IV.—*Fossil horses of the Oligocene of the Cypress hills, Assiniboia.*

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(Read May 25, 1905.)

Among the fossil vertebrate remains obtained by the writer during an expedition to the Cypress hills on behalf of the Geological Survey in 1904 are a number of horse teeth that are of special interest. These teeth are from the Oligocene deposits, at the eastern end of the hills, in Bone coulée, where the greater part of the collection of last year was made. They form the subject of the present paper, and are described in detail, as the majority of the species represented, of which there are a number, appear to be new. It is surprising to find in them so marked a variation, coming as they do from a rather restricted area.

The deposits capping the Cypress hills, from which the collection of 1904 and the previous collections of 1883-84 (also from Bone coulée) were obtained, are referred to as of Miocene age by McConnell in his report of 1885.[1] Cope, from a study of the 1883-84 collections, concluded that these beds are of Oligocene or Lower Miocene age.[2] Matthew has assigned them to a more definite horizon at the bottom of the Oligocene, expressing the opinion that they are probably of approximately the same age as the Titanotherium beds at Pipestone springs, Montana.[3] Judging from a study of the vertebrate remains included in the 1904 and previous collections from the Cypress hills, the writer believes that the deposits in question include, besides beds of the horizon of the Titanotherium beds of Montana and Dakota, the equivalents of the Oreodon beds of a slightly higher horizon, and of probably the still later Upper Oligocene beds, in part at least. This conclusion regarding the precise age of these deposits is reached more particularly from a study of the fossil remains described in this paper. Amongst these

[1] Report on the Cypress hills, Wood mountain and adjacent country, &c., by R. G. McConnell. Part C., Annual Report, 1885. Geological and Natural History Survey of Canada.

[2] The Species from the Oligocene or Lower Miocene beds of the Cypress hills, by E. D. Cope. Contributions to Canadian Palæontology, Vol. III (quarto), Part 1, 1891. Geological Survey of Canada.

[1] The fauna of the Titanotherium beds at Pipestone Springs, Montana, by W. D. Matthew. Bull. of the American Museum of Natural History, Vol. XIX., Article VI., 1903.

remains are representatives of species of decidedly primitive character, such as are to be expected from the Titanotherium (Lower Oligocene) beds; others are of a more advanced type, and approach closely to species known to occur in the Middle (Oreodon) and Upper Oligocene beds.

The conglomeritic nature of the majority of the Oligocene beds of the Cypress hills accounts for the generally scattered and often worn condition of the fossil remains found there, and the isolated state of the exposures, outcropping for the most part in grassy slopes, adds to the difficulty of gauging the relative development of the horizons represented.

The writer has lately had the advantage of an expression of opinion, regarding the affinities of the species represented by the horse teeth from the Cypress hills, from Mr. J. W. Gidley, of the United States National Museum, Washington. Mr. Gidley, who for some years has made a special study of North American fossil horses, very kindly examined the specimens described in this paper, and for his valuable advice and help the writer takes this opportunity of expressing his indebtedness.

MESOHIPPUS WESTONI, Cope.
Plate II, figs. 1, 1a, 1b and 1c.

Anchitherium sp. indet, Cope, 1885. American Naturalist, vol.xix., p. 16. The White river beds of Swift Current river, Northwest Territory.

Anchitherium westoni, Cope, 1889. Ibid, vol. xxiii, p. 153. The vertebrata of the Swift Current river, II.

Mesohippus westonii, Cope, 1891. Contributions to Canadian Palæontology, vol. iii (quarto), pt. i. The species from the Oligocene or Lower Miocene beds of the Cypress hills, p. 20, pl. xiv., figs. 1, 2, 2a.

Mesohippus westoni, Osborn, 1904. Bulletin Amer. Mus. Nat. Hist., vol. xx., New Oligocene horses, p. 169.

Mesohippus westoni, Lambe, 1905. American Geologist, vol. xxxv, p. 243, pl. xiv, figs. 1-4. On the tooth-structure of Mesohippus westoni (Cope).

The type material of this species, from Bone coulée, Cypress hills, consisting of a right upper molar, and two right lower molars in place in a fragment of the mandible, is in the museum of the Geological Survey at Ottawa.

A right upper molar collected by the writer in 1904 is referred to this species. The upper molar described by Cope is imperfect, the outer slope of the ectoloph is missing and the anterior part of the tooth, including the protoloph, is much damaged.

The crown of the molar obtained last summer is practically perfect, and has been subjected to little use during the life of the animal; it is regarded as the second molar, and is shown in figures 1, 1a-c of plate II. This tooth is brachyodont, with well developed low cross crests (protoloph and metaloph). The crown, seen from below, is suboblong in outline, transversely broader in front than behind, and relatively narrow in an antero-posterior direction. The outer border (ectoloph) rises higher than the cross crests. The latter are unequal in length, the protoloph being longer and better developed than the metaloph. The intermediate cusps (protoconule and metaconule) are both well defined, although the protoconule is larger than the metaconule, and more distinctly separated from the protocone than is the metaconule from the hypocone. The protocone is slightly larger at its base than the hypocone, but both have about the same height. There is no hypostyle. The parastyle is large and adds considerably to the crown's anterior transverse diameter. The mesostyle and metastyle are distinct, and the ribs are distinguishable, the anterior one being the better defined of the two. The cingulum is well developed, and passes from the metastyle entirely round the inner side of the crown to the parastyle without interruption, except for a short distance on the front inner slope of the protocone; it connects in front with the parastyle, with which the outer end of the protoloph shows a marked tendency to unite. Outwardly, the cingulum rises on to the parastyle, but does not cross it.

M. westoni, judging of its dental characters principally from the molar obtained last summer, approaches closely to *M. latidens*,[1] Douglass in tooth-structure, but its molars are distinguished principally by the presence of an internal cingulum, by the less pronounced parastyle and a proportionately greater antero-posterior diameter, with the protoloph more nearly equal in length to the metaloph, as well as by other characters. *M. celer*,[2] March and *M. montanensis*,[3] Osborn, are two other nearly related but apparently distinct species from the Lower Oligocene. The presence of the highly developed internal cingulum is one of the most interesting characters in the dentition of *M. westoni*. This character together with the absence of a hypostyle points to this species being probably the most primitive of the known horses of Oligocene age.

[1] Annals of the Carnegie Museum, Vol. II, No. 2, 1903. New Vertebrates from the Montana Territory by Earl Douglass, p. 161, fig. 7.

[2] American Journal of Science, Vol. VII, 1874, p. 251.

[3] 1904, op. cit.

No additional teeth from the lower jaw were obtained last summer. Figures of the two lower molars are given in Cope's memoir of 1891.

Measurements of upper molar of M. westoni, obtained in 1904.		Measurements of type molar of M. westoni as given by Osborn.	Measurements of M^1 (type) of M. montanensis as given by Osborn.
Transverse diameter.....	.013	.012+	.014
Antero-posterior diameter	.0102	.0095	.0105
Height of protocone.....	.0045		
Height of hypocone..... ...	.0045	.004—	
Height of ectoloph.....	.0062	.005+	

Mr. Gidley is of the opinion that the tooth collected last year approaches more closely to *M. montanensis* than to *M. westoni,* and is inclined to refer it to the former species with some degree of doubt. In comparing it with *M. montanensis* he notes the somewhat less elevated inner cones and the presence of an internal cingulum, which he regards as differences of perhaps not more than varietal value which may be explained by calling the tooth a premolar instead of a molar.

Judging from the characters of the teeth and their size it is evident that the two species *M. westoni* and *M. montanensis* approach each other closely. The type of *M. westoni* is not as well preserved (nor as accurately figured in the original description) as is desirable, and the absence of the ectoloph and the anterior margin, including the front slope of the protoloph, precludes the taking of exact measurements. That the tooth of last summer's collecting (figures 1, 1a-c) comes from the same locality as the type of *M. westoni,* and that it has a particularly well defined internal cingulum are facts worthy of every consideration in determining its specific affinity.

MESOHIPPUS PRÆCOCIDENS, sp. nov.

Plate II, fig. 2.

Left upper molar (imperfect).

Measurement:

Height of protocone.... .0047

It is with some hesitation that the writer designates this tooth by a new specific name which may be considered entirely provisional until more perfect material is available. The tooth lacks the ectoloph and the posterior border with the hinder slope of the hypocone, but is otherwise

well preserved. The characters presented will not admit, in the opinion of the writer, of its assignment to any already described species; all point to its probable specific distinctness.

This tooth is about the size of, or possibly smaller than, *M. westoni,* but is more progressive in every way. There is an entire absence of an internal cingulum, the cross crests are better developed and relatively higher with steeper slopes. The protoconule is relatively larger, and the metaconule, although defined, scarcely breaks the continuity of the metaloph which unites in a decided manner with the ectoloph. The protoconule is distinctly defined in the protoloph and connects closely with the forward slope of the paracone. The hypocone has about the same height as the protocone. The anterior cingulum is strong. Mr. Gidley informs the writer that he "would expect to see the hypostyle well developed were that portion of the tooth present."

MESOHIPPUS PROPINQUUS, sp. nov.
Plate II, figs. 3 and 4.

2nd right upper premolar, worn (*figure* 4).
2nd left upper molar, unworn (*figure* 3).
2nd right upper molar, unworn.

The above teeth characterize a species of Mesohippus that is regarded as distinct from *M. bairdi,* Leidy, although closely allied to it and most resembling it.

They are of nearly the same size as those of *M. bairdi,* if anything slightly larger, and on the whole more primitive. Their general proportions are somewhat different.

Measurements:
p^2 *a. p.* ·013 *by tr.* ·0135.
m^2 *left, a. p.* ·012 *by tr.* ·0155, *height of protocone* ·005, *height of hypocone* ·0057, *height of ectoloph* ·008.
m^2 *right, a. p.* ·0122 *by tr.* ·015.

In the unworn tooth, figure 3 (left upper m^2), the ectoloph is well elevated above the cross crests in which the protocone and hypocone are conspicuously higher than the conules. The hypocone exceeds the protocone in height. The protoconule is well defined and distinctly breaks the continuity of the protoloph. The metaloph is fairly continuous and shows a disposition to unite with the ectoloph which, however, it does not reach. The hypostyle is connected at its inner end with the

posterior cingulum and outwardly abuts against the ectoloph; it is of fair size. In the ectoloph the mesostyle is conspicuous, the parastyle is flattened and connects with the protoloph, and the ribs are faintly shown. There is no trace of an internal cingulum.

Mr. Gidley has drawn the writer's attention to the interesting fact that the protocone in these teeth "is peculiar in having the slope of its anterior face about equal to that of its posterior face," while in *M. bairdi* and all the middle and upper Oligocene horses the anterior face of the protocone is always much more abrupt than the posterior one."

A right upper molar, presumably the third, arbitrarily associated with the foregoing, is considerably larger than the corresponding tooth of *M. bairdi*. A flatness of the ectoloph is principally noticeable, as well as the smallness of the hypocone, otherwise its characters are very similar to those of the left upper second molar already mentioned.

MESOHIPPUS BRACHYSTYLUS, Osborn.
Plate II, fig. 5.

4th left upper premolar, worn (*figure* 5).

Measurement:

p^4 *a. p.* ·0125.

A fourth left upper premolar is referred to this species. The internal cingulum is slightly more accentuated than in the corresponding tooth of the type, but the general proportions and the size seem to be the same. In the Cypress hills specimen the greater part of the ectoloph is unfortunately missing, but enough remains of its anterior end to show that the parastyle was rounded and of a relatively large size. There are certain slight differences of detail to be noticed but nothing apparently of importance.

The type of *M. brachystylus* is from the Upper Oligocene, Leptauchenia beds of the Cheyenne river, South Dakota, U.S.A.

MESOHIPPUS STENOLOPHUS, sp. nov.
Plate II, figs. 6, 6a and 6b.

1st left upper molar, unworn.
3rd right upper molar, unworn (*figures* 6, 6*a*, 6*b*).

Measurements:

m^1 *a. p.* ·014.
m^3 *a. p.* ·0125, *by tr.* ·015.

These teeth represent an apparently undescribed species of *Mesohippus* larger than *M. brachystylus*, but resembling it in some particu-

lars. The differences noticed are: (1) the greater relative size of m^3 with a more pronounced obliquity of the cross crests in these teeth; (2) the greater length of the metaloph, which in m^3 is connected with the ectoloph, and (3) the intimate connection of the hypostyle with both the posterior cingulum and the metastyle. The resemblances are:—(1) somewhat similar general proportions with about the same degree of development of the protoconule and a like suppression of the metaconule; (2) the parastyle and internal cingulum similarly developed.

A special character of *M. stenolophus,* seen in m^3, is the oblique crossing of the parastyle by the external cingulum which rises rapidly from without and appears very distinctly on the upper anterior surface of the style (figures 6a, 6b). The cross crests are narrow in proportion to their height, a feature suggested in the name given to the species.

MESOHIPPUS PLANIDENS, sp. nov.
Plate II, fig. 7.

1st and 2nd left upper molars, worn.

Measurements:
m^1—m^2 ·031.
m^1 *a. p.* ·015 *by tr.* ·0178.

These teeth indicate a species of about the size of *M. intermedius,* Osborn and Wortman, from the Upper Oligocene, Protoceras beds of South Dakota, but smaller than *M. validus,* Osborn, from the same horizon and state. They differ from those of *M. intermedius* in the greater obliquity of the protoloph and metaloph in which respect they resemble those of *M. obliquidens,* Osborn. The teeth are brachyodont, and are devoid of an internal cingulum. Externally the ectoloph is noticeably flat with only a slight development of the parastyle and mesostyle, the ribs are absent or but feebly indicated, and the metastyle is particularly inconspicuous. The hypostyle is of fair size, curved and attached at either end to the posterior cingulum. The cross crests are oblique to the ectoloph, well elevated, and moderately continuous, the metaloph more so than the protoloph. The protoconule slightly interrupts the protoloph and unites with the parastyle. The metaconule scarcely breaks the continuity of the metaloph which is sharply separated from the ectoloph and developes a rudimentary crochet. The protocone and hypocone are not so elevated as the ectoloph.

The specific name has reference to the flattened condition of the ectoloph.

MESOHIPPUS ASSINIBOIENSIS, sp. nov.
Plate II, figs. 8, 8a and 8b.

2nd right upper premolar, unworn.

Measurements:

p^2 *a. p.* .0185 *by tr.* .017, *height of tritocone,* .0105 *height of tetartocone* ·008.

This species is larger than *M. intermedius,* Osborn and Wortman, and apparently than *M. validus,* Osborn, from the Protoceras beds of South Dakota. It resembles *M. brachystylus,* Osborn, from the Leptauchenia beds of South Dakota, in the great development of the parastyle which is, however, more distinctly separated in the Cypress hills species.

In the above tooth (p^2) the antero-posterior diameter is greatly increased by the separation and large size of the parastyle. The cross crests are short, steep sided and set almost at right angles to the ectoloph. The two inner cusps (deuterocone and tetartocone) are strongly and about equally developed. The protoconule[1] (anterior intermediate conule) is very much smaller than the metaconule (posterior intermediate conule), and passes posterior to and beyond the inner end of an inwardly directed spur from the protocone (antero-external cusp of the premolar, adopting Scott's nomenclature). The ectoloph has a distinct mesostyle, a broadly rounded and well detached parastyle, and strong ribs of which the anterior one is particularly rotund. The hypostyle tends to separate from the posterior cingulum to which it remains connected by a stout bar. The cingulum is robust, high and sharp edged behind, low and forming a narrow shelf, abutting against the base of the parastyle, in front, and is entirely absent within. The external cusps (protocone and tritocone) rise considerably higher than the internal ones (deuterocone and tetartocone).

This species, known only from the second premolar in which the size of the parastyle would be expected to be accentuated, appears to approach most nearly in tooth development to the much smaller *M. brachystylus.* It exceeds *M. intermedius* and *? M. validus* in size, of which it apparently more closely resembles the latter. It is distinguished from the last two species by (1) the greater development of the protocone and deuterocone in this species, (2) the slight development of the protoconule, (3) the more complete separation of the parastyle, and (4) the intermediate height of the ectoloph.

[1] It has been pointed out by Scott (The Evolution of the Premolar Teeth in the Mammals, Proc. Acad. Nat. Sci., Philadel., Vol. XLIV, 1892) that the anterior and posterior intermediate conules of the premolar tooth are not homologous with the proto—and metaconules of the molar although they correspond in position.

The foregoing species described in this paper are related to or resemble previously described species from Montana and Dakota as follows:—

M. westoni, Cope....	More primitive than M. latidens, Douglass and M. montanensis, Osborn from the Lower Oligocene, Titanotherium beds.
M. præcocidens, sp. nov.	Nearly related to and more advanced than M. westoni (and ? M. montanensis of the Titanotherium beds).
M. propinquus, sp. nov.	Nearly related to and more primitive than M. bairdi, Leidy of the Middle Oligocene, Oreodon beds.
M. brachystylus, Osborn	The type of the species is from the Upper Oligocene, Leptauchenia beds.
M. stenolophus, sp. nov.	Approaches closely M. brachystylus of the Leptauchenia beds.
M. planidens, sp. nov.	Approaches in size M. intermedius, Osborn and Wortman from the Upper Oligocene, Protoceras beds.
M. assiniboiensis, sp. nov.	Some resemblance to but ? larger than M. validus, Osborn of the Protoceras beds.

It would seem probable then that the species from the Cypress hills, in their relative degrees of progressiveness, are to be assigned to the horizons of the Oligocene in the following order:—

M. westoni..... M. præcocidens.....	Lower Oligocene, Titanotherium beds.
M. propinquus	Middle Oligocene, Oreodon beds.
M. brachystylus ..... M. stenolophus.....	Upper Oligocene, Leptauchenia beds.
M. planidens..... M. assiniboiensis.....	Upper Oligocene, Protoceras beds.

Plate II.

Figure 1. —Inferior view of crown of upper molar of *Mesohippus westoni*; twice the natural size.

Figure 1a.—Exterior aspect of the same; twice the natural size.

Figure 1b.—The same viewed from within; twice the natural size.

Figure 1c.—Anterior view of the same; similarly enlarged.

Figure 2. —Inferior view of crown of upper molar of *Mesohippus præcocidens*; natural size.

Figure 3. —*Mesohippus propinquus.* View of crown of upper molar from below; of the natural size.

Figure 4. —*Mesohippus propinquus.* A similar view of an upper premolar; natural size.

Figure 5. —Crown of upper premolar of *Mesohippus brachystylus,* viewed from below; natural size.

Figure 6. —Inferior view of crown of upper molar of *Mesohippus stenolophus*; natural size.

Figure 6a.—The same tooth viewed from without; natural size.

Figure 6b.—Anterior aspect of the same tooth; natural size.

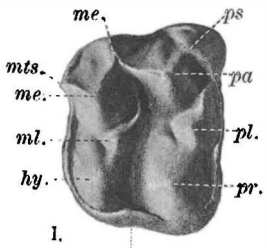
Figure 7. —*Mesohippus planidens.* Crowns of two upper molars viewed from below; natural size.

Figure 8. —*Mesohippus assiniboiensis.* Crown of upper premolar as seen from below; natural size.

Figure 8a.—Exterior aspect of the same; natural size.

Figure 8b.—Posterior view of the same; natural size.

pa., paracone; *me.,* metacone; *pr.,* protocone; *hy.,* hypocone; *pl.,* protoconule; *ml.,* metaconule; *ps.,* parastyle; *ms.,* mesostyle; *mts.,* metastyle; *d.,* deuterocone; *te.,* tetartocone; *tr.,* tritocone.



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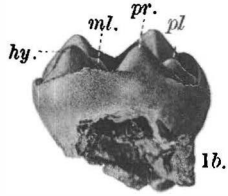

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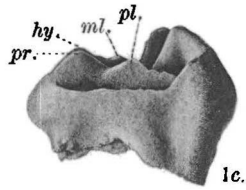


1c.


1a.

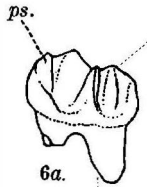

4.


3.


2.


6.


5.



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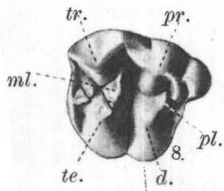

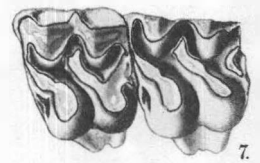
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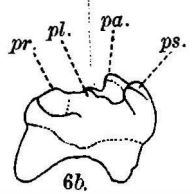

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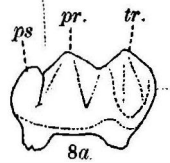

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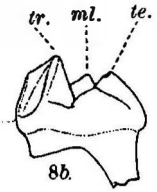

8b.