the American Equidæ and is intended, with the others, as a study preliminary to a forthcoming monographic treatise of the Equidæ by Prof. Henry F. Osborn, to whom I am indebted for the privilege of publishing this revision, as well as for much valuable criticism and aid in its preparation. The pencil drawings, by Mr. B. Yoshihara, of the unfigured types of Eocene Horses have been prepared under Prof. Osborn's direction for use in his Monograph but he has very generously offered them for preliminary reproduction here. I wish also to make acknowledgment to Dr. W. D. Matthew for free use of his notes on American Hyracotheres.

In the preparation of this paper I have had access to all of the types, with one exception, of the American Hyracotheres. These include Marsh's types in the Yale Museum and Cope's New Mexican Wasatch types in the National Museum. Leidy's type of *Lophiotherium sylvaticum* is represented in the collection of the Museum by a cast. All of the remaining types are in the American Museum Collection. Through the courtesy of Dr. F. B. Loomis of Amherst College I have also had for comparison the more important specimens of a rather extensive collection of horses made by him in the Big Horn and Wind River Basin in 1903. The American Museum Collection contains several hundred specimens of Hyracotheres, representing nearly all of the described species. About half of these are from the Cope Collection and the remainder have been collected by the various expeditions sent out by this Museum since 1891.

Distribution.—Hyracotheres have been recorded from the Wasatch of Evanston, Bitter Creek, and the Big Horn Basin in Wyoming, and of the Rio Gallinas in Northern New Mexico; from the Wind River Basin of central Wyoming; from the Huerfano Basin of southeastern Colorado; from the Bridger Basin of southern Wyoming; and from the Uinta Basin of northeastern Utah. So far as I am aware, no horses have yet been found in the Washakie Basin of southern Wyoming. That they occur there and will be found in future exploration seems probable, however, since they are fairly abundant in the Bridger and by no means rare in the Uinta.

The horizon of their greatest abundance is the Wasatch, especially the Wasatch of the Big Horn Basin, where they predominate over all other forms, with the possible exception of *Systemodon*, a very closely related genus. In the Wind River formation they also form a large part of the fauna. In the Bridger, however, they are exceeded in abundance by several families, and the same is true in a more marked degree in the Uinta.

A. List of Original Specific and Generic Descriptions in Chronological Order with Chief Subsequent References to the Species.

WASATCH AND WIND RIVER SPECIES.

1. **Lophiotherium vasacciense** Cope.

- Proc. Amer. Phil. Soc. XII. Separates, July 11, 1872, p. 2.
Notharctus vasachiensis COPE, Palæont. Bull., No. 3, 1872, p. 3.
Notharctus vasacciensis COPE, Proc. Amer. Phil. Soc., XII, 1872, p. 474.
Orotherium vasacciense COPE, Ann. Rep. U. S. G. S. Terrs., 1872 (1873), pp. 606, 646.
Orohippus vasacciensis COPE, System. Cat. Vert. Eocene N. Mex., 1875, p. 21.
Hyracotherium vasacciense COPE, Tertiary Vert., 1884, p. 634, pl. xxiv, fig. 24.
Hyracotherium vasacciense WORTMAN, Bull. A. M. N. H., VIII, 1896, p. 98.
Hyracotherium vasacciense MATTHEW, Bull. A. M. N. H., XII, 1899, p. 33.
Eohippus vasacciensis HAY, Bull. U. S. G. S., No. 179, 1902, p. 610.

Type locality: Evanston, Wyo. *Type Specimen:* A weathered lower molar, probably the second. Amer. Mus., Cope Coll. No. 4658.

An indeterminate type; see *Eohippus borealis*.

2. **Orotherium index** Cope.

- Pal. Bull. No. 17, 1873, p. 4.
Orohippus index COPE, System. Cat. Vert. Eocene N. Mex., 1875, p. 20.
Hyracotherium index COPE, Tertiary Vert., 1884, pp. 630, 650.
Hyracotherium index WORT., Bull. A. M. N. H., VIII, 1896, p. 99.
Hyracotherium index MATT., Bull. A. M. N. H., XII, 1899, p. 33.
Eohippus index HAY, Bull. U. S. G. S., No. 179, 1902, p. 609.

Type locality: Evanston, Wyo. *Type specimen:* lower jaw fragment with p_4 - m_3 . Amer. Mus., Cope. Coll. No. 4680.

= *Eohippus index*.

3. *Orohippus tapirinus* Cope.

System. Cat. Vert. Eocene N. Mex., 1875, p. 20.

Hyracotherium tapirinum COPE, U. S. Geog. Surv. w. 100th M., IV, pt. ii, 1877, p. 263, pl. xvi, fig. 12.

Systemodon tapirinus COPE, Am. Nat., XV, 1881, p. 1018.

Systemodon tapirinus COPE, Tertiary Vert., 1884, p. 619.

Hyracotherium tapirinum WORT., Bull. A. M. N. H., VIII, 1896, p. 94.

Hyracotherium tapirinum MATT., Bull. A. M. N. H., XII, 1899, p. 33.

Eohippus tapirinus HAY, Bull. U. S. G. S., No. 179, 1902, p. 610.

Type locality: Rio Gallinas, Wasatch of New Mexico. *Type specimen:* fragment of ramus with badly worn m_{2-3} . Nat. Mus. Coll. No. 1064.

This type is at least specifically indeterminate. See *Eohippus resartus*.

4. *Orohippus angustidens* Cope.

System. Cat. Vert. Eocene N. Mex., 1875, pp. 20, 21.

Hyracotherium angustidens COPE, U. S. Geog. Surv. w. 100th M., IV, pt. ii, 1877, pp. 262, 265, pl. lxvi, fig. 22a.

Eohippus angustidens KING (= Marsh), U. S. Geol. Expl. 40th P., 1878, p. 377.

Hyracotherium angustidens COPE, Tertiary Vert., 1884, p. 630, 648.

Hyracotherium index WORT., Bull. A. M. N. H., VIII, 1896, p. 99.

Hyracotherium index MATT., Bull. A. M. N. H., XII, 1899, p. 33.

Eohippus index HAY, Bull. U. S. G. S., No. 179, 1902, p. 609.

Type locality: Rio Gallinas, Wasatch of New Mexico. *Type specimen:* A lower jaw fragment with m_{1-3} . Nat. Mus. Coll. No. 1079.

= *Eohippus angustidens*.

5. *Orohippus cuspidatus* Cope.

System. Cat. Ext. Vert. N. Mex., 1875, p. 22.

Hyracotherium cuspidatum COPE, U. S. Geog. Surv. w. 100th M., IV, pt. ii, 1877, p. 267, pl. lxv, fig. 18.

Eohippus cuspidatus KING (= Marsh), U. S. Geol. Expl. 40th P., I, 1878, p. 377.

Hyracotherium cuspidatum COPE, Tertiary Vert., 1884, p. 631.

Hyracotherium index WORT., Bull. A. M. N. H., VIII, 1896, p. 99.

Hyracotherium index MATT., Bull. A. M. N. H., XII, 1899, p. 33.

Eohippus index HAY, Bull. U. S. G. S., No. 179, 1902, p. 609.

Type locality: Rio Gallinas, Wasatch of New Mexico. *Type specimen:* Maxillary fragment with dp^4 and m^1 . Nat. Mus. Coll. No. 1077.

= *Eohippus* (?) *angustidens*.

6. *Eohippus validus* Marsh.

Am. Jour. Sci., XII, 1876, p. 401.

Hyracotherium vasacciense WORT., Bull. A. M. N. H., VIII, 1896, p. 82.

Hyracotherium vasacciense MATT., Bull. A. M. N. H., XII, 1899, p. 33.

Eohippus validus HAY, Bull. U. S. G. S., No. 179, 1902, p. 610.

Type locality: Rio Gallinas, Wasatch of New Mexico. *Type specimen*: Fragments of jaws with p_4 - m_3 r., p_4 - m_1 and m_3 l., p^4 - m^1 r., an m^2 l. of doubtful association and many uncharacteristic fragments of skeleton. Yale Mus. Coll.

Generic type for all American *Hyracotheres* earlier than the Bridger formation.

= *Eohippus validus*.

7. *Eohippus pernix* Marsh.

Am. Jour. Sci., XII, 1876, p. 402.

Eohippus pernix MARSH, Am. Jour. Sci., XLIII, 1892, p. 349, text figs. 14, 15.

Hyracotherium index WORT., Bull. A. M. N. H., VIII, 1896, p. 82.

Hyracotherium index MATT., Bull. A. M. N. H., XII, 1899, p. 33.

Eohippus pernix HAY, Bull. U. S. G. S., No. 179, 1902, p. 609.

Type locality: Bitter Creek, Wyo. *Type specimen*:¹ Various skeletal fragments and teeth belonging to several individuals and to at least two species; from these may be selected, as the actual type, being the parts first separately mentioned, the distal end of a tibia and the accompanying astragalus. Yale Mus.

An indeterminate species; = *Eohippus index* (?).

8. *Orotherium cristonense* Cope.

U. S. Geog. Surv. w. 100th M., IV, pt. ii, 1877, p. 254, pl. lxxv, fig. 13, 14.

Pliolophus cristonensis COPE, Tertiary Vert., 1884, p. 651.

Hyracotherium (Pliolophus) cristonense WORT., Bull. A. M. N. H., VIII, 1896, p. 102, pl. ii, fig. I, text fig. 11.

H. (Pliolophus) cristonense MATT., Bull. A. M. N. H., XII, 1899, p. 33.

Pliolophus cristonensis HAY, Bull. U. S. G. S., No. 179, 1902, p. 610.

Type locality: Rio Gallinas, Wasatch of New Mex. *Type specimen*: Lower jaws. Nat. Mus. Coll. No. 1002.

= *Eohippus cristonensis*.

¹ Included in the various fragments associated with the type is the proximal half of a mt. II showing the articulation for the entocuneiform. This Marsh apparently mistook for the mt. IV of the opposite foot and considered the facet as indicating a free fifth digit. There is no fourth metatarsal with this specimen and it was upon this specimen that Marsh based the determination of the foot structure of *Eohippus* given in his original description of *E. validus*.

9. *Orotherium loevii* Cope.

U. S. Geog. Surv. W. 100th M., IV, pt. ii, 1877, p. 257, pl. lxx, figs. 15-17.

Pliolophus loevii COPE, Tertiary Vert., 1884, p. 651.

H. (Pliolophus) cristonense WORT., Bull. A. M. N. H., VIII, 1896, p. 103.

Pliolophus cristonensis HAY, Bull. U. S. G. S., No. 179, 1902, p. 610.

Type locality: Rio Gallinas, Wasatch of New Mex. *Type specimen:* Fragment of left ramus with p_2 - m_2 . Nat. Mus. Coll. No. 1128.
= *Eohippus cristonensis*.

10. *Hyracotherium craspedotum* Cope.

Amer. Nat., XIV, 1880, p. 747.

Hyracotherium craspedotum COPE, Tertiary Vert., 1884, p. 631, pl. lviii, figs. 1, 2.

Hyracotherium craspedotum WORT., Bull. A. M. N. H., VIII, 1896, p. 97, pl. 11, fig., text fig. 7.

Hyracotherium craspedotum MATT., Bull. A. M. N. H., XII, 1899, p. 36.

Eohippus craspedotus HAY, Bull. U. S. G. S., No. 179, 1902, p. 609.

Type locality: Wind River Basin, Wyo. *Type specimen:* Fragments of both rami with m_{1-3} r., p_2 and p_4 - m_1 l. Am. Mus., Cope Coll. No. 4830.
= *Eohippus craspedotus*.

11. *Hyracotherium venticolum* Cope.

Bull. U. S. G. S. Terrs., VI, Art. xv, 1881, p. 198.

Hyracotherium venticolum COPE, Tertiary Vert., 1884, pp. 630-635, pl. xlixa, xlixb, xlixc.

Hyracotherium venticolum WORT., Revue Sci., V, 1883, p. 709, fig. 128-130.

Hyracotherium venticolum COPE, Am. Nat., XXI, 1887, p. 995, pl. xxx, text figs. 5-7.

Protorohippus venticolus WORT., Bull. A. M. N. H., VIII, 1896, p. 105, pl. ii, fig. D., text fig. 14.

Protorohippus venticolus MATT., Bull. A. M. N. H., XII, 1899, p. 36.

Protorohippus venticolus HAY, Bull. U. S. G. S., No. 179, 1902, p. 610.

Type locality: Alkali Creek, Wind River Basin, Wyo. *Type specimen:* Skull, jaws, and large part of skeleton. Am. Mus., Cope. Coll. No. 4832.
= *Eohippus venticolus*.

12. *Systemodon etsagicus* Cope.

Tertiary Vertebrata, 1884, pl. lxi, fig. 5 (no description).

Type locality: Big Horn Basin, Wyo. *Type specimen:* Fragment of

left ramus with p_4 - m_2 , roots or alveoli of p_{1-3} . Amer. Mus., Cope. Coll. No. 4600.

= *Eohippus etsagicus*.

13. *Hyracotherium cristatum* Wortman.

Bull. A. M. N. H., VIII, 1886, p. 86, pl. ii, fig. H., text fig. 6.

H. (Pliolophus) cristatum WORT., Bull. A. M. N. H., XII, 1899, p. 33.

Eohippus cristatus HAY, Bull. U. S. G. S., No. 179, 1902, p. 609.

Type locality: Big Horn Basin, Wyo. *Type specimen*: Lower jaw fragment with p_3 - m_2 r. Amer. Mus. Coll. No. 258b.

= *Eohippus cristatus*.

14. *Hyracotherium (Pliolophus) montanum* Wortman.

Bull. A. M. N. H., VIII, 1886, p. 103, pl. ii, fig. J., text fig. 13.

H. (Pliolophus) montanus MATT., Bull. A. M. N. H., XII, 1899, p. 33.

Pliolophus montanus HAY, Bull. U. S. G. S., No. 179, 1902, p. 610.

Type locality: Big Horn Basin, Wyo. *Type specimen*: Fragments of both rami with p_4 and roots of p_{1-3} r., and m_{2-3} l. Amer. Mus., Cope. Coll. No. 4593.

= *Eohippus montanus*.

BRIDGER SPECIES.

15. *Lophiotherium sylvaticum* Leidy.

Proc. Acad. Nat. Sci. Phila., 1870, p. 126.

Lophiotherium sylvaticum LEIDY, Rep. U. S. G. S. Terrs., I, 1873, pp. 69, 327, pl. vi, fig. 33-35.

Pliolophus sylvaticus COPE, Tertiary Vert., 1884, pp. 631, 647, 652.

Orohippus sylvaticus MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus sylvaticus HAY, Bull. U. S. G. S., No. 179, 1902, p. 612.

Type locality: Henry's Fork, Upper beds, Bridger Basin. *Type specimen*: Fragment of left ramus with p_4 and m_{1-3} . Nat. Mus. Coll. No. 3753.

= *Orohippus sylvaticus*.

16. *Lophiodon pumilus* Marsh.

Am. Jour. Sci., II, 1871, p. 38.

Helohippus pumilus MARSH, Am. Jour. Sci., XLIII, 1892, p. 353.

Helohippus pumilus MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Helohippus pumilus HAY, Bull. U. S. G. S., No. 179, 1902, p. 611.

Type locality: "Marsh's Fork," Bridger Basin. *Type specimen*: Fragment of right maxilla with p^3 - m^2 and roots of p^{1-2} . Yale Mus. Coll.
= *Orohippus pumilus*.

17. *Lophiotherium ballardi* Marsh.

Am. Jour. Sci., II, 1871, p. 39.

Orohippus sylvaticus MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus ballardi HAY, Bull. U. S. G. S., No. 179, 1902, p. 611.

Type locality: Grizzly Buttes, Hor. B., Bridger Basin. *Type specimen*: Fragment of left ramus with m_{2-3} . Yale Mus. Coll.
= *Orohippus ballardi*.

18. *Orohippus pumilus* Marsh.

Am. Jour. Sci., IV, 1872, p. 207. (Separates issued Aug. 7.)

Orohippus procyoninus COPE, Ann. Rep. U. S. G. S. Terrs., 1872 (1873), p. 606.

Orohippus pumilus MARSH, Am. Jour. Sci., VII, 1874, p. 249.

Orohippus pumilus MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus pumilus SCOTT, OSB. and SPIER., Pal. Rep. Princ. Sci. Exp., 1871, p. 24.

Orohippus pumilus HAY, Bull. U. S. G. S., No. 179, 1902, p. 612.

Type locality: Grizzly Buttes, Lower beds, Bridger Basin. *Type specimen*: The following loose teeth: p^3 l., m^1 l., m^3 ?l. m^3 r. Paratype, m^3 r., p^4 r., p^4 r. of another specimen and a broken tooth. Yale Mus. Coll.
= *Orohippus typicus*.

19. *Helotherium procyoninum* Cope.

Pal. Bull. No. 2, bearing date Aug. 3, 1872, p. 1.

Helotherium procyoninum COPE, Proc. Am. Phil. Soc., XII, 1872, p. 466.

Orohippus procyoninus COPE, Ann. Rep. U. S. G. S. Terrs., 1872 (1873), p. 606.

(?)*Orohippus pumilus* MARSH, Am. Jour. Sci., VII, 1874, p. 249.

Hyracotherium procyoninum COPE, Geog. Surv. W. 100th M., IV, 1877, pp. 262, 266.

Lambdotherium procyoninum COPE, Tertiary Vert., 1884, pp. 631, 711, pl. xxiv, fig. 22.

Hyracotherium procyoninum MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus procyoninus HAY, Bull. U. S. G. S., No. 179, 1902, p. 612.

Type locality: Cottonwood Creek, Horizon B, Bridger Basin. *Type specimen*: Third right upper molar. Amer. Mus., Cope. Coll. No. 5052.
= *Orohippus* (?) *pumilus*.

20. **Orotherium uintanum** Marsh.

Amer Jour. Sci., IV, 1872, p. 217.

Orotherium uintanum COPE, Bull. U. S. G. S., Terts., VI, p.

Pliolophus uintanus COPE, Tertiary Vert., p. 651.

Orohippus uintanus MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus uintanus HAY, Bull. U. S. G. S., No. 179, 1902, p. 612.

Type locality: Henry's Fork, Upper beds, Bridger Basin. *Type specimen*: Lower jaw with p_2 - m_3 . Yale Mus. Coll.

= *Orohippus uintanus*.

21. **Orohippus agilis** Marsh.

Amer. Jour. Sci., V, 1873, p. 407.

Orohippus agilis MARSH, Amer. Jour. Sci., VII, 1874, pp. 248, 249, text fig.

Orohippus agilis COPE, System. Cat. Vert. Eocene N. Mex., 1875, p. 22.

Hyracotherium agile COPE, U. S. Geog. Surv. w. 100th M., IV, pt. ii, p. 267.

Epihippus agilis OSBORN, Trans. Amer. Phil. Soc., XVI, 1890, p. 506.

Orohippus agilis MARSH, Amer. Jour. Sci., XLIII, 1892, p. 349, text fig. 16, 17.

Orohippus agilis MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus agilis HAY, Bull. U. S. G. S., No. 179, 1902, p. 611.

Type locality: Henry's Fork, Upper beds, Bridger Basin. *Type specimen*: Fragmentary skull with p_1 - m_2 l., nearly complete fore limb and many vertebræ all in fine preservation. Yale Mus. Coll.

= *Orohippus agilis*.

22. **Oligotomus cinctus** Cope.

Pal. Bull. No. 12, March 8, 1873, p. 2.

Oligotomus cinctus OSB. SCOTT & SPIER, Pal. Rep. Prince. Sci. Exp., 1877 (1878), p. 17.

Pliolophus cinctus COPE, Tertiary Vert., 1884, p. 653, pl. xxiv, fig. 26.

Orohippus cinctus WORT., Bull. A. M. N. H., VIII, 1886, p. 103.

Oligotomus cinctus MATT., Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus cinctus HAY, Bull. U. S. G. S., No. 179, 1902, p. 611.

Type locality: Cottonwood Creek, Hor. B., Bridger Basin. *Type specimen*: Fragment of right ramus with broken p_4 - m_1 . Amer. Mus., Cope Coll. No. 5050.

= *Orohippus* (?) *ballardi*.

23. **Orohippus major** Marsh.

Am. Jour. Sci., VII, 1874, p. 248.

Pliolophus major OSBORN, Trans. Amer. Phil. Soc., XVI, 1890, p. 544.

Orohippus major MATT. Bull. A. M. N. H., XII, 1899, p. 45.

Orohippus major HAY, Bull. U. S. G. S., No. 179, 1902, p. 611.

Type locality: Millersville, Horizon B., Bridger Basin. *Type specimen:* Upper jaw fragment with m_{2-3} r., and m^2 l. Yale Mus. Coll.

24. *Hyracotherium osbornianum* Cope.

Tertiary Vert., 1884, pp. 630, 647, pl. xxiv, fig. 23.

Hyracotherium osbornianum MATT., Bull. A. M. N. H., 1899, p. 45.

Orohippus osbornianus HAY, Bull. U. S. G. S., No. 179, 1902, p. 611.

Type locality: Black's Fork, Hor. B., Bridger Basin. *Type specimen:* Lower jaw fragment with first molar and roots of p and m_{2-3} . Amer. Mus., Cope. Coll. No. 5051.

= *Orohippus osbornianus*.

UINTA SPECIES.

25. *Anchitherium gracilis* Marsh.

Amer. Jour. Sci., II, 1871, p. 38.

Orohippus gracilis MARSH, Am. Jour. Sci., VII, 1874, p. 249.

Epihippus MARSH (genus only), Popular Sci. Monthly, April, 1878, footnote on p. 678.

Epihippus gracilis KING (= Marsh), U. S. Geol. Expl. 40th P., 1878, p. 407.

Epihippus gracilis SCOTT & OSB., Proc. Am. Phil. Soc., 1887, p. 259.

Epihippus gracilis MATT., Bull. A. M. N. H., XII, 1899, p. 49.

Epihippus gracilis HAY, Bull. U. S. G. S., No. 179, 1902, p. 612.

Type locality: White River, Uinta Basin, Utah. *Type specimen:* Fragments of both rami with dp_{2-4} and m_{1-2} l., dp_{3-4} and m_1 r. Yale Mus. Coll.
= *Epihippus gracilis*.

26. *Orohippus uintensis* Marsh.

Am. Jour. Sci., XIV, 1875, p. 247.

Epihippus MARSH (genus only), Popular Sci. Monthly, April, 1878, footnote on p. 678.

Epihippus uintensis KING (= Marsh), U. S. Geol. Expl. 40th P., 1878, p. 407.

Epihippus uintensis SCOTT and OSB., Proc. Am. Phil. Soc., XXIV, 1887, p. 259.

Epihippus uintensis OSBORN, Trans. Am. Phil. Soc., XVI, 1890, p. 529.

Epihippus uintensis MATT., Bull. A. M. N. H., XII, 1899, p. 49.

Epihippus uintensis HAY, Bull. U. S. G. S., No. 179, 1902, p. 612.

Type locality: White River, Uinta Basin, Utah. *Type specimen:* Upper and lower jaw fragments with $m_{1-2}r$, p_2-m_1l , m_2r . Yale Mus. Coll.

= *Epihippus gracilis*.

B. Generic References.¹

Orohippus² Marsh.³ Type *O. pumilus*, from Henry's Fork, Bridger Basin. It is unfortunate that this name, which is apparently applicable to all of the Bridger horses, should have been founded upon such a fragmentary specimen. The type description was based upon two series of loose upper teeth which represent two individuals and probably two species. The series which forms the actual type, being the first separately mentioned, has but one perfect tooth, the last molar, although a third premolar and first molar are sufficiently well preserved to give their more important characters and to make sure the reference of more complete material. The specific name *pumilus* is preoccupied by *Lophiodon pumilus* Marsh (1871), a name given to a specimen which is generically identical with the type of *Orohippus*.

Helotherium Cope.⁴ The type is a single upper third molar from the Bridger Beds which is generically identical with the type of *Orohippus*. If the date, Aug. 3, printed on "Palæontological Bulletin No. 2," which contained the original description of *Helotherium procyoninum*, represents the actual date of the publication of this pamphlet then the generic name *Helotherium* would have to stand for the Bridger horses and *Orohippus*, proposed by Prof. Marsh on Aug. 7, would become a synonym. Prof. Marsh, however, questioned the correctness of the dates on the various "Bulletins" issued by Cope during the summer of 1872 and apparently not without reason. That Aug. 3 is not the correct date for "Bulletin No. 2" I am unable to prove, but the fact that there is a doubt as to its correctness and that Marsh's name *Orohippus* is the one in general use and that Prof. Cope himself referred his specimen to that genus the following year (1873) warrants, I think, the retention of the name *Orohippus*.

Orotherium Marsh.⁵ Proposed by Prof. Marsh in 1872 (Aug. 13) as a genus from the Upper Bridger, the type being *Orotherium wintanum* from Henry's Fork and based on a lower jaw. In his original description Marsh

¹ Arranged in chronological order.

² Names of valid genera are in heavy type.

³ Amer. Jour. Sci., 1872, p. 207. Separates, Aug. 7.

⁴ Pal. Bulletin, No. 2, 1872 (Aug. 3), p. 1.

⁵ Amer. Jour. Sci., 1872, p. 217. *Orotherium* Marsh is preoccupied by *Orotherium* Aymard, 1850.

distinguishes between this genus and the European genus *Lophiotherium*, but does not give its relationship to *Orohippus*, the type of which consists of upper teeth only. From additional material in the American Museum Collection, which includes upper and lower teeth in association, I am convinced that the type of *Orotherium wintanum*, together with the species *Lophiotherium sylvaticum* Leidy and *Orohippus agilis* Marsh, belong to a separate group from the typical *Orohippus*, as indicated by the more progressive condition of the pre-molars. I hesitate, however, to consider these characters as of full generic importance, preferring to treat the group as a subgenus of *Orohippus*.

Oligotomus Cope.¹ The type *O. cinctus* is a lower jaw fragment with broken teeth and is from the Lower Bridger. In his description Cope distinguishes it from *Orotherium* Marsh "in the possession of but two premolars. The inferior molars are six, leaving four true molars." The specimen unquestionably belongs to the genus *Orohippus* and probably to one of Marsh's previously described species.

Echippus Marsh.² Type *E. validus* from the Wasatch of New Mexico. Assuming that there are generic distinctions between *Hyracotherium* of Owen and the horses of the American Wasatch, *Echippus* stands as the generic name for the American forms from this horizon, since it is the first and only name proposed. Prof. Marsh distinguished this genus from *Orohippus* by the fourth premolar, which he stated was, in both the upper and lower jaw, like the third premolar and not like the first true molar as in *Orohippus*. He remarks further that there are four functional digits in the fore foot and three in the hind foot with a vestige of the fifth metatarsal. This generic description, at least the part referring to the foot structure, appears to have been drawn not from *E. validus* but from fragments associated with the type of *E. pernix* from the Wasatch of Bitter Creek, Wyo., which was described at the same time. There are no metapodials with the type of *E. validus* from which he could have made such determinations, but with the type of *E. pernix* there are both metacarpals and metatarsals. There is no indication of a fifth digit present, however, although he was correct in assuming that there was such a vestige in the pes of the Wasatch horses. I believe that this genus includes not only all of the Wasatch horses but those from the Wind River and possibly those from the Huerfano Basin.

Ephippus Marsh.³ This name was established in 1878. In his description Marsh states that the genus is found in the Diplacodon Beds of

¹ Pal. Bull., Nov. 12, 1873, p. 3.

² Am. Jour. Sci., XII, 1876, p. 401.

³ Popular Science Monthly, Apr., 1878, p. 678, footnote.

the Uinta Basin, that it is larger than *Orohippus*, has the same number of toes but has the premolars like the molars. No species was mentioned as being the generic type, but *E. gracilis* was the first described, and Dr. Hay in his Bibliography designated it as the type of the genus.

The characters pointed out by Marsh do not serve to distinguish the Uinta from the Bridger forms. The distinctions are rather in the highly developed mesostyle, in the advanced condition of the second upper and lower premolars, in the crescentic external cusps of the upper molars and in the more perfect development of the cross crests.

Helohippus Marsh.¹ The type of this genus is Marsh's *Lophiodon pumilus* from the Bridger Basin. In 1892 he elevated the species to generic rank and distinguished it from *Orohippus* by the presence of a diastema between the first and second upper premolars. The type of *Orohippus* consisting as it does of loose teeth shows neither the presence nor the absence of a diastema, but referred specimens show various conditions from a considerable diastema to none at all. The character appears to be one of only specific importance. The type of *Helohippus* is barely distinguishable specifically from the type of *Orohippus* both of which bear the same specific name. The former has specific and the latter generic priority.

Protorohippus Wortman.² This genus was established by Dr. Wortman in 1896, the type being the skeleton from the Wind River Basin described by Cope as *Hyracotherium venticolum*. The characters which Wortman pointed out as distinguishing this species from all other Wasatch and Wind River horses, which he grouped under *Hyracotherium*, were "no vestige of the fifth digit in the hind foot. Superior molars with sub-crescentic external cusps and having a mesostyle and hypostyle. Fourth superior premolar with only three principal cusps, the fourth (antero-internal in this case) small and more or less in the position of an intermediate. Third superior premolar with four principal cusps, the antero-internal considerably enlarged and shifted inwards to form a cusp analogous with the protocone of the true molars." To take up in order these characters which Dr. Wortman considers of generic value,—*First*: There is what I interpret as a coëssified vestigial fifth metatarsal in the type of *H. venticolum*, and this same condition is to be found both in the Bridger and Uinta horses. In a well preserved pes from the Wind River (Amer. Mus. Coll. No. 4848) with which, unfortunately, there are no teeth associated for definite specific determination, there is, on the outer surface of the fourth metatarsal, a well defined facet for a small *free* fifth metatarsal. *Second*: I have not been able to discover a true hypostyle in any of our Eocene horses, even in the Uinta

¹ Amer. Jour. Sci., XLIII, 1892, p. 353.

² Bull. Am. Mus. Nat. Hist., 1896, p. 104.

forms. The mesostyle in the specimens of *H. venticolum* is in such a very rudimentary condition as to amount practically to an absence of that structure, which really makes its first appearance in *Orohippus*. *Third*: There certainly is a very marked advance in the development of the third and fourth premolars, especially in the third, shown in a moderate degree only in the type but more strongly in the smaller specimens from the Wind River which have been referred to *H. venticolum*. There are, from the Wind River Beds, specimens which show various stages of premolar development, from the simple triangular teeth of the Wasatch stage to the more or less quadrate teeth seen in No. 4839 figured by Dr. Wortman¹ as representing the extreme condition of this development in the formation, but the range of variation is not more than might occur within generic limits. I feel, therefore, that these characters, which Dr. Wortman has indicated as separating this species generically from all other Wasatch and Wind River species, are not of sufficient value for the purpose and that *Protorohippus* should be considered as synonymous with *Eohippus*.

If the determinations made above are correct the genera of American Hyracotheres would stand, with relation to the various horizons, as follows:

<i>Eohippus</i>	{	Wasatch, Wind River, (?) Huerfano.
<i>Orohippus</i>	{	Bridger.
<i>Epihippus</i>	{	Uinta.

It remains to compare these three genera with the European forms. Depéret, in his revision of the European Hyracotheres,² has not been able to identify any of the American genera with those of Europe, and since material for extended and careful comparisons is lacking in the American Museum Collection, I cannot do better than to accept Prof. Depéret's determinations. Apparently the closest approach between the forms of the two Continents is of *Eohippus* to *Hyracotherium*, in the Lower Eocene and of *Epihippus* to *Lophiotherium* in the Upper Eocene. Between the former Dr. Wortman has pointed out the important difference of a single external cusp on the second upper premolar in *Hyracotherium* and two external cusps in all American species. If one is to rely upon Owen's figures of *Hyracotherium* there is also an important difference between the two genera shown in the intermediate cusps of the upper molars. In *Hyracotherium* these appear to be more separate and distinct than in *Eohippus*, and show

¹ *Loc. cit.*, p. 105. The figure is slightly exaggerated, the p³ being less quadrate in outline than the drawing indicates.

² Bull. Soc. Géol. de France, 1901, pp. 199-225.

less tendency to form cross-crests. Depéret considers *Eohippus* to be an intermediate stage of evolution between *Hyracotherium* and *Pachynolophus*.

Between *Lophiotherium* and *Epihippus* I may note two distinctions: (1) in the European genus the second upper premolar has a single internal cusp, while in the American form there is a distinct second internal cusp; (2) in *Lophiotherium* the second lower premolar has two anterior and one posterior cusp, and in *Epihippus* this condition is reversed, there being one anterior and two posterior cusps.

C. Descriptions of Valid Genera and Species.

WASATCH AND WIND RIVER STAGES.

Eohippus Marsh.

Syn.: *Protorohippus* Wortman.

Characters: (1) Third and fourth upper premolars with two equal external cusps and one prominent internal cusp, or deuterocone; in the advanced forms a fourth cusp is well indicated, in which case the *third premolar shows more progression than the fourth*, (2) second upper premolar of two equal external cusps and an internal ledge, (3) a diastema between first and second upper premolars, (4) no mesostyle, (5) pes with a vestigial fifth digit, either free or coössified, (6) lower fourth premolar with small entoconid or with entoconid absent, (7) second lower premolar usually with two anterior and one posterior cusps, the second anterior cusp being absent in some species.

(2.)¹ **Eohippus index** Cope.

Syn.: *Orotherium index* Cope.

Type locality: Evanston, Wyo. *Type specimen*: A fragment of the left ramus with p_4 - m_3 and roots of p_{2-3} (Amer. Mus., Cope Coll. No. 4680).

Characters of type.— (1) Molars rather robust, (2) heel of m_3 moderately stout, (3) m_3 wider than m_2 , (4) p_4 without entoconid, at least there is no indication of it in the somewhat weathered tooth, (5) p_2 comparatively very small, (6) cingulum moderately developed on molars, (7) a diastema between p_1 and p_2 , (8) ramus thick and stout.

¹ The numbers in parenthesis prefixed to the species refer to the chronological list already given (*antea*, pp. 222-230).

Measurements of Type.

	mm.
p_4 - m_3	26.5
m_1 - m_3	21.3
p_4 transv. diam.	3.8
m_1 antero-post. diam.	5.5
“ transv. “	4.1
m_3 antero-post. diam.	9.3
“ transv. “	4.8
Depth of ramus at m_2	12.8

This is the smallest of the known American Hyracotheres, the only other types which approach it in size being *E. angustidens* Cope and *E. cuspidatus* Cope, both from New Mexico. Dr. Wortman referred both of these types, as well as much of the material in the American Museum Collection from the Big Horn Basin to this species. *E. cuspidatus* is based on an upper molar belonging to an animal of about the same size as *E. angustidens* to which species I have provisionally referred it rather than to *index* which is from a different locality and possibly different horizon. The extreme slenderness of the molar teeth in *angustidens* is a character of sufficient importance, I think, to distinguish it from the present species. I am also unable to follow Dr. Wortman in his identification of the majority of the Big Horn specimens as pertaining to *E. index*; a few of them do agree fairly well in size and other characters but the greater part of them are materially larger and with proportionately larger and less primitive pre-molars and should be placed in a separate species.

Referred specimens: Accompanying the type specimen and bearing the same number is a single lower third molar which belongs to a different individual but probably to the same species. From New Mexico a single specimen in the American Museum Collection (No. 4637) is apparently referable here. This specimen exhibits on the third lower premolar a well developed antero-internal cusp. From the Big Horn are several specimens (Nos. 193, 4523, 4589, 4604, 4605, 4620) which are close to the type in size and which show no specific structural differences; they are all fragmentary though and do not furnish additional characters.

(4). *Orohippus angustidens* Cope.Syn.: *Orohippus angustidens* Cope.(5) *Orohippus cuspidatus* Cope.

Type locality: Rio Gallinas, New Mexico. *Type specimen:* A fragment of ramus with m_1 - m_3 (Nat. Mus. Coll. No. 1078).

Characters of type: (1) Lower molars very slender, (2) heel of m_3 long

and narrow with a single median crest, (3) antero-internal cusp of molars not twinned, (4) m_2 and m_3 of equal transverse diameter, (5) ramus thin.

Measurements of Type.

	mm.
m_{1-3}	24.1
m_1 antero-post. diam.	6.4
“ transv. “	4.5
m_3 antero-post. diam.	10.
“ transv. “	4.7
Depth of ramus at m_1	12.8

This is one of the smallest species of the genus and differs from *E. index* in the long narrow molars and in the thin, delicate jaw. There are no specimens in the American Museum Collection which approach this type in the slenderness of the molar teeth. The few small specimens from New Mexico and the Big Horn appear to be closer to *index* than to *angustidens*. The type of *Orohippus cuspidatus* Cope, from Rio Gallinas, New Mexico (Nat. Mus. Coll. No. 1077), is a fragment of upper jaw with the fourth milk molar and the first permanent molar. The latter tooth measures in antero-posterior diameter 6.5 mm. and in transverse diameter 7.4 mm. This is about equal to *E. angustidens* in size, to which species it very probably belongs.

(6.) ***Eohippus validus* Marsh.**

Type locality: Rio Gallinas, New Mexico. *Type specimen:* A jaw fragment with p_4 - m_3 r.; p_4 - m_1 and m_3 l.; p^4 - m^1 r.; ? m^2 l. and unimportant skeleton fragments (Yale Mus. Coll.).

Characters of type: (1) Lower molars very short and broad, with m_2 wider than m_3 , (2) heel of m_3 large, with external cusp and internal crescent, (3) p_4 comparatively very small and without entoconid, (4) p^4 very small and narrow antero-posteriorly, (5) ramus stout.

Measurements of Type.

	mm.		mm.
m^1 antero-post. diam.	6.8	p_4 - m_3	31.7
“ transv. “	9.4	m_{1-3}	26.
p^4 antero-post. “	5.4	m_1 antero-post. diam.	7.
“ transv. “	8.	“ transv. “	5.3
		m_3 antero-post. diam.	11.2
		“ transv. “	6.
		p_4 “ “	4.2

This species is the generic type for all known Wasatch and Wind River horses. It is quite the most primitive species of the genus; the very small,

narrow and simple fourth upper premolar is not duplicated in any other type or indeed in any other specimen which I have examined.

(8.) ***Eohippus cristonensis*** Cope.

Syn.: *Orotherium cristonensis* Cope.

(9) *Orotherium loevii* Cope.

Type locality: Rio Gallinas, New Mexico. *Type specimen:* Lower jaws (Nat. Mus. Coll. No. 1002).

Characters of type: (1) Molars of moderate robustness, (2) heel of m_3 extremely broad and heavy, (3) p_4 with small entoconid, (4) p_3 with rudimentary antero-internal cusp, (5) long diastema between p_1 and p_2 , (6) cingulum weak and not continuous.

Measurements of Type.

	mm.
p_2 - m_3	45.5
m_1 - m_3	27.
m_1 antero-post. diam.	7.
“ transv. “	5.2
m_3 antero-post. “	11.7
“ transv. “	5.8
p_4 antero-post. “	6.2
“ transv. “	4.7
Depth of ramus at m_2	15.

The large basin-shaped heel of the last molar of this specimen is not found in any other Wasatch type, although this seems to be a character of considerable variability in the *Hyracotheres*. The size and general proportions of the teeth, however, distinguish this species from any previously described, with the exception, perhaps, of Cope's *Hyracotherium vasacciensis* from Evanston, the type of which is a single (?) second lower molar agreeing pretty closely with the corresponding tooth in the present species.

The type of *Orotherium loevii* Cope (Nat. Mus. Coll. No. 1128), from New Mexico, was regarded by Wortman as being a small variety of *E. cristonensis*. The type is a very inferior one consisting, as it does, of jaw fragment with badly worn and broken p_2 - m_2 . It is considerably smaller than the type of *cristonensis*, but the proportions of the teeth are much the same and there is a distinct entoconid on the fourth premolar.

Measurements of Type of Orotherium loevii.

	mm.
p_2 - m_2	28.5
m_1 antero-post. diam.	6.
“ transv. “	4.2
p_4 antero-post. “	5.5
“ transv. “	3.5
Depth of ramus at m_2	14.

Referred specimens: No. 4634, Amer. Mus. Coll., from the type locality is the closest approach to the type of the present species of any specimens in the collection, and this differs in having bifid antero-internal cusps and a smaller heel. No. 4636, also from the type locality, agrees in having the cusps not twinned but has a short heel. No. 165 from the Big Horn Basin was provisionally referred by Wortman but differs, as he pointed out, in having a short heel, bifid cusps and no diastema between p_1 and p_2 . It probably does not pertain to *E. cristonensis*.

(12.) ***Eohippus etsagicus*** Cope.

Syn.: *Systemodon etsagicus* Cope.

Type locality: Big Horn Basin, Wyo. *Type specimen:* A jaw fragment with p_4 - m_2 l., roots of p_{2-3} and alveolus of p_1 (Amer. Mus., Cope Coll. No. 4600).

Characters of Type: (1) Molars moderately stout, (2) p_4 with entoconid, (3) no diastema between p_1 and p_2 , (4) ramus deep.

Measurements of Type.

	mm.
p_4 - m_2	23.
m_1 antero-post. diam.	8.
“ transv. “	5.4
p_4 antero-post. “	6.5
“ transv. “	4.5
Depth of ramus at p_4	19.

Prof. Cope figured this specimen in his Tertiary Vertebrata, and in the explanation of the plate applied the name *Systemodon etsagicus*. There appears to be no other reference to the specimen. It very clearly is a *Hyracotherium* and is distinct from any previously described species of *Eohippus*. In size it is about equal to *E. cristonensis* but differs (1) in the depth of the ramus, (2) in having no entoconid on the fourth premolar, (3) in the absence of the diastema. The specimen is of importance as being the only type from the Big Horn Basin described previously to Dr. Wortman's revision.

Referred specimens: Two specimens in the American Museum Collection (Nos. 228, 4597) appear to belong to this form; No. 4597 shows a double-rooted first lower premolar and but a slight indication of the antero-internal cusp on the third premolar.

(13.) **Eohippus cristatus** Wortman.Syn.: *Hyracotherium cristatum* Wortman.

Type locality: Grey Bull River, Big Horn Basin, Wyo. *Type specimen:* A lower jaw fragment with p_3 - m_2 r. (Amer. Mus. Coll. No. 258b). Paratype; a jaw fragment with m_3 (No. 240).

Characters of type: (1) Jaw and teeth robust, (2) p_4 without entoconid and with antero-internal cusp weak, (3) p_3 with a single anterior cusp, (4) cross crests of molars strongly developed, (5) heel of m_3 stout.

Measurements of Type.

	mm.
p_3 - m_2	36.
m_1 - m_2	20.
m_1 antero-post. diam.	9.5
“ transv. “	6.8
p_4 antero-post. “	8.
“ transv. “	5.5
<i>Paratype.</i>	
m_3 antero-post. diam.	14.5
“ transv. “	7.3

With the exception of those specimens which Cope and Wortman have referred to *Hyracotherium tapirinum*, this is the largest of the Wasatch horses and may be distinguished by the absence of the antero-internal cusp on the third premolar and the posterior position of the homologous cusp on the fourth premolar. Compared with *E. craspedotus* of the Wind River, the present species has more slender teeth and the fourth premolar is comparatively much smaller and with a narrower heel, also the cross-crests of the molars are better developed.

Referred specimens: Nos. 4650, 4653, 4656 and 4655, Amer. Mus. Coll., are probably referable to this species, but do not add any characters since they consist of lower molars only.

(14.) **Eohippus montanus** Wortman.Syn.: *Hyracotherium (Pliolophus) montanum* Wortman.

Type locality: Big Horn Basin, Wyo. *Type specimen:* Fragments of both rami, with m_{2-3} l., p_4 and roots of p_{1-3} r. (Amer. Mus. Coll. No. 4593).

Characters of Type: (1) Molars robust, (2) heel of m_3 of moderate size, (3) p_4 with small entoconid, (4) p_1 double rooted, (5) no diastema between p_1 and p_2 .

Measurements of Type.

	mm.
p_1 - m_3 (approx.)	52.5
m_1 - m_3	28.
m_3 antero-post. diam.	11.3
“ transv. “	6.
p_4 antero-post. “	6.5
“ transv. “	4.6
depth of ramus at m_2	15.5

Dr. Wortman established this species on the distinguishing characters of “(1) the absence of any diastema between the first and second premolars, and (2) the two rooted condition of the first premolar.” The first character is observed in the type of *E. (Systemodon) etsagicus* Cope from the same locality but it is not possible to determine whether the premolar was double rooted or not. The Cope type is deep-jawed, has more slender molars and there is no distinct entoconid on the fourth premolar, characters which would seem to indicate that the present species is distinct.

Referred specimens: The only specimen in the collection which appears to be referable here is No. 221, a fragmentary jaw from the Big Horn Basin, which shows the additional character of a strong antero-internal cusp on the third premolar.

***Eohippus resartus* sp. nov.**

Type locality: Big Horn Basin, Wyo. *Type specimen:* A portion of a left ramus with p_3 - m_2 l. and, in somewhat doubtful association, fragments of upper jaws with p^4 - m^1 l., m^{2-3} r. (Amer. Mus., Cope Coll. No. 4657).

Characters of type: (1) Lower molars stout and with cross crests well developed, (2) p_4 without entoconid, (3) p_3 with well developed antero-internal cusp, (4) ramus deep and massive.

Measurements of Type.

	mm.		mm.
p^4 - m^3	38.	p_3 - m_2	36.4
m^1 - m^3	30.	m_1 antero-post. diam.	10.
m^1 antero-post. diam.	10.	“ transv. “	6.5
“ transv. “	11.5	p_4 antero-post. “	8.
p^4 “ “	10.	“ transv. “	5.5

This species is proposed for the purpose of embracing the various specimens from the Big Horn Basin which have been referred by Cope and Wortman to *Hyracotherium (Orohippus) tapirinum* Cope, of the New Mexican Wasatch, a type which is not generically determinable and which, I think, should be abandoned as useless for the reference of additional material.

The type is a fragment of lower jaw with very badly worn second and third molars (Nat. Mus. Coll. No. 1064). It was originally described as *Orohippus tapirinus*, was later referred by Cope to the genus *Hyracotherium*, and when *Systemodon* was discovered in the Big Horn Basin, Cope made it the type of that genus. Dr. Wortman, however, in his treatise on the subject, considered that Cope's original determination of the specimen as a horse was the correct one. The only reason, which I can determine, for considering it a horse is the fact that in the last molar the oblique ridge which connects the anterior pair of cusps with the posterior pair has its anterior termination, as nearly as can be made out from the worn teeth, between the two anterior cusps and not at the posterior face of the external cusp as in the

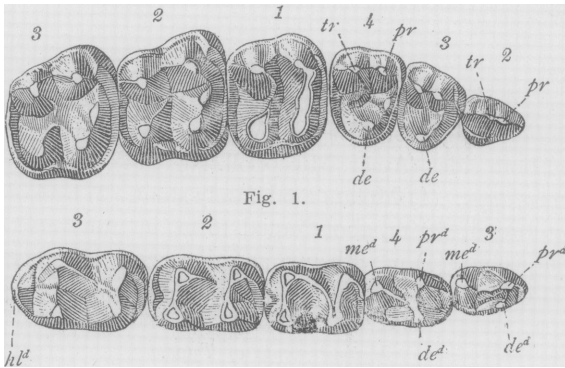


Fig. 2.

Figs. 1 and 2. *Eohippus resartus*. (After Wortman.)

Fig. 1. Upper teeth, crown view (composition from Nos. 139 and 212). Wahsatch, Big Horn. $\times \frac{1}{4}$.

Fig. 2. Lower teeth, crown view. Type specimen No. 4657 (third molar from No. 143a). Wahsatch, Big Horn. $\times \frac{1}{4}$.

Abbreviations: *pr.* = protocone, *de.* = deutocone, *tr.* = tritacone, *pr^d.* = protoconid, *de^d.* = deutoconid, *me^d.* = metaconid, *hl^d.* = hypoconulid.

majority of specimens of *Systemodon* from the Big Horn. There are from the Big Horn specimens which are intermediate in this respect between *Eohippus* and *Systemodon* and which do not fall satisfactorily into either genus. The present species is the largest of the Wasatch or Wind River Hyracotheres, exceeding in size *E. craspedotus* and *E. cristatus*. From the former it is distinguished by the strong cross crests of the lower molars and from the latter by the presence of a second anterior cusp on the third premolar and by the subequal anterior cusps of the fourth premolar.

Referred specimens include Nos. 139 and 212 (Fig. 1), both from the Big Horn Basin. The first of these is a palate with the molars and third and fourth premolars and the second has molars and second and third premolars

in association with a lower molar. These two specimens combined give a fairly complete representation of the upper teeth of this species. The characters of importance are (1) metaconules not clearly defined, (2) strong parastyle on third and fourth premolars, (3) outer cusps of second and third premolars placed close together, (4) a postero-internal ledge on second premolar.

The specimens in the National Museum Collection from New Mexico which have been referred by Cope to *H. tapirinum* are probably referable to the present species, although in the absence of premolar teeth it is not possible to definitely separate them from Wortman's *E. cristatus*. They do not agree well with Cope's type of *tapirinum* in which the second molar has a much greater transverse diameter than the third.

***Echippus borealis* sp. nov.**

Type locality: Big Horn Basin, Wyo. *Type specimen:* Lower jaws with p_2 - m_3 of both sides (Amer. Mus. Coll. No. 214).

Characters of type: (1) Molars moderately stout, (2) heel of m_3 short and stout but not broad, (3) m_2 about equal to m_3 in transverse diameter, (4) p_4 without entoconid, (5) p_3 with two anterior cusps, (6) diastema between p_1 and p_2 , (7) cingulum weak on p_4 , moderate on molars, (8) jaw stout but not deep.

Measurements of Type.

	mm.
p_2 - m_3	44.
m_1 - m_3	26.
m_1 antero-post. diam.	7.2
“ transv. “	5.2
m_3 antero-post. “	11.
“ transv. “	5.4
p_4 antero-post. “	6.5
“ transv. “	4.6
Depth of ramus of m_2	18.

In the American Museum Collection there are between two and three hundred specimens of *Hyracotheres* from the Big Horn Basin. These consist mainly of fragmentary upper and lower jaws. In only a few instances are there upper and lower teeth in association. A large proportion of the specimens, perhaps one third, appear to belong to a single medium sized species. In the general structure of the lower teeth they do not differ very materially from the type of *E. index* from Evanston, and Dr. Wortman has referred the majority of these Big Horn specimens to this species. As I have mentioned before, however, it seems to me that there is too great a

difference in size between the Evanston type and the majority of the referred specimens from the Big Horn Basin to be bridged over by a single species, and I propose this name to embrace these numerous specimens and also a few from the Wind River which appear to be referable to the same species. This form appears not to be represented from the Wasatch of New Mexico. It may be distinguished from the various New Mexican types as follows; from *E. cristonensis* Cope by (1) the absence of an entoconid on the fourth premolar, (2) the relatively smaller third molar and shorter narrower heel; from *E. angustidens* Cope by greater size and relatively broader molars; from *Hyracotherium tapirinum* Cope, by size; and from *E. validus* Marsh by (1) relatively narrower molars and (2) larger fourth premolar. From the three types from the Big Horn Basin, *E. etsagicus* Cope, *E. montanus* Wort. and *E. cristatus* Wort., it is clearly distinguishable. In the first two species there is no diastema between the first and second premolars, and in the last (*E. cristatus*) there is no antero-internal cusp on the third premolar, and the species is also much larger compared with *Hyracotherium vasac-ciense* Cope, from Evanston, the present species has more slender molars.

Referred specimens: Among the more important specimens in the collection which may be referred to this species are Nos. 179, 4498, 4583, 4602, 4613, 4624. One of these, No. 4613¹, has upper molars associated with lower jaw; the upper molars agree well with those of No. 4602, and as the latter specimen has, in addition to the upper molars the third and fourth premolars, it may be selected for description of the upper dentition of *E. borealis*. (1) The molars show a moderate parastyle, (2) have the protoconules distinct and the metaconules well separated on first and second teeth, (3) last molar with its posterior border square cut, a condition materially different from that seen in some other specimens of about the same size in which the last molar shows strong lateral compression at the metacone, giving the tooth almost a triangular outline. These latter probably represent a species distinct from the present one.

The measurements of No. 4602, which is a slightly smaller individual than the type, are:

p ³ -m ³	35.
m ¹ - ³	22.5
m ¹ antero-post.	diam.	7.
“ transv.	“	8.5
m ³ antero-post.	“	7.5
“ transv.	“	9.
p ⁴ antero-post.	“	6.
“ transv.	“	7.3

¹ See Bull. Am. Mus. Nat. Hist., 1896, p. 100, figs. 9 and 10.

The single lower molar from Evanston, Wyo., described by Cope as *Lophiotherium vasacciense*, is a type to which the reference of other specimens from widely separated localities and possibly different geological horizons must be attended with much uncertainty. The lower jaw (Amer. Mus. Cope Coll. No. 4659), from the Big Horn Basin, which Dr. Wortman has described and figured as representing this species, agrees with the type, as he states, fully as well as any of the specimens from this locality do, but it seems preferable, for the reason given above, not to consider it as representing *vasacciense* but rather as a large deep-jawed variety of *E. borealis*. Aside from size and the depth of jaw it differs from the present species in having a weaker deutoconid on the third premolar and a shorter heel on the third molar.

The measurements of No. 4659 are:

p_2 - m_3 (approx.)	45.
m_1 - m_3	26.
m_3 antero-post. diam	10.
depth of ramus at m_1	20.

Nos. 4504 and 4660 pertain to this variety.

Several specimens (Nos. 4617, 4596, 4578, 4591, 4626) represent a smaller variety of *E. borealis*, being closer to this species than to *E. angustidens* in which the molars are extremely slender. No. 4578 has the molar series measuring 24 mm. as compared with 26 mm. in the type. The other specimens are intermediate in size.

From the Wind River there are several upper and lower jaws (Nos. 12807, 12795, 12799) from the lower level (Cottonwood Draw and Bridger Creek) which I am unable to distinguish from this species.

(10.) ***Eohippus craspedotus*** Cope.

Syn.: *Hyracotherium craspedotum* Cope.

Type locality: Wind River Basin, Wyo. *Type specimen*: Parts of both lower jaws with m_{1-3} r., p_2 and p_4 - m_1 l. (Amer. Mus., Cope Coll. No. 4830).

Character of type: (1) Molars very robust, with low massive cusps, (2) m_2 considerably wider than m_3 , (3) heel of m_3 broad and very heavy, (4) cross crests of molars but little developed, (5) p_4 without a distinct entoconid, (6) very short diastema between p_1 and p_2 , (7) prominent posterior cusp on p_2 .

Measurements of Type.

	mm.
p ₂ -m ₃	56.
m ₁ - ₃	33.
m ₁ antero-post. diam.	9.
“ transv. “	7.
m ₃ antero-post. “	13.5
“ transv. “	7.5
Depth of ramus at m ₂	20.

This is the largest species found in the Wind River and nearly as large as any from the Wasatch. It is readily distinguishable by the short broad teeth and the low, obtuse and well separated cusps of the molars.

Referred specimens: As probably belonging to this species is a crushed skull (No. 4831) with the molars and third and fourth premolars in fine preservation. Both Cope and Wortman have referred this specimen to this species. The premolars show but very slight progression, the third and fourth being very simple triangular teeth, quite distinct in this respect from *E. venticolus*, from the same beds in which the third premolar has the second internal cusp well indicated. The molars show less development of the parastyle than is seen in the larger Wasatch species.

A second specimen (No. 12819) which is either referable to this species or to one undescribed has upper and lower jaws in association. The lower molars are more slender than in the type and there is no trace of an entoconid on the fourth premolar. The upper teeth are similar to No. 4831. Both of these referred specimens are from the Wind River.

Measurements of No. 4831 are:

p ² -m ³ (approx.)	57.
m ¹ - ³	27.5
m ¹ antero-post. diam.	9.
“ transv. “	10.7
p ⁴ antero-post. “	7.2
“ transv. “	9.6

(11.) ***Eohippus venticolus* Cope.**

Syn.: *Hyracotherium venticolum* Cope, 1881.

Protorohippus venticolus Wortman, 1896.

Type locality: Alkali Creek, Wind River Basin, Wyo. *Type specimen:* Skull, jaws and large part of skeleton. (Amer. Mus., Cope Coll. No. 4832).

Characters of type: Lower dentition, (1) molars moderately stout, (2) heel of m₃ broad and heavy, (3) m₁ equal to m₃ in transverse diameter, (4) p₄ with well developed entoconid, (5) p₃ with two sub-equal anterior cusps

and no posterior cusp, (6) diastema between p_1 and p_2 ; Upper dentition, (1) parastyle moderate, (2) intermediate cusps well indicated on all molars, (3) p^4 triangular in outline, (4) p^3 more advanced than p^4 , the antero-internal cusp being fairly well developed, (5) p^2 with postero-internal ledge, (6) short diastema between p^1 and p^2 .

Measurements of Type.

	mm.		mm.
p^2 - m^3	45.	p_2 - m_3	48.8
m^1 - m^3	24.3	m_1 - m_3	28.2
m^1 antero-post. diam.....	8.1	m_1 antero-post. diam.....	8.
“ transv. “.....	10.5	“ transv. “.....	6.
m^3 antero-post. “.....	8.3	m^3 antero-post. “.....	12.
“ transv. “.....	10.3	“ transv. “.....	6.5
p^4 antero-post. “.....	7.		
“ transv. “.....	9.		
Length of skull from occipital condyles to tip of nasals.....	138.	p_4 antero-post. diam.....	6.8
Length of femur.....	188.	“ transv. “.....	5.5
“ “ tibia.....	122.	Length of humerus.....	96.
“ “ mt. III.....	68.	“ “ ulna.....	116.
		“ “ radius.....	93.
		“ “ mc. III.....	51.

This is the most important specimen of a Hyracothere from our lower Eocene, and it has been thoroughly described and figured by Cope. The characters of the upper premolars serve at once to distinguish it from any Wasatch species, while its size, and the proportions of the lower molars; separate it from *E. craspedotus* of the same beds.

Referred specimens: There are no other specimens in the collection which can with absolute certainty be referred to this species although there are two (Nos. 4837, 4839), each with upper premolars, which represent either a small variety or a closely allied species, since both present the character seen in the third premolar of the type. A third specimen (No. 4834), lower jaw, is also smaller than the type and has no entoconid on the fourth premolar although the premolars are relatively larger.

HUERFANO STAGE.

? *Echippus*.

In the small collection of fossils obtained by Prof. Osborn and Dr Wortman in the Huerfano Basin in 1897 there are a few fragmentary remains of Hyracotheres, including portions of two lower jaws, and representing two species. One (No. 2685), a small slender jawed type, is

recorded as coming from the lower beds, and the other (No. 2658a), a medium sized species with short broad teeth, is from the middle or upper beds. I am unable to determine definitely the generic position of these two specimens. The fourth premolar is preserved in both jaws and, while the entoconid is rather more highly developed than in the Wind River species, yet the tooth does not show the progressive character found in *Orohippus*. Until the upper teeth are known the reference of the Huerfano horses to either *Eohippus* or *Orohippus* must be more or less conjectural. Prof. Osborn has referred¹ the smaller of the two specimens to the Wind River genus, provisionally.

*Measurements of No. 2685**Measurements of No. 2685a*

	mm.		mm.
p_2 - m_3 (approx.).....	44.	p_3 - m_2	21.4
m_1 - m_3	25.	m_2 transv. diam.....	6.
m_3 antero-post. diam.....	10.8	Depth of jaw at m_2	15.3
" transv. "	5.4		
Depth of ramus at m_2	13.5		

BRIDGER STAGE.

***Orohippus Marsh*, 1872.**Syn.: *Helotherium* Cope, 1872.*Oligotomus* Cope, 1873.*Helohippus* Marsh, 1892.

Characters: (1) Third and fourth upper premolars either molariform or well advanced toward that condition, *the fourth always showing* progression equal to the third, (2) second upper premolar with two external cusps and, in advanced species, a small internal cusp, (3) first upper premolar double rooted, (4) diastema between first and second upper premolars either present or absent, (5) mesostyle present (practically absent in *O. major*), (6) lower fourth premolar molariform, (7) third premolar, usually, with two anterior and one posterior cusp, (8) diastema between lower first and second premolar either present or absent.

(16.) ***Orohippus pumilus* Marsh.**Syn.: *Lophiodon pumilus* Marsh.(9) *Helotherium procyoninum* Cope.

Type locality: "Marsh's Fork,"² Bridger Basin, Wyo. *Type specimen:* A right maxilla with p^3 - m^2 and roots of p^{1-2} (Yale Mus. Coll.).

¹ Bull. Amer. Mus., 1897, p. 258.² I cannot determine the position of "Marsh's Fork" but it probably is one of the numerous small dry creeks leading into either Smith's or Black's Fork, and hence in the Lower Bridger. There is a Marsh Creek indicated on some maps in the upper part of the Green River Basin, north of Piney Creek, but I think this must be beyond the northern limits of the Bridger exposures.

Characters of type: (1) Teeth considerably compressed antero-posteriorly, (2) parastyle much reduced, (3) mesostyle rudimentary, at least on m^{1-2} , (4) strong internal ledge on p^2 , as indicated by roots of the tooth, (5) moderately advanced toward full molariform condition, (6) short diastema between p^1 and p^2 .

<i>Measurements of Type.</i>	
p^2-m^2	29.5
m^{1-2}	13.
m^2 antero-post. diam.	6.8
“ transv. “	8.

Prof. Marsh in 1892 elevated this type to separate generic rank giving it the name *Helohippus*. He distinguished the genus by “a diastema between the first and second premolars, and the last premolar like the first molar.” These characters are apparently meant as distinctions from *Orohippus*, the type of which consists of four loose teeth, and the presence or absence of a diastema cannot be determined although it is probable that there was one. There is no fourth premolar with the typical *Orohippus* but the third premolar certainly does not show any characters separating it from the present species generically. Specific distinctions between the two species are confined principally to the greater antero-posterior compression of the teeth in the present form.

The single third upper molar from Cottonwood Creek, Hor. B. (Amer. Mus., Cope Coll. No. 5052), described by Cope as *Helotherium procyoninum* resembles the present species pretty closely although the mesostyle is rather better developed than in the first and second molars of *O. pumilus*. The specimen surely belongs to this genus and very probably to this species.

The measurements of *H. procyoninum* are:

m^3 antero-post. diam.	mm. 7.
“ transv. “	8.3

(17.) ***Orohippus ballardi* Marsh.**

Syn.: *Lophiotherium ballardi* Marsh.

(22) *Oligotomus cinctus* Cope.

Type locality: Grizzly Buttes, Lower beds, Bridger Basin, Wyo. *Type specimen:* Fragment of left ramus with m_{2-3} (Yale Mus. Coll.).

Characters of type: (1) Molars short and broad with outer and inner cusps placed well apart, (2) heel of m_3 short and not basin shaped, (3) ingulum weak.

Measurements of Type.

	mm.
m ₂ antero-post. diam.	6.7
“ transv. “	4.7
m ₃ antero-post. diam.	9.3
“ transv. “	4.4

This is one of the smaller Bridger forms, about equal in size to *O. pumilus* with which it may prove to be identical when more complete material is secured.

Referred specimens: Referable to *O. ballardi* are two fragments of jaws from horizon B. (Nos. 11627, 12648a). One specimen (No. 12122), from Dry Creek, Hor. C., is considerably smaller than the type and smaller than anything else in the American Museum Collection. The molar series measures, in millimeters, 21.5, m₁₋₂ = 13., width of m₁ = 4.5.

Oligotomus cinctus Cope from the same horizon is not specifically distinguishable from this species and should be included under it.

Measurements of O. cinctus.

	mm.
p ₂ -m ₁ (approx.)	26.
m ₁ antero-post. diam.	7.
p ₄ antero-post. “	6.3
“ transv. “	5.
Depth of ramus of p ₂	12.

(18.) **Orohippus typicus** nom. nov.¹

Type locality: Henry's Fork² (?), Upper beds, Bridger Basin, Wyo. *Type specimen:* Loose teeth, p³, m¹, m²³l.; m³r. (Yale Mus. Coll.).

Characters of type: (1) Parastyle rudimentary, (2) mesostyle rudimentary, (3) molars broad antero-posteriorly (4) third and (?) fourth premolars well advanced toward molariform condition but not fully molariform.

Measurements of Type.

	mm.
m ³ antero-post. diam.	7.
“ transv. “	8.

This is the type of the genus. Since this species is not generically distinct from the species described by Marsh the year before as *Lophiodon pumilus*, and since the reference to *Lophiodon* was erroneous, a new specific name is necessary to designate this species, and the name *typicus* is assigned. The specific differences between this form and *O. (Lophiodon) pumilus* are

¹ To replace *O. pumilus* Marsh, preoccupied.

² In the original description of this species the type is recorded as coming from Grizzly Buttes.

slight. So far as comparisons can be made, about the only differences are in the greater antero-posterior diameter of the molars in *O. typicus* and in the slightly different form of the third and fourth premolars. The two types agree in the rudimentary condition of parastyle and mesostyle. Although *O. typicus* is recorded as coming from Henry's Fork, and hence from the upper beds, it is a rather primitive form such as might be expected from the lower horizons. This species also compares in size with *O. ballardi*.

Referred specimens: In the American Museum Collection are two specimens (Nos. 12121, 11631) which are pretty certainly referable to this species, but neither is sufficiently complete to afford any additional characters.

***Orchippus progressus* sp. nov.**

Type locality: Twin Buttes, Hor. C., Bridger Basin, Wyo. *Type specimen:* Fragmentary skull with molar and premolar teeth. (Amer. Mus. Coll. No. 12120). Collected by Mr. C. S. Mead, 1904.

Characters of type: (1) Parastyle well developed, (2) mesostyle moderately developed on molars and on p^3 and p^4 , (3) molars broad antero-posteriorly, (4) p^3 and p^4 each with two equal internal cusps but with outlines not fully quadrate, (5) p^2 three rooted but the internal ledge is narrow and abruptly sloped, (6) moderate diastema between p^1 and p^2 .

Measurements of Type.

	mm.
p^2 - m^3	39.
m^1 - m^3	20.
m^1 antero-post. diam.	7.2
“ transv. “	8.7
m^3 antero-post. “	7.
“ transv. “	8.3
p^4 antero-post. “	6.8
“ transv. “	8.

A small species from the upper beds which shows a very general and uniform progression towards *Epihippus* of the Uinta formation. In size the species is about the same as *O. typicus*, but it is distinguished from it by the greater development of the parastyle and mesostyle and the less rounded outline of the last molar.

(23.) ***Orohippus major* Marsh.**

Type locality: Millersville, Lower beds, Bridger Basin, Wyo. *Type specimen:* An upper jaw fragment with m^{2-3} r. and loose m^2 l. (Yale Mus. Coll.).

Characters of type: (1) Parastyle moderately developed, (2) mesostyle but slightly indicated on m^3 , absent on m^2 , (3) m^3 more quadrate in outline than in other Bridger species, (4) external cusps much flattened.

Measurements of Type.

	mm.
m^2 antero-post. diam.	8.5
“ transv. “	11.
m^3 antero-post. “	8.5
“ transv. “	10.

This is the largest of the Bridger horses and probably the most primitive. The molars show, in the practically absent mesostyle and in their outline, a rather strong resemblance to the molars of *Eohippus craspedotus* from the Wind River, and the discovery of more complete material may compel its removal from the genus *Orohippus*.

Referred specimens: A lower jaw (No. 11634) from Church Buttes, Hor. B., supporting the second and third molars, agrees with the type in size and is probably referable to it. The characters are, (1) heel of m_3 moderately stout, (2) cingulum heavy, (3) m_2 short and with greater transverse diameter than m_3 , (4) ramus very robust.

Measurements.

	mm.
m_2 - m_3	20.7
m_3 antero-post. diam.	12.
“ transv. “	6.
m_2 “ “	6.4
Depth of ramus at m_2	18.

A lower jaw (No. 11633) from Henry's Fork, with the fourth milk molar and first and second true molars, equals the type in size and may belong to the species. Of interest in this specimen is the great length of the diastema between the first and second premolars, a character which separates it at once from the large advanced forms of the upper beds which I have grouped under the sub-genus *Aminippus* (*Orotherium*) Marsh, and which includes the species *agilis*, *uintanus* and *sylvaticus*.

Measurements of No. 11633.

	mm.
m_1 - m_2	18.5
m_1 antero-post. diam.	9.
“ transv. “	6.3
Length of diastema	+10.

(24.) **Orohippus osbornianus** (Cope).

Syn.: *Hyracotherium osbornianum* Cope.

Type locality: Black's Fork, Hor. B., Bridger Basin, Wyo. *Type specimen*: Lower jaw fragment with m_1 and roots of p_{3-4} and m_{2-3} (Amer. Mus., Cope Coll. No. 5051).

Measurements of Type.

	mm.
p_4-m_3 (approx.)	34.
m_{1-3} (approx.)	27.
m_1 antero-post. diam.	8.
“ transv. “	5.5
Depth of ramus at m_2	14.

The type of this species exhibits but few characters for comparison, but it represents a medium sized form from the lower horizon and does not appear to be referable to any previously described member of the genus.

Referred specimens: No. 12648, consisting of skull, jaws and a large part of the skeleton, was obtained for the American Museum by the writer in 1905 in the lower levels of the Bridger formation, near Granger, and agrees reasonably well so far as comparisons can be made with the type of this species, the chief differences being in the depth of the ramus, a character of variability in Eocene horses. The dental characters of this referred specimen are: *upper series*, (1) Parastyle strong, (2) mesostyle remarkably well developed on all teeth posterior to p^1 , (3) p^3 and p^4 primitive, p^4 being considerably more quadrate than p^3 , (4) p^2 with no distinct internal cusp, (5) diastema very short on one side and absent on the other, (6) p_1 double rooted, (7) canine very small and weak, not larger than p^1 ; *lower series*, (1) molars moderately robust, (2) cingulum very heavy, (3) heel of m_3 short and stout, (4) p_3 without entoconid, (5) diastema about equal to antero-posterior diameter of p_2 , (6) canine very weak, (7) short diastema in front of canine, (8) incisors of equal size and with expanded and sharp cutting edges, (9) ramus thin.

Measurements of No. 12648.

	mm.		mm.
p^1-m^3	49.3	p_2-m_3	46.4
m^1-m^3	24.	m_{1-3}	26.
m^1 antero-post. diam.	7.9	m_1 antero-post. diam.	7.3
“ transv. “	9.5	“ transv. “	5.7
m^3 antero-post. “	8.	m_3 antero-post. “	10.5
“ transv. “	9.	“ transv. “	5.4
p^3 antero-post. “	7.2	p_4 antero-post. “	7.
“ transv. “	8.4	“ transv. “	5.4
		depth of ramus at m_2 (increased by crushing)	16.

Some of the more important measurements of the skull and skeletal parts are:

	mm.
Length of skull	140.
“ “ nasals	64.
“ “ humerus	102.
“ “ mc. II	45.
“ “ III	50.
“ “ “ IV	42.
“ “ “ V	34.5
“ “ mt. III	70.
“ “ “ IV	65.

Aside from the skull and jaws there are preserved all of the pre-sacral vertebræ, parts of both fore and hind limbs including nearly complete manus and pes, a few ribs, fragments of pelvis and three sternal bones. The skull is badly crushed and the hind limbs and vertebræ are broken or weathered. A few characters of importance are to be noted, however, There are parts of thirty presacral vertebræ preserved; of these the seven cervicals are clearly distinguishable, of the remaining twenty-three dorso-lumbar fifteen are rib-bearing and eight seem to be lumbar. In the fore limb there is no material difference from *Eohippus venticolus*, the fibula has a very slender shaft but it is not interrupted. In the manus and pes there is a slight advance over *E. venticolus* in the reduction of the lateral digits, the ischium is remarkably long and the blade of the scapula relatively broad in comparison with *Hyrachyus*.

Five other specimens of lower jaws in the collection (Nos. 12656, 12657, 11622, 11623, 11624) agree with the type in measurements and, with No. 12648, in the development of the premolar cusps, but all differ from the latter in having more robust jaws, one specimen (No. 11624) has canines fully twice the size of those of No. 12648. This size of the canines may very easily be a sexual character, though.

Orohippus atavus sp. nov.

Type locality: Mouth of Cottonwood Creek, Lower beds, Bridger Basin, Wyo. Collected by Dr. O. P. Hay, 1903. *Type specimen:* A fragmentary skull and portions of a hind limb (Amer. Mus. Coll., No. 11625).

Characters of type: (1) Parastyle strong on first and second molars, weak on other teeth, (2) mesostyle only slightly indicated, except on m_2 , where it is well developed, (3) p^3 and p^4 very primitive; the p^3 is nearly triangular in outline, the p^4 has the postero-internal cusp well developed and is more quadrate in outline than p^3 , (4) p^2 with no distinct internal cusp, (5) moderate diastema, (6) canines of moderate size.

Measurements of Type.

	mm.
p ² -m ³	44.3
m ¹ - ³	23.
m ¹ antero-post. diam.	7.6
“ transv. “	9.3
m ³ antero-post. diam.	7.6
“ transv. “	8.6
p ⁴ antero-post. “	6.3
“ transv. “	8.
Diastema	5.5

A medium sized species from the lower beds and, excepting *O. major*, the most primitive of any yet found in the Bridger. The third premolar shows but little advance over *Eohippus venticolus*. The fourth premolar, however, has the postero-internal cusp, or tetartacone in a higher developed condition than is found in any Wind River specimens. The cusp is nearly as large as the deuterocone but its position is less internal. It is the development of this fourth premolar beyond that of the third, together with the presence of a mesostyle, which places the species in the genus *Orohippus* instead of *Eohippus*.

This species may readily be distinguished from *O. osbornianus* by its weak development of mesostyle, as well as by the moderate diastema and by the more primitive condition of the third and fourth premolars.

Referred specimens: Provisionally referred to this species is a lower jaw, (No. 11626) from Grizzly Buttes, which shows a very primitive condition of the third premolar, there being but a single anterior cusp and a large unicuspid heel, which is the condition of the second premolar in most species of Bridger horses. The fourth premolar is a molariform tooth, however, the two posterior cusps being sub-equal.

Measurements of this jaw are:

	mm.
p ₃ -m ₃	40.
m ₁ - ₃	26.
m ₁ transv. diam.	5.5

Subgenus **Aminippus** nom. nov.¹

Several species of the Equidæ from the Upper Bridger are decidedly more advanced than any from the lower part of the formation, but the differences are here regarded as of only subgeneric value. *Orotherium* Marsh, 1872, is the only generic name founded upon a species unquestionably from this level; as this is preoccupied it becomes necessary to propose

¹ To replace *Orotherium* Marsh, preoccupied. *Aminippus* = better horse, *i. e.*, more like the modern forms.

a new name for these more progressive forms and the name *Aminippus* is chosen. *Orotherium uintanum* Marsh is the type of the subgenus, which includes the species *sylvaticus* of Leidy and *agilis* of Marsh.

Characters: (1) Third and fourth upper premolars molariform, (2) second upper premolar with internal cusp, (3) no diastema between first and second upper premolars, (4) mesostyle moderately developed, (5) second lower premolar with single anterior and single posterior cusps, (6) no diastema between first and second lower premolars, (7) third and fourth lower premolars molariform.

15. *Orohippus (Aminippus) sylvaticus* Leidy.

Syn.: *Lophiotherium sylvaticum* Leidy.

Type locality: Henry's Fork, Upper Beds, Bridger Basin, Wyo. *Type specimen:* A portion of the left ramus with p_4-m_1 and m_3 (Nat. Mus. Coll. No. 3753). This is the first form described from the Bridger; in fact, the first species of *Hyracothere* described from any of the American Eocene stages.

Characters of type: (1) p_3^1 and p_4 molariform, but with p_3 very narrow anteriorly, (2) anterior pair of cusps on both molars and premolars placed closer together than the posterior pair; this character serves to distinguish the present species from *O. uintanus*, the closest allied form, (3) m_3 robust and with short stout heel, (4) well developed cingulum.

Measurements of Type.

	mm.
p_3-m_3	33.
m_1-m_3	26.
m_1 antero-post. diam.	7.3
“ transv. “	5.6
m_3 antero-post. diam.	10.5
“ transv. “	5.
p_4 transv. “	5.2
Depth of ramus at m_2	13.

In an important specimen (Amer. Mus. Coll., No. 12649) of this species from Sage Creek Spring, Hor. C., collected by Mr. P. C. Miller, the upper and lower teeth are found associated.

The characters of the upper teeth are: (1) Molars not compressed antero-posteriorly but m^3 shows strong compression at the postero-external angle, giving the tooth a sheared off appearance as in *Systemodon* and *Hyrachyus*, (2) parastyle moderately developed, weakest on m^3 , (3) mesostyle moderately

¹ The third premolar is not present in the type, but in an associated specimen (No. 12649) in the American Museum Collection.

developed on molars, strongest on m^3 , (4) metaconule not well separated in last molar, (5) p^3 and p^4 fully molariform quadrate teeth.

Measurements of No. 12649.

	mm.		mm.
p^3 - m^3	41.	p_3 - m_3	42.3
m^1 - m^3	24.	m_1 - m_3	27.2
p^4 antero-post. diam.....	7.5	m_1 antero-post. diam.....	8.2
“ transv. “.....	9.2	“ transv. “.....	6.
m^1 antero-post. “.....	8.4	m_3 antero-post. “.....	10.5
m^3 transv. “.....	10.6	“ transv. “.....	5.6
m^3 antero-post. “.....	8.		
“ transv. “.....	10.6		

Distinctions between this species and *O. uintanus* are found: (1) In the shorter, broader third molar, (2) the placing closer together of the anterior pair of cusps of both the molars and the premolars, (3) the comparatively stronger entoconid on the third premolar.

(20.) **Orohippus (Aminippus) uintanus** Marsh.

Syn.: *Orotherium uintanum* Marsh.

Type locality: Henry's Fork, Upper Beds, Bridger Basin, Wyo. *Type specimen*: A lower jaw with p_2 - m_3 r., in fine state of preservation (Yale Mus. Coll.).

Characters of type: (1) No diastema between p_1 and p_2 , (2) p_3 with comparatively weak entoconid, (3) anterior pair of cusps on the molars as wide apart as the posterior pair, (4) m_3 very slender with long narrow heel.

Measurements of Type.

	mm.		mm.
p_2 - m_3	47.	p_4 antero-post. diam.....	7.
m_1 - m_3	26.5	“ transv. “.....	5.
m_3 antero-post. diam.....	11.5	Depth of ramus m_3	16.
“ transv. “.....	5.		

Prof. Marsh made this the type of the genus *Orotherium*, distinguished from the European *Lophiotherium* by a posterior tubercle on p_2 and by the twinned condition of the antero-internal cusp of the molars, and transferred the species *L. sylvaticum* and *L. ballardi* to this genus. He did not, however, make any distinction between *Orotherium* and *Orohippus*, the type of the latter consisting of upper teeth only.

The species is distinguished from *O. sylvaticus* by the slenderness of the m_3 , by the wider separation of the anterior pair of cusps on the molars, and

by the comparatively weaker entoconid on the third premolar. With *O. agilis*, the third member of the subgenus, comparison's cannot be made since there are no specimens of either species with upper and lower teeth in association. These two species agree in size, however, and it is possible they may belong to the same form.

(21.) **Orchippus (Aminippus) agilis Marsh.**

Type locality: Henry's Fork,¹ Upper beds, Bridger Basin, Wyo. *Type specimen:* Anterior portion of skull, nearly complete fore limb, and several vertebrae. (Yale Mus. Coll., No. 1268.)

Characters of type: (1) Parastyle rudimentary, (2) mesostyle weak, strongest on m^2 , (3) p^3 and p^4 fully molariform quadrate teeth, (4) p^2 with well developed internal cusp, (5) no diastema between p^1 and p^2 , (6) canine large.

Measurements of Type.

		mm.
Length of mc II.....	51.	
" " " III.....	55.5	p^1 - m^3 (approx.).....49.
" " " IV.....	49.	m^{1-3}23.
" " " V.....	40.	m^1 antero-post. diam..... 8.
		" transv. " 9.5
		p^4 antero-post. " 7.2
		Antero-post. diam. of canine alveolus 7.2

Separable from *O. sylvaticus* Leidy by the weaker parastyle and mesostyle and probably by the more quadrate outline of the last molar. In the type of *O. agilis* only the root of this tooth is preserved but it indicates a tooth of rather different shape from that of *O. sylvaticus*.

UINTA STAGE.

Ephippus Marsh.

Characters: (1) Third and fourth upper premolars molariform, (2) mesostyle fully developed, (3) external cusps of upper molars crescentic, (4) second upper premolar with prominent postero-internal and small antero-internal cusp, (5) no diastema, (6) third and fourth lower premolars molariform, (7) second lower premolar with one anterior and two posterior cusps, (8) no diastema.

¹ There is no definite locality given for this type in Prof. Marsh's records but Mr. J. Heisey, one of Marsh's collectors in the Bridger, has informed me that it was collected on Henry's Fork and is therefore from the upper beds. The advanced condition of the premolars, as well as the nature of the matrix in which the specimen was imbedded, would seem to bear out this statement.

(25.) **Epihippus gracilis** Marsh.Syn.: *Anchitherium gracilis* Marsh.(26) *Orohippus uintensis* Marsh.

Type locality: White River, Uinta Basin, Utah. *Type specimen*: Lower jaws with dp_{2-4} , m_{1-2} l.; dp_{3-4} , m_1 r (Yale Mus. Coll.).

Characters of type: (1) Crowns of molars high, (2) m_1 and m_2 of about equal antero-posterior and transverse diameters, (3) antero-internal cusp strongly bifid, (4) ingulum rather weak but continuous.

Measurements of Type.

	mm.
m_{1-2}	16.5
m_1 antero-post. diam.	8.
“ transv. “	6.

E. (Orohippus) uintensis Marsh: I am unable to distinguish between this species and *E. gracilis*. The type is from the same locality and horizon as *E. gracilis* and consists of jaw fragments with p_2 - m_1 l, m_2 r, m^{1-2} r. The first and second lower molars agree so closely with those of *E. gracilis* that the differences may be due entirely to individual variations and to age.

The characters of E. uintensis are (1) Parastyle moderate, (2) mesostyle large and massive, not compressed antero-posteriorly, (3) metaconule distinct, (4) p_3 with four nearly equal cusps, (5) p_2 with one anterior and two posterior cusps and strong oblique crest, (6) p single rooted, (7) p_{3-4} with antero-internal cusps bifid.

Measurements of type of E. uintensis.

	mm.
p_1 - m_3 (approx.)	60.
m_{1-3}	31.
m_1 antero-post. diam.	9.
“ transv. “	6.5
m_{1-2}	18.
m_2 antero-post. diam.	9.
“ transv. “	12.

Referred specimens: No. 2042 (Amer. Mus. Coll.) is a young individual with milk teeth and first and second true lower molars. These are similar in structure to those of *E. gracilis* and *E. uintensis*, and are intermediate in size between the two types.

Epihippus parvus sp. nov.

Type locality: White River, Hor. C., Uinta Basin, Utah. *Type speci-*

men: Both upper and both lower jaws and fragments of the skeleton (Am. Mus. Coll., No. 2038, Coll. by Exp. of 1895).

Characters of type: (1) Parastyle very prominent, (2) mesostyle complete and compressed antero-posteriorly into a sharp ridge, (3) p³ and p⁴ similar to molars, (4) p² with a strong postero-internal cusp and an incipient cusp at the antero-internal angle of the tooth, (5) m₃ with a very much reduced heel.

Measurements of Type.

	mm.		mm.
p ¹ -m ³ (approx.)	42.	p ₃ -m ₃	36.
m ¹ - ³	20.	m ₁ - ₃ (approx.)	23.5
m ¹ antero-post. diam.	7.	m ₃ antero-post. diam.	9.
" transv. "	9.	" transv. "	4.5
m ³ antero-post. "	6.5	p ₄ antero-post. "	6.3
" transv. "	9.	" transv. "	4.3
p ⁴ antero-post. "	5.5		
" transv. "	7.8		

The distinguishing characters are the small size, the great development of parastyle and the compressed mesostyle.

Referred specimens: No. 2066 (Am. Mus. Coll.) comprising an upper and lower jaw, apparently represents a large variety of this species. It is intermediate in size between *E. gracilis* and *E. parvus* but has the characters of mesostyle and parastyle found in the latter.

STATUS OF GENERA AND SPECIES AS HERE TREATED, IN CHRONOLOGICAL ORDER IN THEIR RESPECTIVE HORIZONS.

	{ <i>index</i> Cope. <i>angustidens</i> Cope, includes <i>cuspidatus</i> Cope. <i>cristonensis</i> Cope, includes <i>loevii</i> Cope. <i>validus</i> Marsh.		
<i>Eohippus</i> (Wasatch)		<i>etsagicus</i> Cope.	
		<i>cristatus</i> Wortman.	} <i>vasacciense</i> Cope <i>tapirinum</i> Cope <i>pernix</i> Marsh
		<i>montanus</i> Wortman.	
		<i>resartus</i> sp. nov.	
		<i>borealis</i> sp. nov.	
Indet. types.			
(Wind River)	{ <i>craspedatus</i> Cope. <i>venticolus</i> Cope.		

	}	<i>pumilus</i> (<i>Lophiodon</i>) Marsh, includes <i>procyoninus</i> Cope.			
		<i>ballardi</i> Marsh, includes <i>cinctus</i> Cope.			
		<i>typicus</i> nom. nov. (to replace <i>O. pumilus</i> Marsh, preoccupied).			
		<i>major</i> Marsh.			
Orohippus (Bridger)		<i>osbornianus</i> Cope.			
		<i>atavus</i> sp. nov.			
		<i>progressus</i> sp. nov.			
		}	<i>sylvaticus</i> Leidy.	} Subgenus <i>Aminippus</i> nom. nov. (to re-	
			<i>uintanus</i> Marsh.		place <i>Orotherium</i> Marsh, preoccupied).
			<i>agilis</i> Marsh.		
Epihippus (Uinta)	}	<i>gracilis</i> Marsh, includes <i>uintensis</i> Marsh.			
		<i>parvus</i> sp. nov.			

OBSERVATIONS ON PREMOLAR DEVELOPMENT.

One of the progressive characters of the Eocene Horses is the gradual

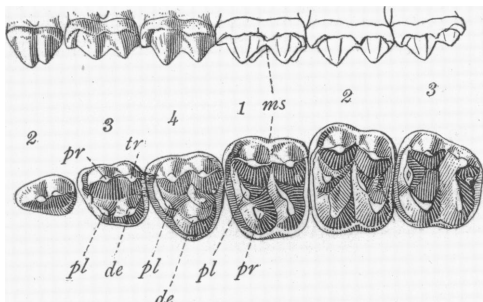


Fig. 3. *Eohippus venticolus*. Upper teeth, side and crown views. $\times \frac{1}{3}$. (After Wortman.)

molarization of the second, third and fourth premolars in both the upper and lower jaws. Dr. Wortman discusses in his paper on the Wasatch and Wind River Hyracotheres¹ the premolar evolution in the American horses and takes issue with Prof. W. B. Scott as to the method by which the quadritubercular condition of the third and fourth upper premolars of the Upper Eocene Hyracotheres has been brought about from the tritubercular condition of these teeth in the Lower Eocene forms.

Prof. Scott states in his article on the evolution of the mammalian premolar teeth² that the fourth cusp is added, in the fourth premolar at least, always at the postero-internal angle of that tooth. Dr. Wortman's studies of the Hyracotheres, however, led him to conclude that in this group the process of development has been different, and he says: "In the horse series of America, however, the addition of this fourth main element to the crowns of the superior premolars has pursued an entirely different course, and

¹ *Loc. cit.*, p. 106.

² Proc. Acad. Nat. Sci. Phil., 1892, p. 414.

instead of appearing at the postero-internal angle of the crown *it has been added at the antero-internal angle.* The proof of this assertion is to be seen in the third and fourth superior molars of *Hyracotherium index* and *Protorohippus venticolus.*”

My own conclusions, based upon much more extensive material than Dr. Wortman had, especially from the important Bridger stage, are that in

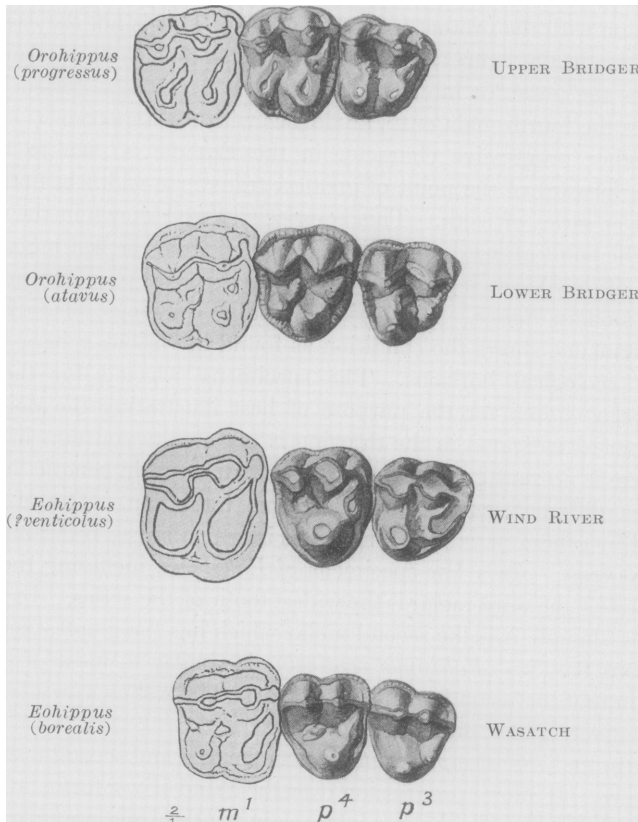


Fig. 4. Four stages of Eocene Horses, to show development of internal cusps on the upper premolars.

the fourth premolar this fourth cusp has been added, as Prof. Scott states, at the *postero-internal angle*, while in the third premolar it has been added at the *antero-internal angle.* The mode of development is, therefore, different in the two teeth, a fact which may account for the advancement of the third over the fourth premolar in the process of development as shown in some Wind River horses. Apparently Dr. Wortman’s error was due to

the fact that he did not have a fourth premolar of *Orohippus* for comparison, and in assuming that the method of development was the same in the fourth as in the third premolar. In *Eohippus venticolus* there are in the fourth premolar three principal cusps, two external and one internal, also two smaller cusps occupying the position of intermediates. The anterior one of these latter, the protoconule, Wortman believes to be the cusp which is destined to become, in *Orohippus*, the fourth principal cusp, corresponding in position with the protocone of the molars. This is not the case, however, as is shown in the figures; the protoconule remains as an intermediate cusp and it is the posterior intermediate which is eventually shifted inward and becomes the fourth main cusp, analogous with the hypocone.

Another progressive character in the Equidæ is seen in the gradual shifting forward of the point of greatest transverse width in both the upper and lower series of teeth. This is especially well shown in the lower teeth, where the point of maximum width is shifted from the last molar, in certain species of the Wasatch genus *Eohippus*, to the third premolar in individuals of the modern *Equus*. The series of outline drawings, made from careful measurements, shows the condition as found in various genera in the successive geological horizons. The specimens selected for these outlines have been chosen for the purpose of best illustrating the point, and the character as indicated in the drawing is not always constant in that genus, but there is no very great variation to be found within generic limits or even between different genera from the same formation. The characters exhibited by genera in various formations in which horses occur are as follows:

WASATCH.—In a few specimens of *Eohippus*, including the type of *E. cristonensis*, the third molar is the widest tooth of the series. In the majority of cases, though, it is the second molar which has the greatest width.

WIND RIVER.—*Eohippus venticolus* is similar to most of the Wasatch forms in that the second molar is the widest, but it shows an advancement in the relatively wider premolars.

BRIDGER.—*Orohippus uintanus* has the first and second molars of about equal size. It shows progression over the Wind River forms in the reduced third molar and in the further increase in width of the premolars.

UINTA.—In *Ephippus* the first molar is usually slightly wider than the second, a condition not found in any Bridger horses.

OLIGOCENE.—In the genus *Mesohippus* the fourth premolar is quite uniformly the widest tooth of the series and there is a marked reduction of the molars.

MIOCENE.—*Hypohippus* and other Miocene genera show an advance over Oligocene forms in reduction of molars and in having the third and fourth premolars of nearly equal width.

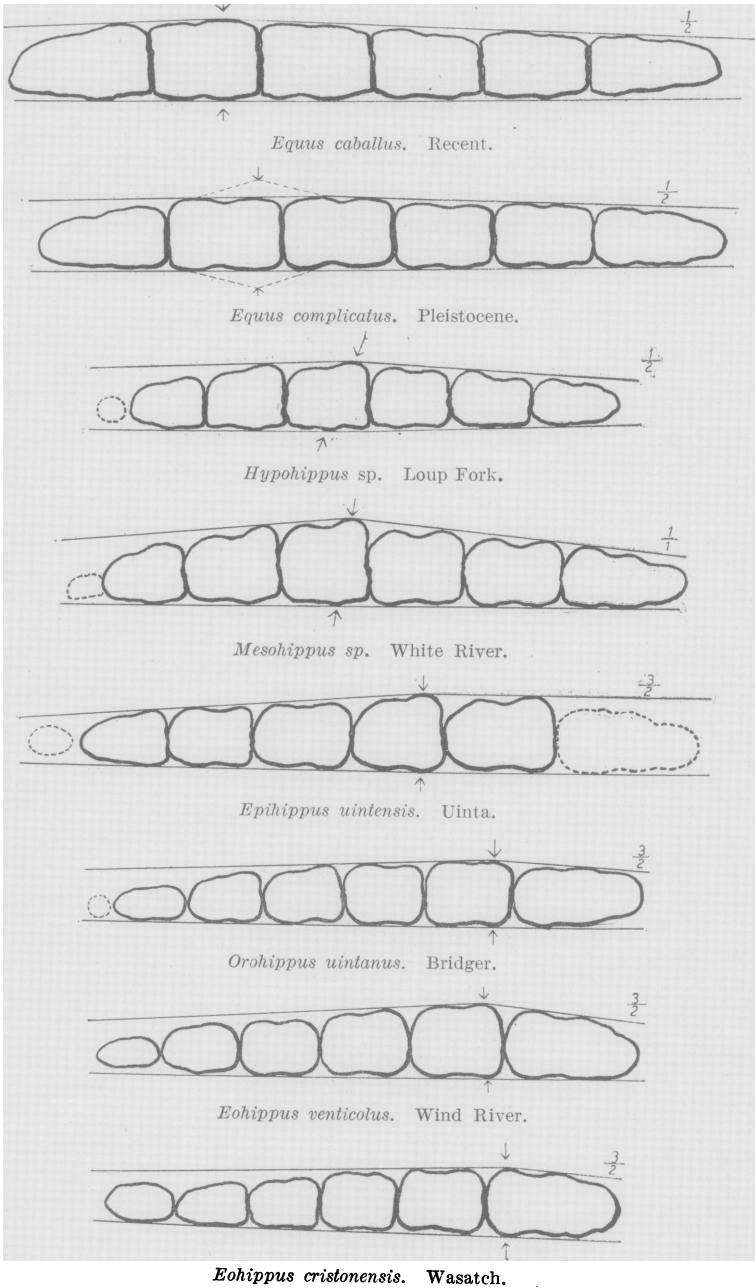
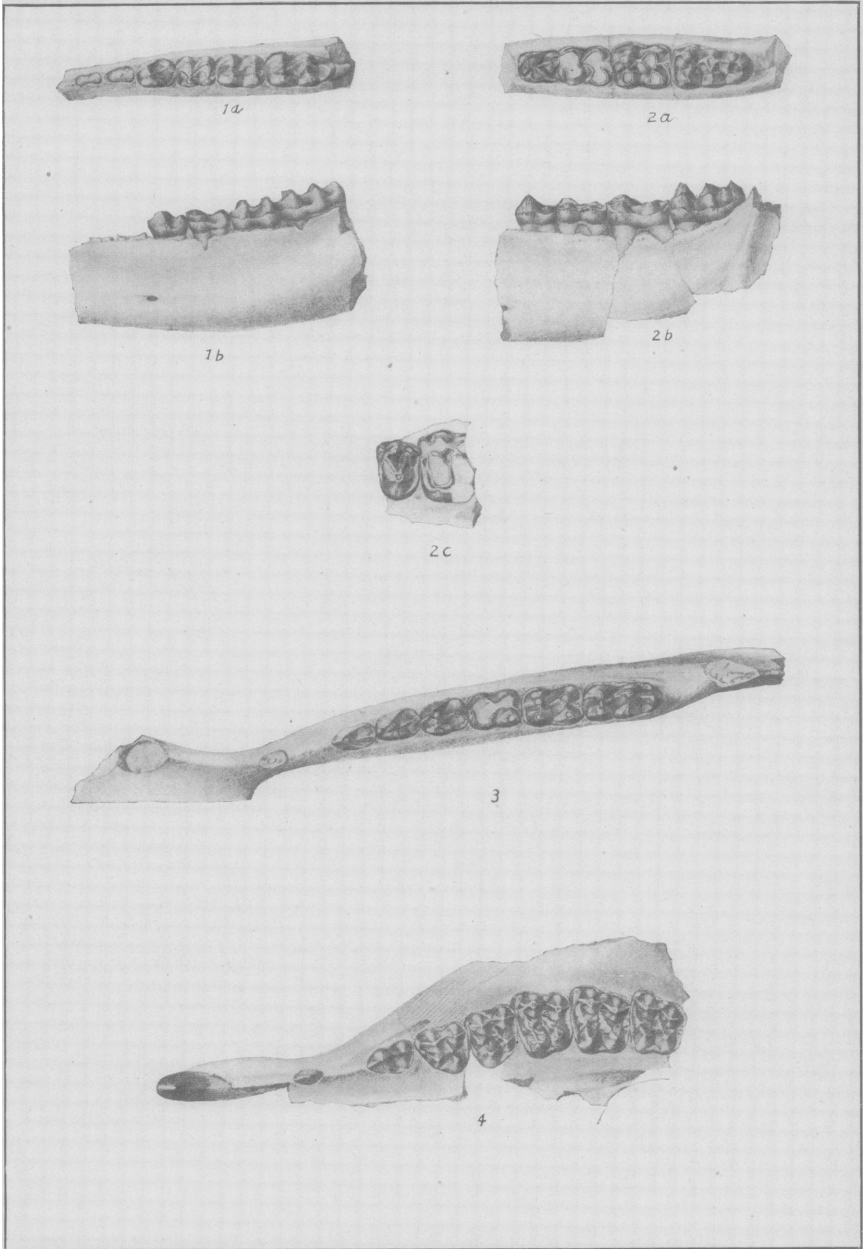


Fig. 5. Accurate outlines of lower cheek teeth of Equidæ. Arrows indicate point of greatest transverse diameter in each series, ranging from the third molar in the Wasatch species to the third premolar in the modern *Equus*.

PLEISTOCENE.— In nearly all specimens of Pleistocene horses the third and fourth premolars are the broadest of the series and of nearly equal width.

RECENT.— There is an occasional specimen of the modern *Equus* in which the third premolar is the widest tooth of the series, a condition not observed in any of the Pleistocene species. The second premolar is relatively larger than in any fossil forms examined.



WASATCH AND LOWER BRIDGER HORSES.

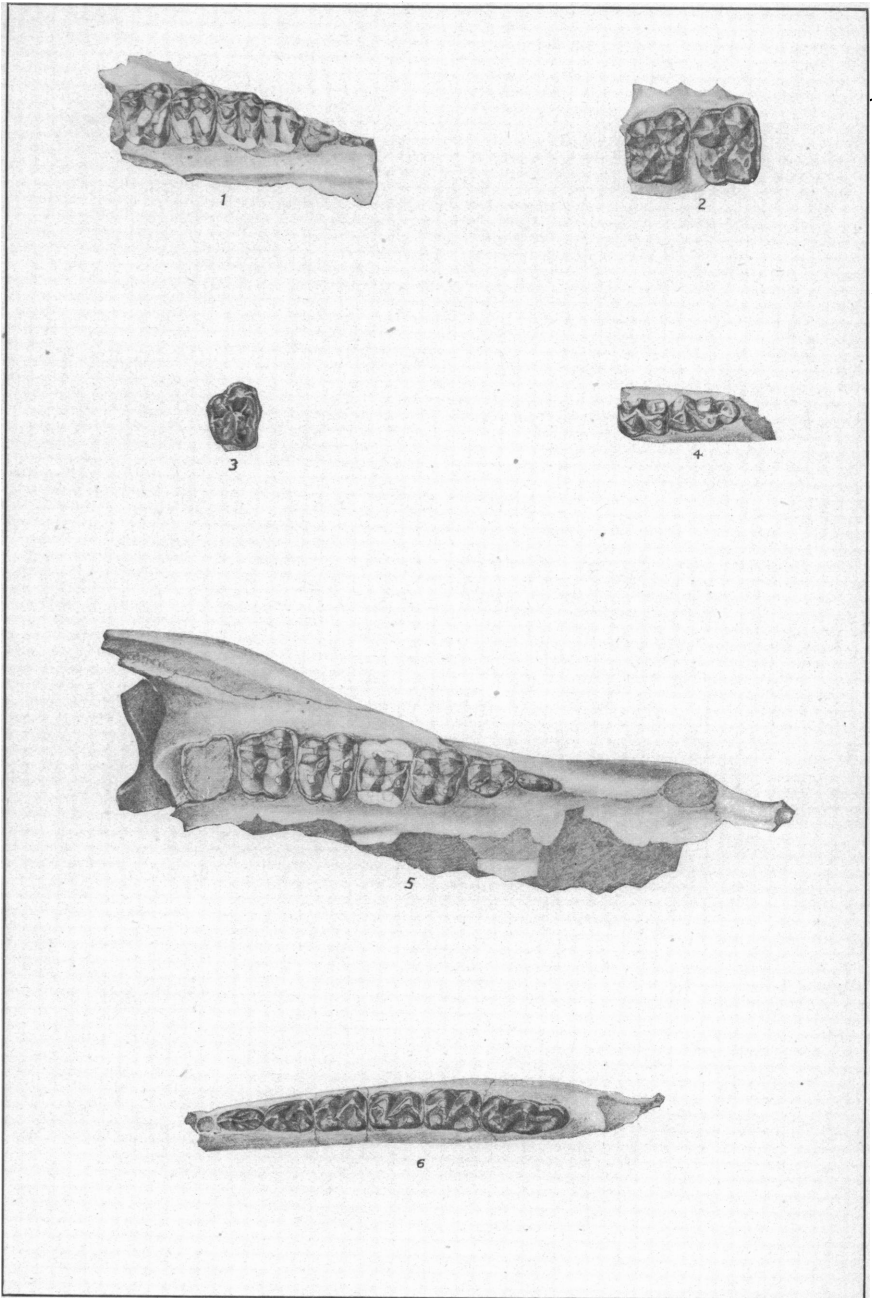
All figures natural size.

Fig. 1. *Eohippus index* Cope. Type. Amer. Mus. Coll. a, crown view, b, outer view of lower jaw.

Fig. 2. *Eohippus validus* Marsh. Type. Yale Mus. Coll. a, crown view and b, outer view of lower jaw; c, crown view of fourth upper premolar and first molar.

Fig. 3. *Eohippus borealis* Granger. Type. Amer. Mus. Coll.

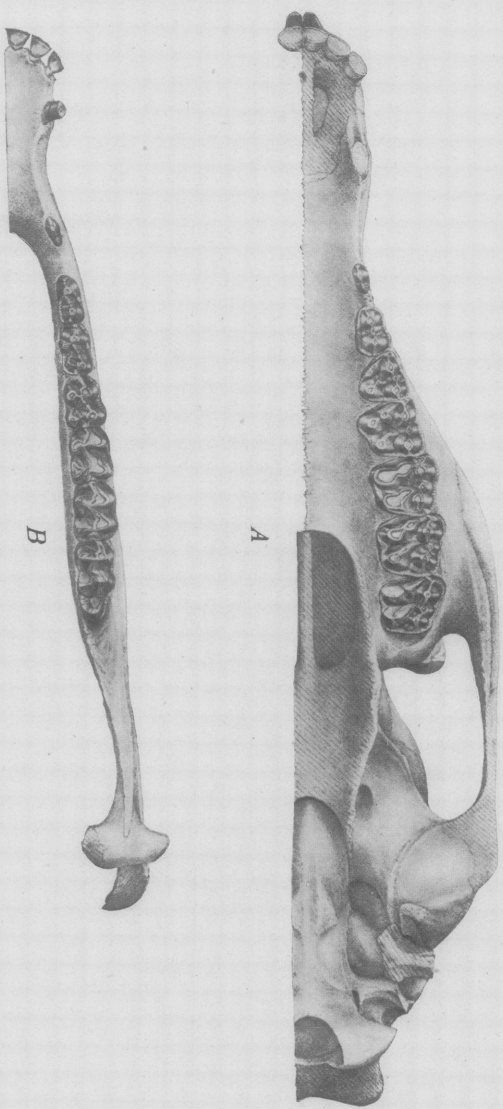
Fig. 4. *Orohippus atavus* Granger. Type. Amer. Mus. Coll.



BRIDGER HORSES.

All figures natural size.

- Fig. 1. *Orohippus (Lophiodon) pumilus* Marsh. Type. Yale Mus. Coll.
 Fig. 2. *Orohippus major* Marsh. Type. Yale Mus. Coll.
 Fig. 3. *Orohippus typicus* Marsh. Type. Yale Mus. Coll. Third upper molar, right.
 Fig. 4. *Orohippus ballardi* Marsh. Type. Yale Mus. Coll.
 Fig. 5. *Orohippus agilis* Marsh. Type. Yale Mus. Coll.
 Fig. 6. *Orohippus uintanus* Marsh. Type. Yale Mus. Coll.

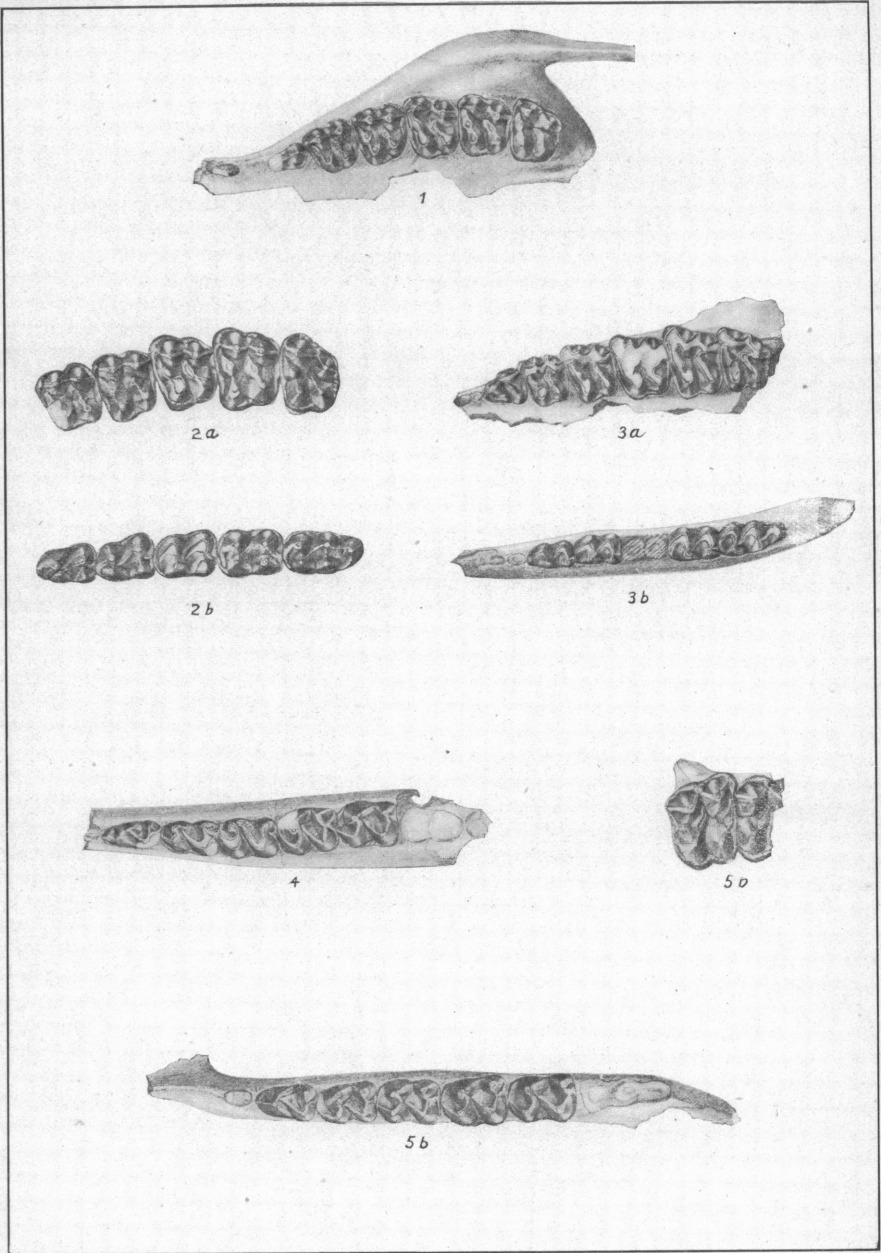


A

B

BRIDGEER HORSES.

Orohippus osbornianus Cope. Amer. Mus. Coll. No. 12648. A, skull. B, lower jaw. Nat. size.



UPPER BRIDGER AND UINTA HORSES.

All figures natural size.

- Fig. 1. *Orohippus progressus* Granger. Type. Amer. Mus. Coll.
 Fig. 2. *Orohippus sylvaticus* Leidy. Amer. Mus. Coll. No. 12649. *a*, upper teeth, *b*, lower teeth.
 Fig. 3. *Epihippus parvus* Granger. Type. Amer. Mus. Coll. *a*, upper teeth, *b*, lower teeth.
 Fig. 4. *Epihippus gracilis* Marsh. Type. Yale Mus. Coll.
 Fig. 5. *Epihippus uintensis* Marsh. Type. Yale Mus. Coll. *a* first and second upper molars of right side, *b*, lower jaw.

