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MARSUPIALS FROM THE CHADRONIAN (LATEST EOCENE) MEDICINE POLE HILLS LOCAL FAUNA, NORTH DAKOTA

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ABSTRACT

The Medicine Pole Hills local fauna is a very diverse early Chadronian fauna, particularly for smaller taxa. The marsupials represent an important element of the mammalian fauna constituting approximately 15% of all specimens. Included are three didelphid species, *Herpetotherium valens*, *Herpetotherium* sp. cf. *H. fugax* and *Herpetotherium* sp. cf. *H. marsupium*; and two peradectid species, *Peradectes* sp. cf. *P. californicus* and *Didelphidectes* sp. cf. *D. pumilis*. This diversity of marsupials has not previously been reported for Chadronian faunas and is more similar to the diversity of Uintan and Duchesnean faunas. The occurrence of *Herpetotherium* sp. cf. *H. marsupium* and *Peradectes* sp. cf. *P. californicus* represent chronologic range extensions from the Duchesnean into the Chadronian. The diverse marsupial fauna, together with previously noted relict taxa in the fauna suggest a late early Chadronian (Ch2) biochron for the fauna.

INTRODUCTION

The first report of fossils from the Medicine Pole Hills was by Leonard (1922) who recovered a brontothere specimen from a gravel pit south of Rhame, in southwestern North Dakota. The first systematic collections from these latest Eocene rocks were made by crews from the Pioneer Trails Regional Museum (PTRM) in 1989 with a preliminary faunal list published by Pearson and Hoganson (1995). Although preliminary, it indicated a diverse vertebrate fauna and subsequent collection of matrix from one of these localities, V89002 (Figure 1), has significantly expanded both the number of recovered specimens and number of taxa. The geology of the locality has been described in a previous paper (Schumaker and Kihm, 2006) and portions of this fauna have been described (Smith, 2006, 2011a, 2011b, 2013; Kihm and Schumaker, 2008, Kihm, 2011, 2013; Kihm and Tornow, 2014).

The marsupials are an important element of the mammalian fauna. They represent the second most abundant order (based on number of specimens) constituting approximately 15% of all mammalian specimens. Five species are recognized in the fauna, a greater diversity than reported from other Chadronian localities and more similar to species diversity reported from older late Eocene faunas. This includes the occurrence of *Peradectes*, the youngest report of this genus. This age range extension of *Peradectes* into the Chadronian is predicated on *Nanodelphys* being a distinct genus (Korth 1994, 2007) rather than a synonym of *Peradectes* (Krishtalka and Stucky 1983a). In addition to *Peradectes*, the fauna include *Didelphidectes* and three species of *Herpetotherium*.

METHODS AND MATERIALS

The marsupial material from the Medicine Pole Hills local fauna consists primarily of isolated teeth. Analysis of the material proceeded by a series of steps. First the specimens were identified as didelphid or peradectid by morphologic characteristics following Korth (1994). Specimens were then identified by tooth position with the realization that the level of certainty of position was not 100%. The third step involved measuring the specimens using an optical micrometer. For the upper molars, the anterior-posterior length was taken as the maximum length perpendicular to a line through the paracone and metacone (Figure 2A-B). This alignment is similar to that used by Eberle and Storer (1995) and anterior-posterior length values are likely slightly less than they would be with the alignment used by Korth (1994) for specimens in jaw fragments. The molar width was taken perpendicular to the anterior-posterior length. For lower molars the total anterior-posterior length, length of the trigonid, width of the trigonid and width of the talonid were taken to allow the most comparisons to published data (Figure 2C). Overall anterior-posterior length values

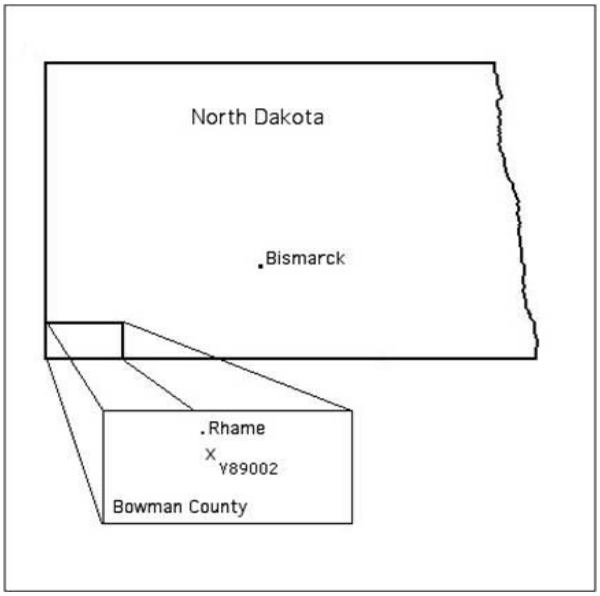

FIGURE 1. Location map of Locality V89002.

may be somewhat greater than if the teeth were in jaw fragments because of variations in orienting the teeth during measurement.

The M1 is probably the most reliably identified tooth, so these data were plotted as a scatter-gram to identify if one or more populations were represented. The data indicated three herpetotherine species (Figure 3A). The herpetotherines included a common mid-sized species, a second less common, smaller species and a rare larger species. The M2 data corroborated this interpretation (Figure 3B). The data of the M3 indicated only two herpetotherine species with the largest (and rarest) species being absent. These species groups were confirmed using the m1 (Figure 4A) and the m2 and m3 (undifferentiated, Figure 4B). In each case the most common species was the mid-sized herpetotherine. Once the species groups were identified based on size, the upper molars of each taxon were analyzed for morphologic variation.

The same type of analysis was applied to the premolar data, but with less conclusive results, in that for some tooth positions only two species appear to be represented (Figures 5-6).

The peradectid specimens were analyzed in the same way. The M2 and m1 data suggested only a single, variable species was present (Figure 7A, C). The M3 data indicated a second larger species (Figure 7B).

This analysis has weaknesses. First, not all isolated teeth may have been correctly identified by tooth position. Second, an assumption based on the size of the M1 may not be valid for other teeth leading to artificially identifying groupings that may not exist. Third, the number of species may be correct, but assignment of individual specimens to species may be in error because of where gaps were perceived to exist. Of note is that no consistent morphologic differences were seen between species of *Herpetotherium* that would allow a specific assignment other than by size.

Abbreviations used in the text are given in Table 1. Stylar cusp designations are shown in Figure 2D. All measurements are in millimeters. All specimens are from Locality V89002 and are deposited in the Pioneer Trails Regional Museum in Bowman, North Dakota.

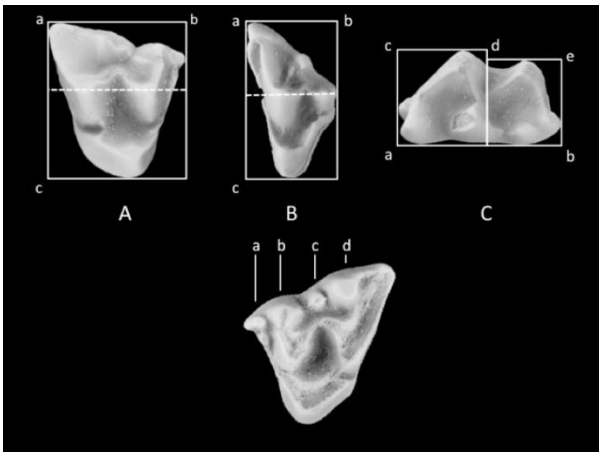

FIGURE 2. Tooth measurements and stylar cusp designations used in this report. A, measurement orientations for M1, 2 and 3, a to b = anterior-posterior length; a to c = width; dashed line is through the paracone and metacone. B, measurement orientation for M4, a to b = anterior-posterior length; a to c = width; dashed line is through the paracone and metacone. C, lower molars, a to b = anterior-posterior length; a to c = trigonid width; c to d = trigonid length; b to e = talonid width. D, stylar cusp designations for a typical upper molar.

SYSTEMATIC PALEONTOLOGY

Order Didelphimorpha Gill, 1872
Family Didelphidae Gray, 1821
Genus *Herpetotherium* Cope, 1873
Herpetotherium valens (Lambe, 1908)
(Figures 3-6, 8; Tables 2-4)

Referred Specimens—RdP3 4939, 5784, 6201, 6252, 7258, 7484, 7686, 10469, 10901, 10906, 14653, 14657, 14661; LdP3 4856, 5435, 5789, 6138, 6255, 7675, 7826, 7836, 8241, 10864, 10880, 14073, 14076, 14080, 14643, 17304; RP2 1368, 5801, 7474, 8281, 10265, 10792, 10827, 14034, 14043, 14045, 14047, 14130, 14615, 14628; LP2 1482, 5902, 8280, 8284, 10254, 10820, 14038, 14622, 17518; RP3 2046, 2619, 4952, 7471, 7900, 8293, 10680, 10683, 10684, 10816, 14612, 17363; LP3 1987, 4954, 8277, 8291, 10263, 10682, 10701, 10800, 10803, 14624, 17361; RP2 or 3

2717,10798, 14617, LP2 or 3 7469, 8286,14044,16015; RM1 1338, 2708, 4794, 4798, 4940, 5436, 5807, 5892, 7253, 7257, 7261, 7362, 7677, 7682, 7684, 7845, 8239, 8245, 8247, 10243, 10249, 10839, 10855, 10861, 10862, 10870, 10912, 10920, 17371, 17372; LM1 1339, 2076, 4844, 4943, 5433, 5800, 7408, 7447, 7680, 7850, 8254, 8255, 8261, 10450, 10463, 10842, 10889, 10900, 10903, 10908, 10916, 17364, 17365, 17367, 17368, 17369; RM2 1340, 2706, 4796, 4800, 4801, 4847, 5776, 5794, 5803, 6220, 7360, 7481, 7683, 7847, 8243, 8256, 10847, 10856, 10865, 10883, 10890, 10904, 10918, 17370; LM2 4795, 4799, 4942, 4944, 5535, 5775, 5849, 5869, 7262, 7482, 7685, 7687, 7821, 7842, 7844, 7846, 10246, 10842, 10871, 10883, 10914, 10917, 17373, 17374, 17375; RM3 1341, 2626, 4804, 4805, 4846, 7255, 7835, 7848, 8248, 8250, 8251, 8258, 10840, 10902, 14985, 17376; LM3 5120, 5434, 5437, 5482, 7252, 7679, 7832, 7837, 7848, 8242, 8257, 8259, 10241, 10458, 10844, 10858, 10866, 10882, 10892; RM4 1334, 4746, 4788, 4857, 7254, 7409, 7829, 7834, 8260, 14093, 14647, 14654, 14656, 17377, 17519; LM4 4719, 4789, 5547, 7251, 7817, 7897, 8246, 8252, 8253, 10239, 10242, 10251, 10451, 10491, 10850, 14085, 14650, 14651, 14652; L dentary 10791; Rdp3 4858, 7676, 7843, 10257, 14072, 14079, 14645; Ldp3 4851,5544,5556,6253, 8228, 14096, 17359, 17520; Rp2 or 3 2718, 5566, 7476, 7488, 7691, 7868, 7871, 7903, 8273, 8276, 8278, 8282, 10694, 10805, 14031, 14037, 14049, 14625, 16016, 16018, 17381; Lp2 or 3 1336, 2693, 7472, 7869, 7906, 8236, 8279, 8290, 10795, 10806, 10807, 10810, 10811, 10814, 10831, 14028, 14036, 14614, 14618, 16017, 17380; Rm1 4753, 4793, 4859, 5430, 5542, 5552, 5810, 5851, 7820, 8233, 8235, 8237, 8238, 10240, 10250, 10455, 10468, 10471, 10472, 10477, 10852, 10869, 10876, 10897, 14083, 14644, 14662, 15019, 17386; Lm1 1941, 1959, 2715, 2719, 5539 , 5559, 5855, 5882, 6250, 7245, 7825, 7840, 8234, 10247, 10454, 10853, 10857, 10872, 10888, 10891, 10913, 14077, 14658, 14660, 17382, 17383, 17385; Lm1-2 10473; Lm1-3 1953; Rm2 or 3 1373, 1940, 1961, 2006, 2011, 2043, 2611, 2710, 2716, 4722, 4723, 4726, 4731, 4739, 4743, 4751, 4807, 4811, 4852, 4854, 4860, 4908, 4909, 5122, 5533, 5545, 5590, 5770, 5809, 5867, 7249, 7681, 7818, 7819, 7822, 7849, 8230, 8232, 10245, 10452, 10457, 10459, 10460, 10461, 10464, 10834, 10845, 10846, 10851, 10854, 10863, 10873, 10874, 10879, 10893, 10895, 10896, 10898, 10899, 10907, 14986, 15020; Lm2 or 3 1337, 1342, 2085, 4724, 4727, 4735, 4808, 4809, 4810, 4862, 4864, 5428, 5429, 5484, 5530, 5569, 5790, 5850, 5856, 5860, 5862, 7246, 7247, 7250, 7434, 7435, 7816, 7827, 7888, 8229, 8231, 10248, 10453, 10835, 10838, 10841, 10848, 10849, 10885, 10894, 10910, 10919, 14095, 14826, 15021, 17387; Rm2-3 15018; Lm2-3 7248; Lm3 10474; Rm3-4 4906; Lm3-4 2633; Rm4 4806, 5124, 5531, 5551, 7366, 10470, 10836, 10837; Lm4 2641, 4730, 5782, 6254, 7866, 10412, 10449, 10456, 10466, 10696, 10833, 14039, 14987.

TABLE 1. Abbreviations used in this report.

Measurements in mm	
AP	Total Anterior-posterior length
Trigonid AP	Anterior-posterior length of trigonid
AP/W	Length vs Width posterior ratio
Trig/AP	Trigonid length vs Total length ratio
Wa	Width anterior
Wp	Width posterior
Teeth	
P, p	Upper premolar, lower premolar
d	Deciduous
M, m	Upper molar, lower molar
R, L	Right, Left
Statistics	
OR	Observed Range
stdev	Standard Deviation
CV	Coefficient of Variation

Description—The dP3 has the metacone generally larger than the paracone although subequal in some specimens. The metacone shows greater wear than does the paracone. The protocone has a preprotocrista, often with a small paraconule. The trigon basin is always closed posteriorly by a postprotocrista. The preprotocrista merges into an anterior cingulum that is typically complete to the parastyle (or stylar cusp A). The parastyle forms a triangular anterobuccal corner of the tooth. On a few specimens, the parastyle is doubled. Stylar cusp D is always present as a well developed, elongate cusp directly buccal to the metacone (Figure 8A). On some specimens stylar cusp C is present on the anterior slope of cusp D (Figure 8B). This cusp may be very small to moderately developed.

The P2 and P3 specimens do not differ in any apparent way, other than size, from the description given by Lillegraven (1976) for these teeth of *Herpetotherium* sp. cf. *H. knighti*. P2 specimens have a variably developed anterior cuspule at the base of a steep slope from the primary central cusp (Figure 8C-D). The posterior slope is a narrow crest, less steep than the anterior slope, that ends in a small to moderate posterior cuspule. The crest is slightly buccal to the midline of the tooth. On some specimens there is a slight development of a cingulum extending from the anterior, or more commonly, the posterior cuspule.

The P2 has it greatest width approximately below the peak of the primary cusp.

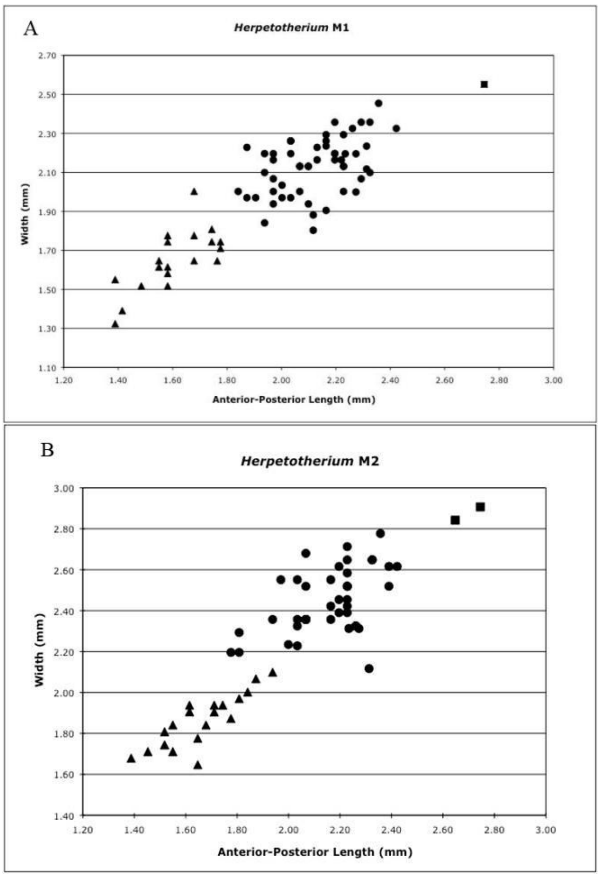

FIGURE 3. Length versus width of *Herpetotherium* upper molars from the Medicine Pole Hills local fauna. A, M1; B, M2. Circles represent *Herpetotherium valens*, triangles represent *Herpetotherium* sp. cf. *H. fugax*, squares represent *Herpetotherium* sp. cf. *H. marsupium.*

The P3 is generally similar to the P2 but larger. The anterior cuspule is present more consistently and the posterior cuspule tends to be better developed (Figure 8E). The ridge from the primary cusp is somewhat more trenchant than on P2 and cingula are better developed both anteriorly and posteriorly. On some specimens, the development of the lingual cingulum from the posterior cuspule creates a minor talon basin. The P3 has its greatest width posterior to the primary cusp.

The M1-M3 match the description and variation described for the species by Eberle and Storer (1995). On M1 stylar cusp B is developed at the buccal end of the preparacrista and cusp D is the largest stylar cusp in all specimens . Typically an anterobuccal spur is present (absent on only 4 of 42 specimens) with about one-third of the specimens showing some development of cusp A. Eighteen of 37 specimens have some development of cusp C, most often as a small cusp on the anterior slope of cusp D. On a few specimens, cusp C is larger and more central, but it is always closer to cusp D than to cusp B (Figure 8F). On three specimens cusp C is doubled (Figure 8G). Nine specimens show development of both cusps A and C and these tend to be the larger specimens (Figure 9A). Those specimens with either cusp A or cusp C alone do not show any correlation to size of the tooth.

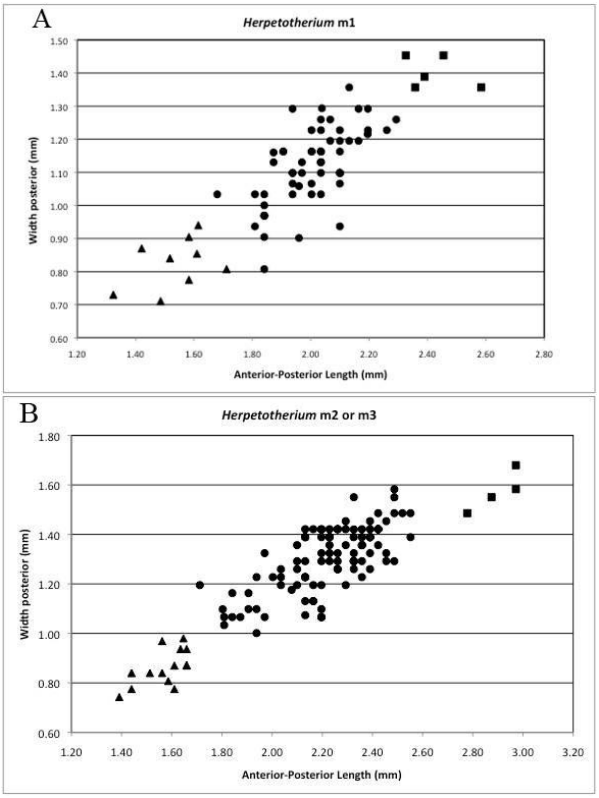

FIGURE 4. Length versus width of lower molars from the Medicine Pole Hills local fauna. A, m1; B, m2 or m3 undifferentiated. Symbols as in Figure 3.

The M2 shows features similar to M1 with cusps B and D present on all specimens (Figure 8H). There is typically an anterobuccal spur (absent on 2 of 36 specimens) with 13 of 36 specimens showing some development of cusp A. On all specimens with a cusp A, cusp C is also present (Figure 9B). Cusp C is present on 26 of 33 specimens, with 18 having cusp C developed on the anterior slope of cusp D (doubled in one specimen). The remaining 8 specimens have cusp C more centrally placed with its base attached to cusp D (Figure 8I). Cusp C is always much smaller than both cusp D and cusp B. Of the sample, 7 of 33 specimens lack both cusp A and cusp C and these tend to be the smaller specimens (Figure 9B). Specimens

with cusp C present or those with both cusps A and C present show no apparent correlation to size.

TABLE 2. Measurements of *Herpetotherium valens* upper teeth from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	stdev	CV
P2	AP	23	1.73	1.51-1.90	0.0977	5.66
	W	23	0.73	0.61-0.83	0.0622	8.54
dP3	AP	24	1.83	1.61-2.00	0.0980	5.37
	W	24	1.76	1.61-2.00	0.1001	5.70
P3	AP	23	1.89	1.73-2.05	0.0896	4.75
	W	23	0.94	0.78-1.07	0.0883	9.39
M1	AP	53	2.12	1.84-2.42	0.1426	6.72
	W	53	2.13	1.80-2.45	0.1452	6.81
	AP/W	53	1.00	0.84-1.17		
M2	AP	40	2.16	1.78-2.42	0.1588	7.37
	W	40	2.45	2.12-2.78	0.1603	6.55
	AP/W	40	0.88	0.77-1.09		
M3	AP	29	2.22	1.80-2.52	0.1673	7.54
	W	29	2.62	2.36-2.97	0.1835	7.00
	AP/W	29	0.85	0.75-0.92		
M4	AP	26	1.59	1.26-2.00	0.1805	11.33
	W	26	2.38	1.88-2.68	0.1974	8.29
	AP/W	26	0.67	0.54-0.79		

M3 differs from the M1 and M2 in having cusp C as the largest stylar cusp. An anterobuccal spur is present on all specimens preserving this portion of the tooth and 8 of 28 specimens have a small cusp A on this spur. Cusp C is variable with 10 of 28 specimens showing some degree of twinning. Two of these have a small anterior cuspule, 4 have a small posterior cuspule and 4 specimens show a slight to moderate fissure on cusp C that partially bisects the cusp (Figure 8J). A distinct cusp D is present on only 4 of 28 specimens. It is always smaller than and may have the base joined to cusp C (Figure 8K). The presence or absence of cusps A and D showed no correlation to size (Figure 9C). Cusp E is not a distinct cusp but is represented as a narrow ridge on most unworn specimens. For the M1-M3, the variations and percentages are similar to those described by Eberle and Storer (1995) for *H. valens*.

The M4 of *H. valens* has been described by Russell (1984) but the Medicine Pole Hills sample shows some additional variations. The paracone is the largest cusp and the preparacrista forms a large ridge to the anterobuccal corner of the tooth. A cusp (stylar cusp B) that projects above the level of the preparacrista is present on 12 of 23 specimens where the condition can be determined. The only other stylar

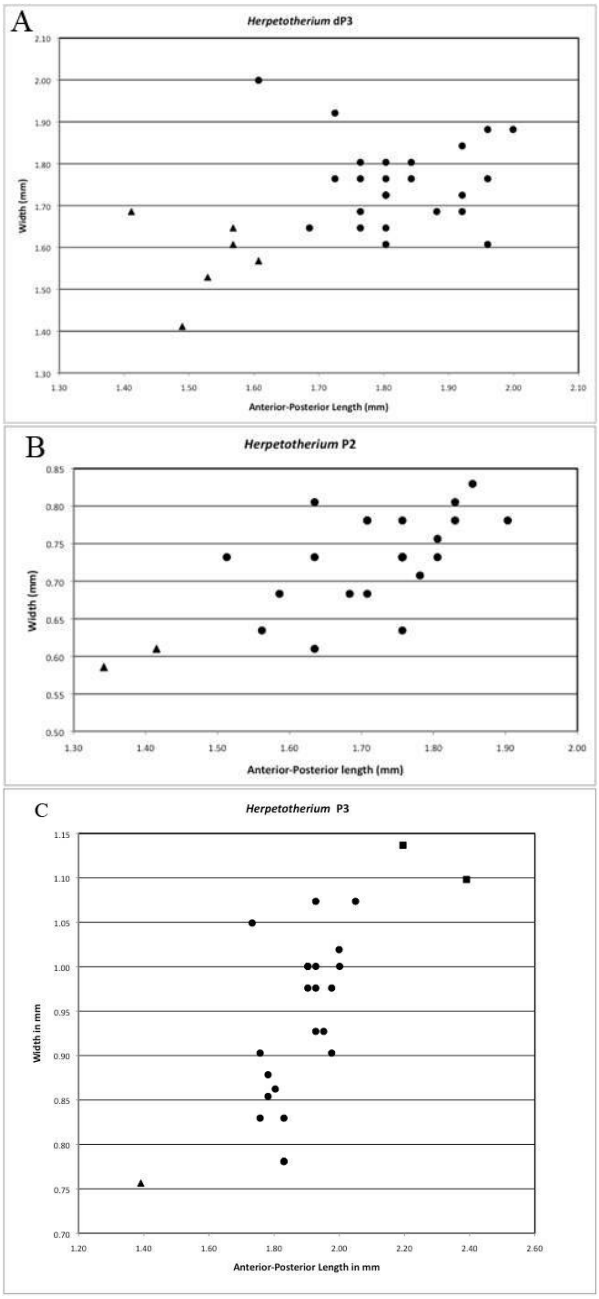

FIGURE 5. Length versus width of *Herpetotherium* upper premolars from the Medicine Pole Hills local fauna. A, dP3; B, P2; C, P3. Symbols as in Figure 3.

cusp is a low to conical cusp C that forms a projecting bulge on the posterobuccal margin of the tooth (Figure 8L). The preprotocrista extends along the margin of the tooth to form an anterior cingulum to the anterobuccal corner of the tooth in 17 of 26 specimens. In the remaining specimens the anterior cingulum is absent at the base of the paracone. A metaconule is present on 11 of 22 specimens, in the remaining specimens the postprotocrista merges with the base of the metacone.

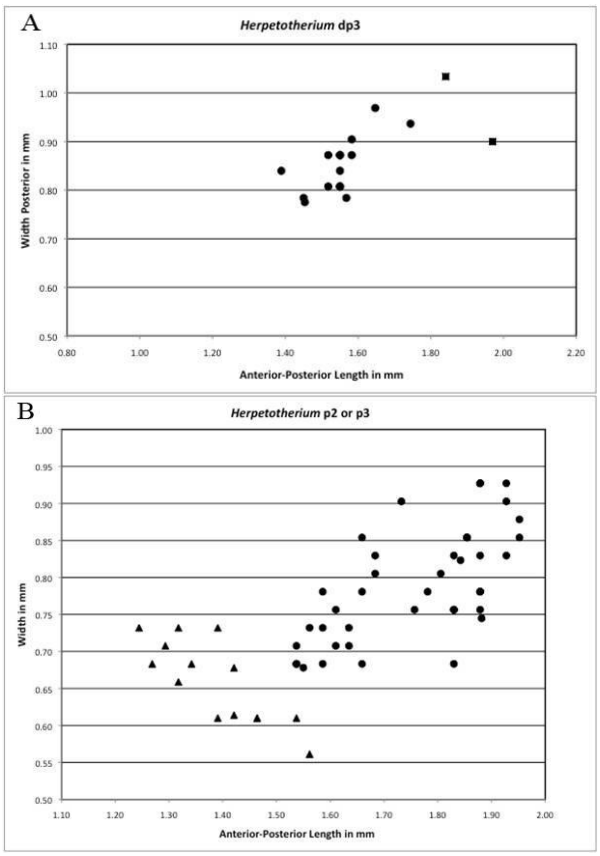

FIGURE 6. Length versus width of *Herpetotherium* lower premolars from the Medicine Pole Hills local fauna. A, dp3; B; p2 or p3 (undifferentiated). Symbols as in Figure 3.

PTRM 10791 is a left edentulous dentary referred to *H. valens* based on the length of the molar alveoli and other partial jaws of *H. valens*. This specimen preserves the alveoli for the canine to the m3. The p1 is double-rooted with the roots separated (Figure 8Q). There is a very short diastema between the p1 and p2. The anterior mental foramen is below the anterior root of p1, the posterior foramen is below the anterior root of m1. Other dentary specimens show a very large masseteric fossa and a large mandibular foramen.

The dp3 of *Herpetotherium valens* has the trigonid more narrow than the talonid, each with three distinct cusps. The protoconid is always the largest, the metaconid is attached to the protoconid and slightly posterolingual to that cusp (Figure 8M). The paraconid is both lower and smaller than the metaconid on the anterolingual corner of the tooth. The talonid has three distinct cusps, the hypoconid being the largest. The entoconid is large and connected to the metaconid by a low ridge, enclosing the talonid basin. The hypoconulid is the smallest cusp, slightly posterobuccal to the entoconid and connected to the hypoconid by a low crest. All of the dp3 specimens in the Medicine Pole Hills sample, except for two large specimens, were assigned to *H. valens*. A scatter-gram of the specimens did not show any apparent distinct small species (i.e. *Herpetotherium* sp. cf. *H. fugax*; Figure 6A). It is possible that the dp3 does not show the size distinction seen in the other teeth, but more likely that the dp3 of the smaller species is absent from the sample.

The sample of lower permanent premolars consists entirely of isolated teeth, and based on material of *Herpetotherium* sp. cf. *H. fugax*, there are no characteristics that consistently distinguish the p2 and p3 by position. As such, all of the specimens referred to *H. valens* are considered as either p2 or p3. The specimens are distinguished from lower premolars of *H.* sp. cf. *H. fugax* only on the basis of size (Figure 6B) and the description of the p2 and p3 of *H.* sp. cf. *H. fugax* given below adequately describes the morphology of the lower premolars of *H. valens*.

The m1 can be differentiated from the m2 and m3 by the more narrow trigonid relative to the talonid (Figure 8O). The m2 and m3 are more difficult to confidently identify by tooth position and were not differentiated except for those specimens preserved in jaw fragments. In general, the m2 has the trigonid width nearly equal to the talonid width whereas the m3 has the trigonid width greater than the talonid width. However some m3 specimens preserved in jaw fragments had the trigonid and talonid of nearly equal width. The m4 is distinctive because of the narrow talonid (Figure 8P). The morphology of the lower molars of *H. valens* matches the description given by Korth (1994) for *Herpetotherium*. The trigonid length of lower molars average 54.5-55.7% of the total anterior-posterior length of the tooth (Table 3). These values are in line with those of *H. valens* from Pipestone Springs given by Korth (1994) and for the other species of *Herpetotherium* from the Medicine Poles Hills local fauna.

Discussion: *Herpetotherium valens* differs from the *Herpetotherium* sp. cf. *H. fugax* in being consistently larger. T-test comparisons of the two species (Table 4) show *H. valens* to be significantly larger at a 97% confidence level or greater for all measurements of all tooth positions. The only exception is the P3 for which

TABLE 3. Measurements of *Herpetotherium valens* lower teeth from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	stdev	CV
dp3	AP	16	1.57	1.39-1.84	0.1089	6.95
	Wa	16	0.74	0.67-0.84	0.0549	7.43
	Wp	16	0.86	0.78-1.03	0.0722	8.39
p2 or 3	AP	41	1.76	1.54-1.95	0.1373	7.82
	W	41	0.79	0.68-0.93	0.0752	9.53
	AP/W	41	2.23	1.92-2.68		
m1	AP	55	2.01	1.68-2.29	0.1259	6.27
	Trigonid AP	55	1.12	0.90-1.39	0.1166	10.38
	(Trig/AP)X100	55	55.9%	49.1-63.5		
	Wa	55	0.99	0.71-1.20	0.1027	10.39
	Wp	55	1.12	0.81-1.36	0.1152	10.24
m2	AP	4	2.18	2.13-2.23	0.0418	1.91
	Trigonid AP	4	1.19	1.10-1.26	0.0644	5.42
	(Trig/AP)X100	4	54.5%	51.8-57.4%		
	Wa	4	1.20	1.00-1.29	0.1359	11.30
	Wp	4	1.33	1.07-1.42	0.1691	12.75
m3	AP	6	2.37	2.20-2.49	0.1133	4.77
	Trigonid AP	6	1.32	1.20-1.45	0.0867	6.54
	(Trig/AP)X100	6	55.7%	54.4-58.4%		
	Wa	6	1.37	1.29-1.45	0.0700	5.10
	Wp	6	1.38	1.26-1.49	0.0945	6.83
m2 or 3	AP	86	2.21	1.71-2.55	0.1947	8.81
	Trigonid AP	86	1.21	0.78-1.45	0.1257	10.41
	(Trig/AP)X100	86	54.7%	45.3-60.0		
	Wa	86	1.24	0.98-1.49	0.1311	10.57
	Wp	86	1.30	1.00-1.58	0.1330	10.24
m4	AP	19	2.31	1.94-2.65	0.1787	7.73
	Trigonid AP	19	1.29	1.00-1.49	0.1285	9.93
	(Trig/AP)X100	19	56.0%	50.0-60.6		
	Wa	19	1.25	1.07-1.42	0.1059	8.47
	Wp	19	0.93	0.74-1.10	0.1207	12.99

only a single P3 specimen of *H*. sp. cf. *H. fugax* is available. The only noted morphologic distinction between the species is in the development of the stylar cusps of the M3. In *H. valens*, cusp C is always the largest stylar cusp and is often twinned. Cusp D is present on a few specimens and is always smaller than cusp C. In *H*. sp. cf. *H. fugax*, cusp C and D are consistently present, but cusp C varies in size and is typically smaller than cusp D.

Herpetotherium sp. cf. *H. marsupium* differs from *H. valens* in being significantly larger in all comparable dimensions (Table 4). Too few specimens of the larger species exist to determine if there are any consistent differences in the stylar cusp development of the upper molars.

Herpetotherium sp. cf. *H. fugax* Cope, 1873
(Figures 3-6, 10-11, Tables 4-6)

Referred Specimens—all PTRM; RdP3 8249, 14648; LdP3 7833, 7864, 10238, 10255, 14663; LP2 4744, 4749; LP3 14140; RM1 5483, 5560, 7823, 8262, 10244, 10462, 14090, 14659; LM1 4850, 5487, 6249, 6251, 6256, 7256, 7361, 7666, 7830, 10467, 10877, 10905, 10911, 14668, 17366; RM2 5778, 5868, 7259, 7260, 7365, 8264, 10859, 14082, 14089; LM2 4812, 4849, 5534, 5842, 6257, 7364, 7674, 7851, 8244, 14087, 14088; RM3 4803, 5432, 5546, 5786, 6230, 7839, 8240, 10495, 10868, 10886; LM3 4848, 6246, 10465, 10867, 10884; RM1, 2 or 3 11065; LM1, 2 or 3 10843, 14091; RM4 5486, 7867, 8263, 14097; LM4 5797, 7828, 10476; L dentary 10259; Rp1 14139; Rp2 or 3 4747, 7473, 10258, 10808, 10813, 10830, 14033, 14626; Lp2 or 3 4953, 14032, 14040, 14042, 14610, 14618; Rp2-3 4787; Rm1 8274; Lm1 4790, 4792, 4863, 7485, 10237, 10256, 14086, 14655; Rm2 or 3 4853, 5798, 5843, 7854, 10482, 14078, 14092, 14649; Lm2 or 3 4791, 4941, 8265, 14074, 14084, 14094, 14646, 17388; Rm4 7363, 7865, 10881; Lm4 5485

Description—The dP3 differs from that of *H. valens* only in being smaller. The P2 and P3 specimens are similar to those of *H. valens* and are tentatively referred to *H*. sp. cf. *H. fugax* because of their smaller size. The P3 has an anterior cuspule but lacks a distinct posterior cuspule (Figure 10C). The crest from the primary cusp runs to the posterior margin and a

cingulum extends from this point onto the lingual portion of the tooth.

TABLE 4. T-test comparison of *Herpetotherium* populations from the Medicine Pole Hills local fauna.

		H. valens vs. *H.* sp. *H. fugax*	*H. valens* vs. H. sp. *H. marsupium*
Tooth	measurement	Probability	Probability
P2	AP	0.0223	
	W	0.0014	
dP3	AP	<0.0001	
	W	0.0038	
P3	AP		
	W		
M1	AP	<0.0001	
	W	<0.0001	
M2	AP	<0.0001	0.0198
	W	<0.0001	0.0037
M3	AP	<0.0001	
	W	<0.0001	
M4	AP	<0.0001	
	W	0.0010	
p2 or 3	AP	<0.0001	
	W	<0.0001	
m1	AP	<0.0001	0.0003
	trigonid AP	<0.0001	0.0014
	Wa	<0.0001	<0.0001
	Wp	<0.0001	<0.0001
m2 or 3	AP	<0.0001	0.0001
	trigonid AP	<0.0001	0.0166
	Wa	<0.0001	0.0033
	Wp	<0.0001	0.0032
m4	AP	0.0004	
	trigonid AP	0.0013	
	Wa	0.0009	
	Wp	<0.0001	

The M1 is similar to that of *H. valens*, with stylar cusps B and D present on all specimens, with cusp D being the largest (Figure 10D). An anterobuccal spur is present on most specimens (17 of 19) with a small cusp A present on 4 specimens. Stylar cusp C is present as a small cusp on the anterior slope of cusp D on 5 of 15 specimens and is somewhat separate from cusp D on 2 additional specimens. Stylar cusps A and C are both present on three of the larger specimens (Figure 10E), but otherwise the development of the stylar cusps does not appear to be related to tooth size. Overall, stylar cusps A and C are not as commonly developed as in *H. valens* (Figure 11A).

M2 is shorter and more transverse than M1, with stylar cusps B and D present on all specimens. An anterobuccal spur is typically present but a small cusp A is only present on 4 of 16 specimens. On 7 of 13 specimens, Cusp C is present, either on the anterior slope of cusp D or as a small cusp somewhat separated from Cusp D (Figure 10G). On three specimens, both cusps A and C are present. The presence of cusps A and C, either separately or together, does not seem to correlate to tooth size (Figure 11B).

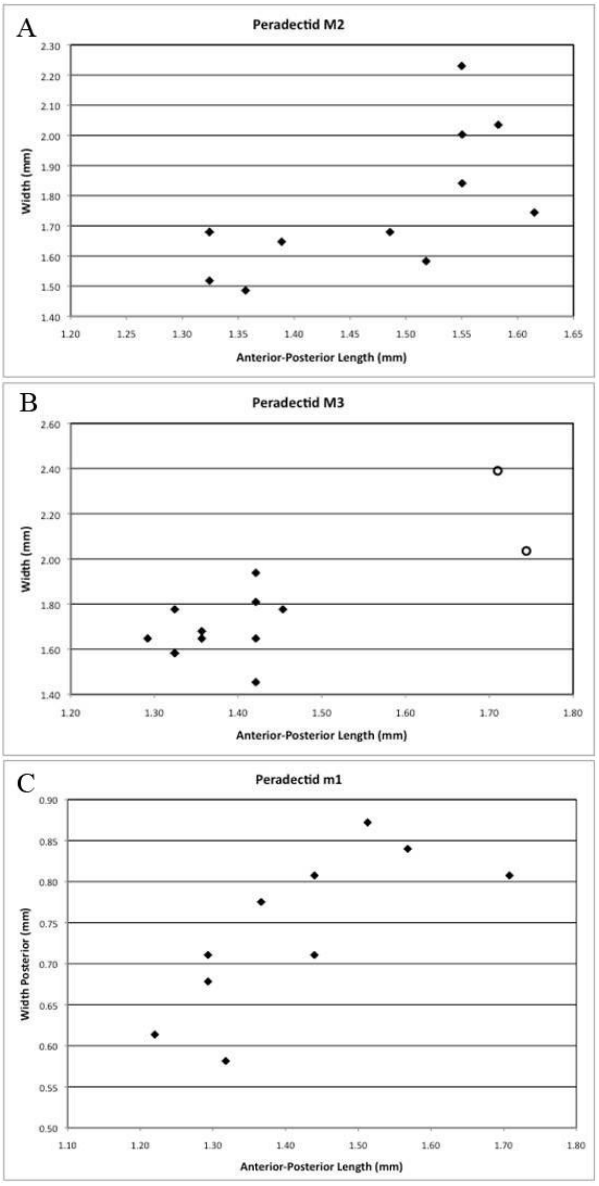

FIGURE 7. Length versus width of peradectid teeth from the Medicine Pole Hills local fauna. A, M2; B, M3; C, m1. Diamonds represent *Peradectes* sp. cf. *P. californicus*, open circles represent *Didelphidectes* sp. cf. *D. pumilis*.

M3 is more V-shaped than M2 with cusps B, C and D consistently present. An anterobuccal spur is present on 10 of 12 specimens, with a small cusp A present on 3 of 8 specimens. Cusp C is the most variable in size. It may be the largest stylar cusp (Figure 10H), but may also be smaller than either cusp B or cusp D (Figure 10I). In contrast to *H. valens*, cusp C of the M3 does not show the tendency to be twinned with a smaller cusp.

The M4 is similar to that of *H. valens*. On 2 of 7 specimens there is a very small stylar cusp B, a complete anterior cingulum and a metaconule. On 2 of 7 specimens stylar cusp B is absent, the anterior cingulum is incomplete and the postprotocrista connects to the metacone. Stylar cusp C does not project as far buccally as in most specimens of *H. valens*.

TABLE 5. Measurements of *Herpetotherium* sp. cf. *H. fugax* upper teeth from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	stdev	CV
P2	AP	2	1.38	1.34-1.42	0.0518	3.75
	W	2	0.60	0.59-0.61	0.0173	2.89
dP3	AP	6	1.53	1.41-1.61	0.0701	4.59
	W	6	1.57	1.41-1.69	0.0973	6.18
P3	AP	1		1.39		
	W	1		0.76		
M1	AP	20	1.60	1.39-1.78	0.1245	7.76
	W	20	1.65	1.32-2.00	0.1518	9.21
	AP/W	20	0.98	0.84-1.07		
M2	AP	20	1.66	1.39-1.94	0.1504	9.09
	W	20	1.85	1.65-2.10	0.1287	6.94
	AP/W	20	0.89	0.83-1.00		
M3	AP	9	1.62	1.42-1.68	0.0923	5.70
	W	9	2.03	1.71-2.29	0.0452	5.64
	AP/W	9	0.80	0.73-0.89		
M4	AP	5	1.23	1.13-1.29	0.0770	6.28
	W	5	1.87	1.58-2.04	0.1773	9.26
	AP/W	5	0.66	0.55-0.73		

The mental foramina of the dentary are similar to those of *H. valens*. The premolars are crowded, with no space between any of the premolars nor between the p1 and canine (Figure 10O). The spacing of the anterior dentition differs from that described by Fox (1983) for *H. fugax*, although as noted by Hough (1961), the spacing between marsupial premolars tends to vary with the age and sex of the individuals. A single p1 is tentatively referred based on its small size and comparison to the available dentaries. The tooth is double rooted with the posterior root larger (Figure 10K) . The roots are very close together and the anterior root may have shared an alveolus with the canine. The anterior face is a smooth convex curve with no anterior cuspid. A very minor crest extends from the primary cusp to a small posterior cuspid. The tooth appears to have been semi-procumbent based on the enamel line.

A single specimen, PTRM 4787, preserves the p2-p3 (Figure 10P). The teeth are similar with p2 slightly larger than the p3. The primary cusp is slightly anterior to the mid-length of the tooth. The anterior face forms a smooth convex curve without an anterior cuspid. A minor crest extends from the primary cusp to the posterior margin of the teeth. This crest is slightly buccal of the midline of p2 and more medial on p3. A posterior cuspid is present on both teeth, being somewhat better developed on p3. Minor cingulids extend both lingually and buccally from the posterior cuspid and create a shallow talonid basin. All other lower premolar specimens are isolated teeth and not assigned to a specific tooth position. These specimens do not show any characteristics not seen in PTRM 4787, although the relative development of cuspids and cingulids does vary.

The lower molars do not differ, other than in size, from the lower molars of *Herpetotherium valens*.

TABLE 6. Measurements of *Herpetotherium* sp. cf. *H. fugax* lower teeth from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	stdev	CV
p1	AP	1		1.52		
	W	1		0.59		
p2	AP	1		1.39		
	W	1		0.73		
	AP/W	1		1.90		
p3	AP	1		1.29		
	W	1		0.71		
	AP/W	1		1.83		
p2 or 3	AP	12	1.40	1.24-1.56	0.1010	7.24
	W	12	0.65	0.56-0.73	0.0540	8.33
	AP/W	12	2.18	1.70-2.78		
m1	AP	9	1.54	1.32-1.71	0.1162	7.55
	Trigonid AP	9	0.88	0.78-1.00	0.0781	8.92
	(Trig/AP)X100	9	56.9%	50.9-62.1%		
	Wa	9	0.76	0.66-0.87	0.0755	9.99
	Wp	9	0.83	0.71-0.94	0.0771	9.33
m2 or 3	AP	15	1.56	1.39-1.66	0.0936	6.00
	Trigonid AP	15	0.93	0.83-1.07	0.0712	7.69
	(Trig/AP)X100	15	54.3%	53.1-68.8%		
	Wa	15	0.84	0.71-0.98	0.0694	8.30
	Wp	15	0.86	0.74-0.98	0.0712	8.28
m4	AP	4	1.50	1.36-1.71	0.1636	10.90
	Trigonid AP	4	0.85	0.68-0.94	0.1161	13.62
	(Trig/AP)X100	4	56.5%	50.0-62.8%		
	Wa	4	0.78	0.68-0.90	0.1067	13.62
	Wp	4	0.54	0.48-0.61	0.0666	12.31

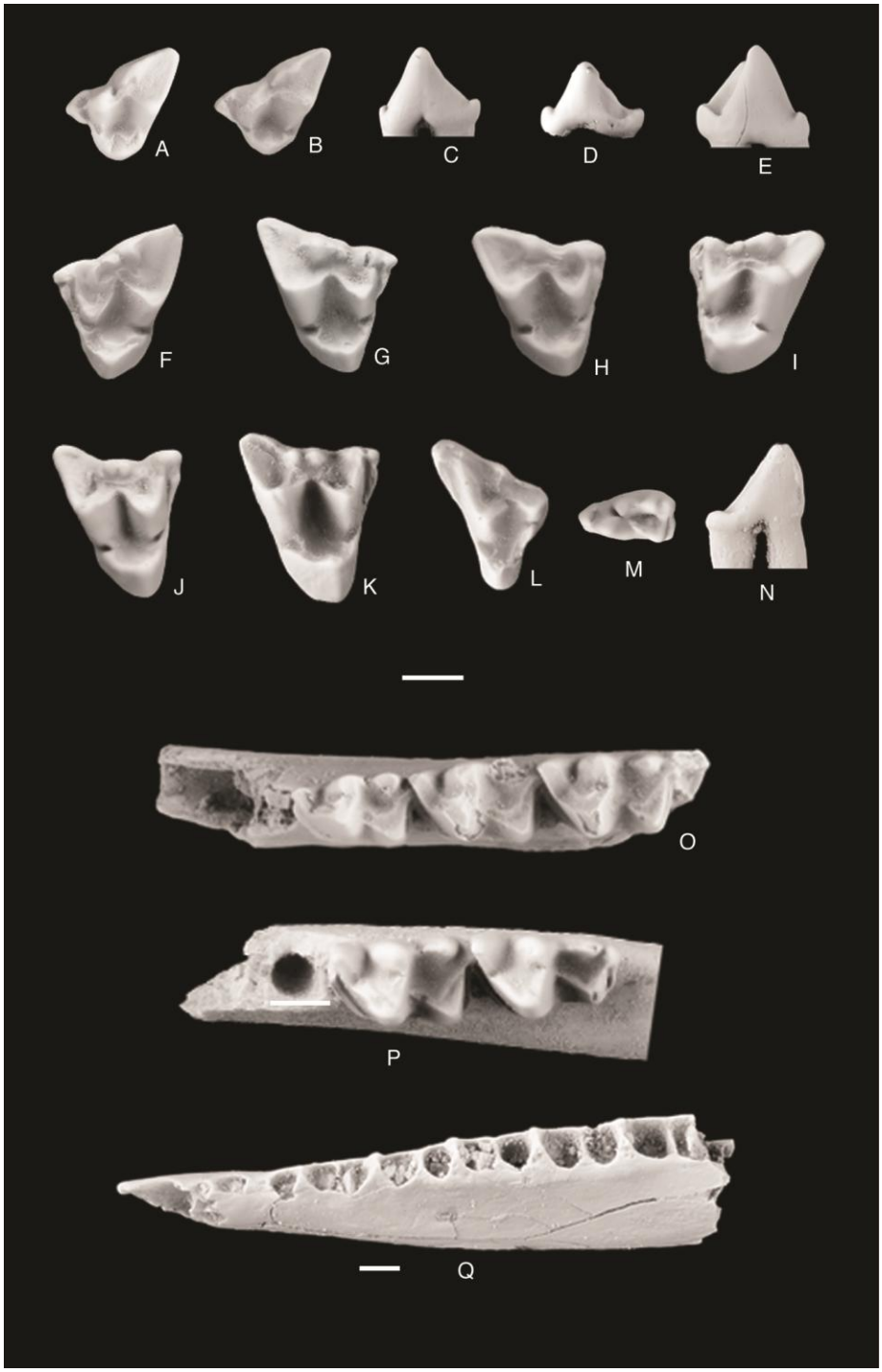

FIGURE 8. *Herpetotherium valens* from the Medicine Pole Hills local fauna. A, PTRM 5789 LdP3; B, PTRM 4856 LdP3; C, PTRM 14615 RP2 buccal view; D, PTRM 14038 LP2 lingual view; E, PTRM 7900 RP3 lingual view; F, PTRM 10889 LM1; G, PTRM 8245 RM1; H, PTRM 10904 RM2; I, PTRM 10842 LM2; J, PTRM 2626 RM3; K, PTRM 14985 RM3; L, PTRM 10251 LM4; M, PTRM 8228 Ldp3; N, PTRM 1336 Lp2 or p3 lingual view; O, PTRM 1953 Lm1-3; P, PTRM 2633 Lm3-4; Q, PTRM 10791 oblique buccal view of left dentary. Bar scales are approximately 1 mm. Lower bar scale applies to Q only.

Discussion—Based on the upper molars, the material cannot be assigned to *Copedelphys* as stylar cusps B, C and D of M1 and M2 are not equal, or nearly equal in size. On M1 and M2 cusp C is absent on about 50% of the specimens. In M3, cusp C may beequal to cusp D, but may also be minute. In the lower dentition, the premolars average 91% the length of the m1 (Table 6), unlike the relatively shorter premolars (66% of m1 length) of *Copedelphys* (Korth, 1994). It should be noted, however, that the proportions of the premolars and m1 length are based on isolated teeth with tooth position somewhat uncertain. The m1 trigonids are shorter relative to total tooth length (56.9%) than is seen in *Copedelphys* (60-61%). The m2 or 3 trigonid to total length ratio (59.6%) is more similar to *Copedelphys*. In addition, the Medicine Pole Hills specimens average 10-20% larger (except for M2) than *C. titanelix* from Pipestone Springs (Korth, 1994).

The material is thought to represent *Herpetotherium* rather than *Copedelphys* because of the differences cited above and because of the overall similarity to *Herpetotherium valens*. The only distinguishing features separating specimens of *H.* sp. cf. *H. fugax* and *H. valens* are size and development of cusp C on the M3 noted above. *Herpetotherium fugax* as diagnosed by Korth (1994), has a reduced cusp D and cusp C fused to cusp D on M2. The Medicine Pole Hills sample does not have cusp D as reduced and cusp C is variably present, although typically fused with cusp D when present. Comparison of the Medicine Pole Hills sample to those of *H. fugax* listed by Korth (1994), show the Medicine Pole Hills specimens to be smaller than specimens from Chadronian samples from both Cedar Creek and Pipestone Springs.

Herpetotherium sp. cf. *H. marsupium* (Troxell, 1923)
(Figures 3-6, 12, Tables 4, 7)

Referred Specimens—all PTRM; LP3 2004, 17362; LM1 4802; RM2 10875, LM2 4797; Rdp3 14081; Ldp3 10878; Rm1 10909, Lm1 4745, 7407, 10860, 14642; Rm2 or 3 4721, 7852; Lm2 or 3 7483, 7678, 10915.

Description—The P3 are referred to *H.* sp. cf. *H. marsupium* primarily on the basis of their larger size (Figure 5C). The P3 has a minor anterior cuspule (Figure 12A), a strong ridge from the primary cusp to the posterior cuspule and a lingual cingulum that forms a narrow talon basin. Only a single M1 is represented in the collection. There is an anterobuccal spur with a distinct cusp A. Stylar cusps B and D are large and subequal. Cusp C is present, larger than cusp A, and separate from cusp D, although the bases merge (Figure 12B). Only one relatively unworn M2 is represented in the collection (Figure 12C). There is a large anterobuccal spur but because of wear, the presence or absence of cusp A is uncertain. Cusps B and D are large and subequal. A small cusp C is present on the anterior slope of cusp D. The anterior cingulum is complete to the anterobuccal spur and the metaconule is present on both the M1 and M2. No M3 or M4 specimens are represented.

The dp3 referred to *H.* sp. cf. *H. marsupium* differs in both overall size and morphology from of *H. valens*. The metaconid is more separated from the protoconid, the paraconid is lower and forms a more open triangle than in *H. valens* (Figure 12D).

None of the permanent lower premolars in the *Herpetotherium* sample stand out as larger than the others, so it is unlikely that *H.* sp. cf. *H. marsupium* is represented in the sample. The lower molars referred to this species are based on their large size relative to those of *H. valens*, no morphologic differences were noted.

TABLE 7. Measurements of *Herpetotherium* sp. cf. *H. marsupium* from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	stdev	CV
P3	AP	2	2.29	2.20-2.39	0.1379	6.01
	W	2	1.12	1.10-1.40	0.0273	2.44
M1	AP	1		2.75		
	W	1		2.55		
	AP/W	1		1.08		
M2	AP	2	2.70	2.65-2.75	0.0686	2.54
	W	2	2.87	2.84-2.91	0.0460	1.60
	AP/W	2	0.94	0.93-0.94		
dp3	AP	1		1.97		
	Wa	1		0.84		
	Wp	1		0.90		
m1	AP	5	2.42	2.33-2.58	0.1021	4.21
	Trigonid AP	5	1.31	1.23-1.39	0.0672	5.15
	(Tri/AP)X100	5	53.9%	52.6-57.5%		
	Wa	5	1.23	1.20-1.29	0.0354	2.87
	Wp	5	1.40	1.36-1.45	0.0490	3.49
m2 or 3	AP	4	2.90	2.78-2,97	0.0928	3.20
	Trigonid AP	4	1.51	1.32-1.62	0.1302	8.62
	(Tri/AP)X100	4	52.0%	47.7-54.3%		
	Wa	4	1.59	1.49-1.68	0.0965	6.06
	Wp	4	1.57	1.49-1.68	0.0807	5.13

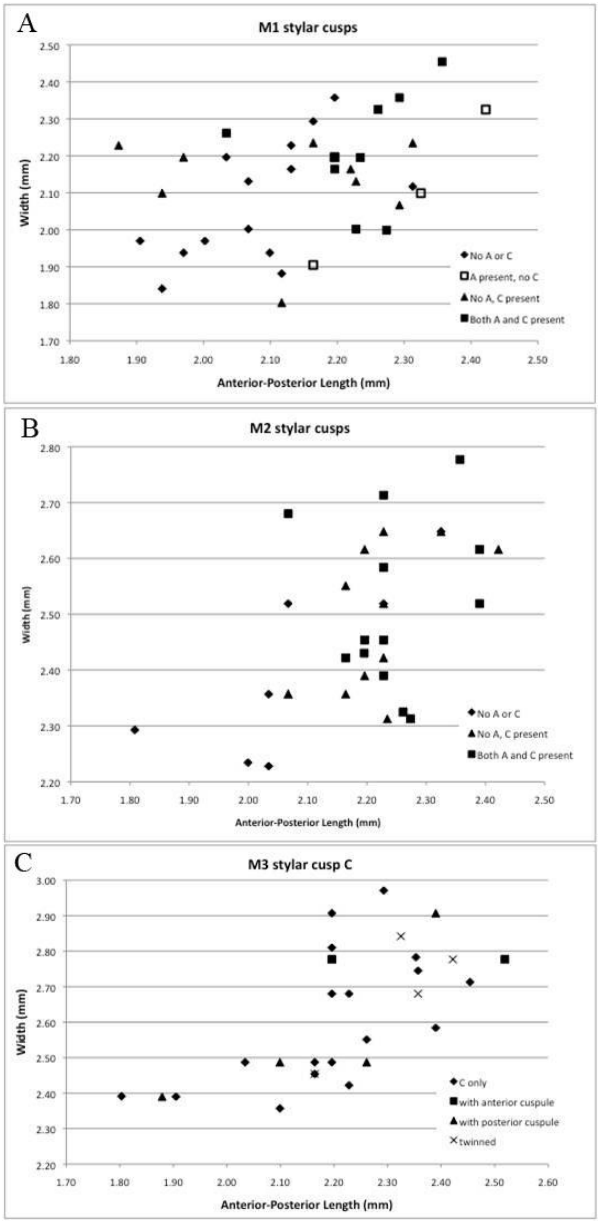

FIGURE 9. *Herpetotherium valens* upper molar stylar cusps. A, M1; B, M2; C M3.

Discussion—The material assigned to *H.* sp. cf. *H. marsupium* represents the largest marsupial species in the fauna and it is considerably larger than any reported Chadronian or Orellan species of *Herpetotherium*. Specimens differ from *H. valens* by being significantly larger (Table 4, 7), but lack any other distinguishing features. The M1 is within the rather variable morphology of *H.* sp. cf. *H. marsupium* described by Rothecker and Storer (1996). M2 differs in that cusp C is not separated from cusp D. The Medicine Pole Hills specimens are somewhat larger than those described from the Lac Pelletier local fauna (Rothecker and Storer, 1996) or the Swift Current local fauna (Storer 1984) but more similar to specimens from the Wind River Basin (Krishtalka and Stucky 1983b).

Family Peradectidae Crochet, 1979
Genus *Peradectes* Matthew and Granger, 1921
Peradectes sp. cf. *P. californicus* (Stock, 1936)
(Figure 7, 13A-M; Tables 8-9)

Referred Specimens—all PTRM: RdP3 10478, 14069, 14070, 17306; LdP3 10496, 14071, 14670; LP3 (cf) 10797, 17504; RM1 5805; LM1 10483, 14068; RM2 8270, 10480, 10484, 10485,10497, 10498; LM2 7267, 7862, 8268, 10499, 14665, 17389; RM3 7861, 8272, 10490, 14667; LM3 4843, 5554, 7853, 7859, 14066; RM2 or 3 10487, 14098; LM2 or 3 10481; RM2-M3 7265; LM2-M3 8269, 8271; Rdp3 10500; Rp2 or p3 4736, 10828, 10832; Lp2 or p3 8285, 10819, 14025, 14026; Lp2-m1 5787; Lp3-m2 7266; Rm1 7863, 14671; Lm1 5772, 7688, 8267, 17505; Lm1-m2 1343, 4752; Rm2 or 3 4725, 5804, 6115, 8266, 10253, 14664, 17305; Lm2 or 3 5591, 6147, 6258, 7856, 7858, 10252, 10264, 14666, 17506; Rm4 5431, 7690, 14669; Lm4 7692, 7857, 10492.

Description—The referral of dP3 specimens to *Peradectes* is based on the small size of the specimens compared to other marsupial dP3 in the fauna, and consistent morphologic differences. The dP3 of *Peradectes* sp. cf. *P. californicus* has three main cusps with the protocone the smallest of the three (Figure 13A). The paracone is larger than, or subequal to the metacone. The protocone is either weakly connected to the paracone and metacone by low crests, connected only to the paracone, or unconnected to either cusp. Conules are not present. There is a conical parastyle directly anterior to the paracone. The stylar shelf does not exist buccal to the parastyle or paracone, but begins at the posterobuccal margin of the paracone. The only stylar cusp is a small to moderately developed stylar cusp D which may be directly buccal or posterobuccal to the metacone. There is a postmetacrista to the posterobuccal corner of the tooth.

None of the marsupial P2 specimens in the collection are referred to *Peradectes*. It is possible that no *Peradectes* specimens are present, or that if present, the specimens do not differ in size or morphology from the P2 of *Herpetotherium* sp. cf. *H. fugax*. The two smallest P3 specimens in the collection show some distinctive features and are tentatively identified as P3 of *Peradectes*. The tooth has a single tall central cusp. There is a low ridge at the anterior end of the tooth with a small cuspule. A narrow ridge extends posteriorly from the apex of the central cusp to the posterior margin and a low ridge borders the posterior margin, but there is no distinct cusp, unlike

Herpetotherium. The anterior slope from the central cusp is steeper than the posterior slope with the main cusp just anterior to the midline of the tooth (Figure 13B).

The upper molars fit the generalized description of *Peradectes* given by Krishtalka and Stucky (1983a) with the paracone and metacone of nearly equal height and a straight centrocrista. The salient points for this discussion are in the development of the stylar cusps. Cusp B is the largest stylar cusp on M1-M3. No M4 specimens are present in the collection. On M1 stylar cusp D is variable, moderately developed on one, small on a second and absent on the third specimen (Figure 13C). Stylar cusp A is present on two of three specimens. On M2 stylar cusps A (6 of 14 specimens) and D (9 of 13) are often present with cusp D typically small. On M3 stylar cusps A, D and C are each present on 6 of 11 specimens, although in different combinations. In some cases all three of these cusps are present, but either cusp D or C is larger. Cusp C is well developed on two specimens (Figure 13E), cusp D is moderately developed on five specimens. The ectoflexus is least evident on the M1, and although variable, wider and deeper on M2-M3 (Figure 13K).

TABLE 7. Measurements of *Herpetotherium* sp. cf. *H. marsupium* from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	stdev	CV
P3	AP	2	2.29	2.20-2.39	0.1379	6.01
	W	2	1.12	1.10-1.40	0.0273	2.44
M1	AP	1		2.75		
	W	1		2.55		
	AP/W	1		1.08		
M2	AP	2	2.70	2.65-2.75	0.0686	2.54
	W	2	2.87	2.84-2.91	0.0460	1.60
	AP/W	2	0.94	0.93-0.94		
dp3	AP	1		1.97		
	Wa	1		0.84		
	Wp	1		0.90		
m1	AP	5	2.42	2.33-2.58	0.1021	4.21
	Trigonid AP	5	1.31	1.23-1.39	0.0672	5.15
	(Tri/AP)X100	5	53.9%	52.6-57.5%		
	Wa	5	1.23	1.20-1.29	0.0354	2.87
	Wp	5	1.40	1.36-1.45	0.0490	3.49
m2 or 3	AP	4	2.90	2.78-2,97	0.0928	3.20
	Trigonid AP	4	1.51	1.32-1.62	0.1302	8.62
	(Tri/AP)X100	4	52.0%	47.7-54.3%		
	Wa	4	1.59	1.49-1.68	0.0965	6.06
	Wp	4	1.57	1.49-1.68	0.0807	5.13

The mandible of *Peradectes* sp. cf. *P. californicus* has two mental foramina, one at a point below the posterior root of the p1 and the anterior root of p2 and one below the m1 at a point between the roots (Figure 13L). The p1 is either single rooted or has a small anterior root crowded confluent with the alveolus for the canine (Figure 13M). There is no space between the canine and the p1, nor between the p1 and p2.

The dp3 of *Peradectes* sp. cf. *P. californicus* has the protoconid as the largest cusp with a small paraconid directly anterior (Figure 13F). There is no metaconid. The hypoconid is the largest talonid cusp and attaches to the trigonid by a low cristid obliqua. The entoconid is a low, elongate cusp subequal to the hypoconulid. The hypoconulid is posterobuccal to the entoconid and connected to the hypoconid by a low crest. The talonid basin is enclosed. The dp3 of *Peradectes* differs from that of *Herpetotherium* in the lack of a metaconid, smaller entoconid and more buccal placement of the hypoconulid.

Two specimens preserve the p2 and or p3 along with the m1 and can be confidently assigned to this taxon. The remainder of the premolar specimens referred to *Peradectes* sp. cf. *P. californicus* are assigned on the basis of size alone. The p2 has a single primary cusp with an convexly curved anterior slope. None of the specimens shows any evidence of an anterior cuspid. The posterior slope is slightly concave upward rising to the posterior end of the tooth. The p3 is essentially the same as the p2. In the only specimen with the p2-p3, the p3 is shorter than the p2, and the posterior portion of the tooth is wider. In several of the isolated specimens, there is a small cuspid at the posterior end of the tooth, these specimens are more likely to be p3 but isolated lower premolars are only assigned as either p2 or p3.

The lower dentition of *Peradectes* has been characterized by Krishtalka and Stucky (1983a) as having the entoconid and hypoconulid subequal, in addition the cristid obliqua is more labial and the hypoconulid is posterior to the entoconid in herpetotherines. The specimens here referred to *Peradectes* sp. cf. *P. californicus* have some additional features that distinguish them from *Herpetotherium*. In *Herpetotherium valens* the talonid width is greater than the trigonid width in m1 and m2 and nearly equal on m3 (Table 3). In *P.* sp. cf. *P. californicus* the trigonid and talonid are approximately equal in width on the m1 and the talonid is more narrow than the trigonid on m2 and m3 (Table 9). The paracristid on m1-m3 of *P.* sp. cf. *P. californicus* trends anterolingually but bends to be nearly lingually oriented (Figure 13I), a feature of

TABLE 8. Measurements of *Peradectes* sp. cf. *P. californicus* upper teeth from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	stdev	CV	variance
dP3	AP	7	1.41	1.26-1.58	0.1290	9.18	0.0170
	W	7	0.93	0.87-1.00	0.0540	5.81	0.0030
P3	AP	2	1.25	1.24-1,26	0.0110	0.88	0.0001
	W	2	0.64	0.63-0.65	1.0110	1.72	0.0001
M1	AP	3	1.51	1.42-1.65	0.1223	8.11	0.0150
	W	3	1.44	1.32-1.55	0.1134	7.86	0.0129
	AP/W	3	1.05	1.00-1.07			
M2	AP	13	1.47	1.32-1.62	0.1084	7.38	0.0150
	W	12	1.76	1.49-2.23	0.2255	12.81	0.0508
	AP/W	12	0.84	0.70-0.96			
M3	AP	11	1.37	1.29-1.45	0.1189	8.46	0.0141
	W	11	1.69	1.45-1.94	0.1615	9.42	0.0260
	AP/W	11	0.82	0.73-0.98			

TABLE 9. Measurements of *Peradectes* sp. cf. *P. californicus* lower teeth from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR	Stdev	CV	variance
dp3	AP	1		0.90			
	Wa	1		0.45			
	Wp	1		0.58			
p2	AP	1		1.07			
	W	1		0.48			
	AP/W	1		2.23			
p3	AP	2	0.92	0.90-0.94	0.0228	2.48	0.0005
	W	2	0.53	0.52-0.55	0.2284	4.28	0.0005
	AP/W	2	1.73	1.71-1.75			
m1	AP	10	1.42	1.22-1.71	0.1489	10.52	0.0222
	Trigonid AP	10	0.85	0.71-0.98	0.1072	12.66	0.0115
	(Trig/AP)X100	10	59.8%	56.6-69.6			
	Wa	10	0.72	0.55-0.90	0.1225	17.09	0.0150
	Wp	10	0.74	0.58-0.87	0.0969	13.10	0.0094
m2	AP	3	1.42	1.32-1.49	0.0924	6.49	0.0085
	Trigonid AP	3	0.94	0.88-1.00	0.0614	6.57	0.0038
	(Trig/AP)X100	3	65.8%	62.3-68.3			
	Wa	3	0.85	0.68-0.97	0.1526	17.95	0.0233
	Wp	3	0.78	0.65-0.90	0.1292	16.67	0.0167
m2 or 3	AP	15	1.48	1.34-1.69	0.1133	7.63	0.0128
	Wa	15	0.82	0.65-0.97	0.0772	9.38	0.0006
	Wp	15	0.76	0.61-0.94	0.1013	13.32	0.0103
m4	AP	6	1.39	1.29-1.42	0.0654	4.72	0.0043
	Trigonid AP	6	0.85	0.73-1.00	0.0951	11.14	0.0090
	(Trig/AP)X100	6	61.5%	56.6-67.3			
	Wa	6	0.71	0.65-0.87	0.0853	11.91	0.0073
	Wp	6	0.46	0.36-0.58	0.0748	16.35	0.0056

Peradectes noted by Korth (1994) and in contrast to the straighter paracristid of *Herpetotherium*. The hypoconid of *P.* sp. cf. *P. californicus* is typically compressed anteroposteriorly, creating an acute angle between the cristid obliqua and the hypolophid. In *Herpetotherium*, the hypoconid is not compressed and the angle created by the crests to more nearly a right angle. In *Herpetotherium* material in the Medicine Pole Hills collection, the m1-m3 typically have both an anterior and posterior cingulum. In *P.* sp. cf. *P. californicus* the anterior cingulum is often present, but a posterior cingulum is typically absent or only weakly developed.

Discussion—The Medicine Pole Hills specimens cannot be assigned to *Nanodelphys* as defined by Korth (1994) because of the relative greater development of stylar cusps, A, C and D on M1-M3 in addition to a large cusp B. In addition, the length/width ratio (Table 8) of the M1-M3 are greater than the ratio of *N. hunti* and more typical of the ratio in species of *Peradectes* (Korth, 1994: table 8). In the lower molars the cristid obliqua typically connects to the trigonid (20 or 22

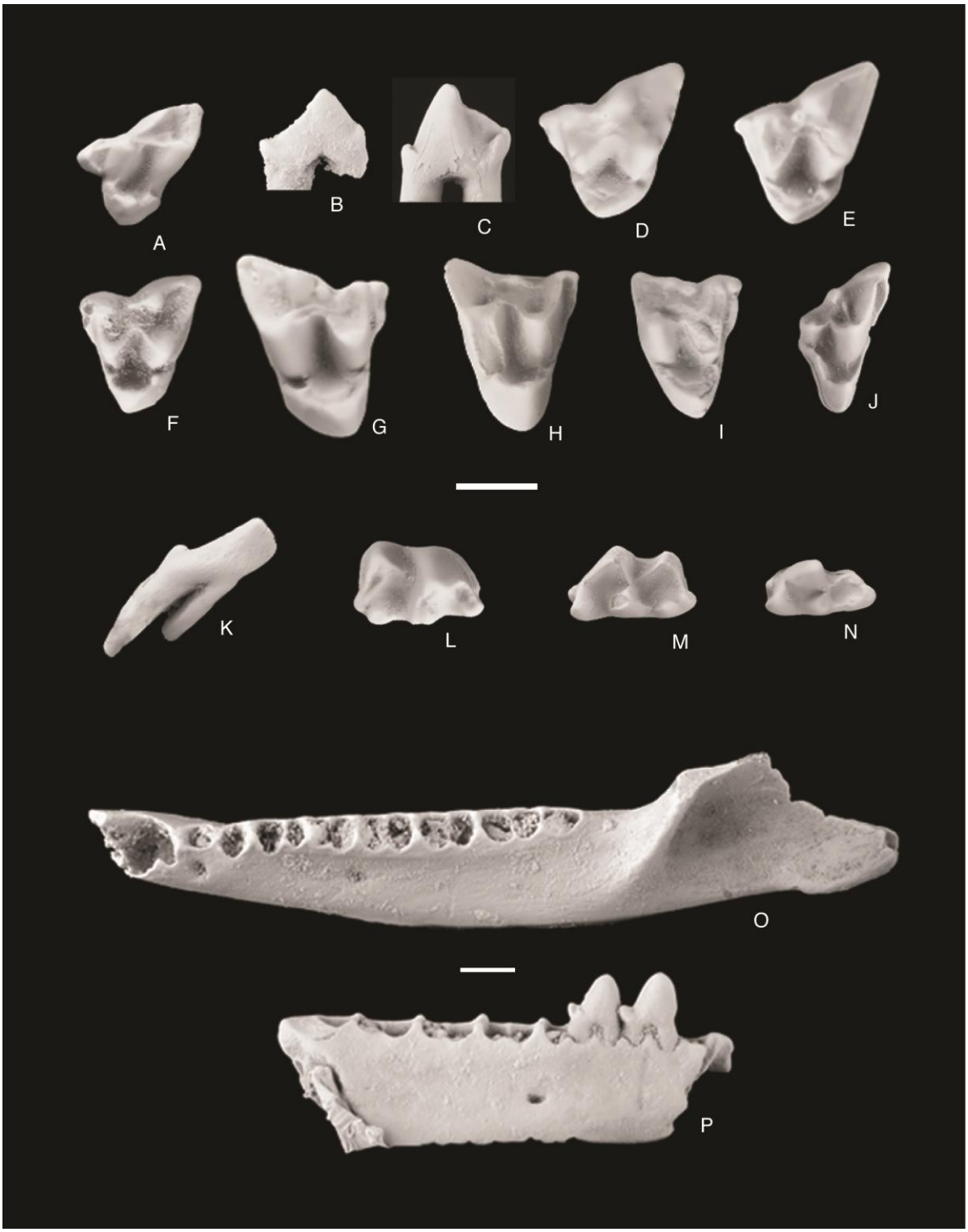

FIGURE 10. *Herpetotherium* sp. cf. *H. fugax* from the Medicine Pole Hills local fauna. A, PTRM 14663 LdP3; B, PTRM 4744 LP2 buccal view; C, PTRM 14140 LP3 lingual view; D, PTRM 7666 LM1; E, PTRM 10467 RM1; F, PTRM 4849 LM2; G, PTRM 10859 RM2; H, PTRM 10495 RM3; I, PTRM 8240 RM3; J, PTRM 8263 RM4; K, PTRM 14139 Rp1 buccal view; L, PTRM 4792 Lm1; M, PTRM 14649 Rm2 or 3; N, PTRM 7865 Rm4; O, PTRM 10259 left dentary oblique view; P, PTRM 4787 Rp2-3. Bar scales are approximately 1mm. Lower bar scale applies to O-P only.

specimens), although weakly in some specimens, and the paracristid typically shows a bend, unlike the condition described for *N. hunti* (Korth, 1994).

The Medicine Pole Hills specimens are approximately the same size and have the same general proportions as *P. californicus* (length/width of upper molars, trigonid width vs. talonid width on the lower molars) as described by Lillegraven (1976) although the M1 and M2 are slightly larger on average. The only noted difference is a deeper ectoflexus on the upper molars. The lower premolars and molars do not differ from those described for the *P. californicus*.

TABLE 10. Measurements of *Didelphidectes* sp. cf. *D. pumilis* from the Medicine Pole Hills local fauna.

Tooth	measurement	n	mean	OR
M1	AP	1		1.81
	W	1		1.68
	AP/W	1		1.08
M3	AP	2	1.73	1.71-1.74
	W	2	2.21	2.03-2.39
	AP/W	2	0.79	0.72-0.86
m2 or 3	AP	1		1.66
	Trigonid AP	1		1.02
	Wa	1		0.90
	Wp	1		0.90

Genus *Didelphidectes* Hough, 1961
Didelphidectes sp. cf. *D. pumilis* Hough 1961
(Figure 13, N-P; Table 10)

Referred Specimens—all PTRM: RM1 7855; LM3 7263, 7264; Rm2 or 3 14067.

Description—The upper dentition of *Didelphidectes* has not been described. The upper dentition referred to *Didelphidectes* by Hough (1961) was identified as *Herpetotherium* by Korth (1994). The isolated upper molars referred here are only tentatively included in the genus because of their larger size relative to *Peradectes* sp. cf. *P. californicus*. Stylar cusp B is the largest cusp on both M1 and M3. The only M1 has a large anterobuccal spur but lacks a distinct cusp A. Cusp D is present but small (Figure 13N). The two M3 specimens are similar. Cusp A is present on one M3 but absent on the other (Figure 13O). No other stylar cusps are developed.

The single lower molar differs from *Peradectes* sp. cf. *P. californicus* in having the trigonid cusps nearly equal in size, a characteristic feature of *Didelphidectes* (Figure 13P). In the Medicine Pole Hills specimens of *Peradectes* sp. cf. *P. californicus*, the protoconid is always the largest trigonid cusp, with the metaconid and paraconid lower and smaller in area (occlusal view). The specimen differs from the description of the lower molars *Didelphidectes pumilis* given by Korth (1994) in only a single feature. The hypoconulid is smaller than the hypoconid and more nearly equal to the entoconid in size.

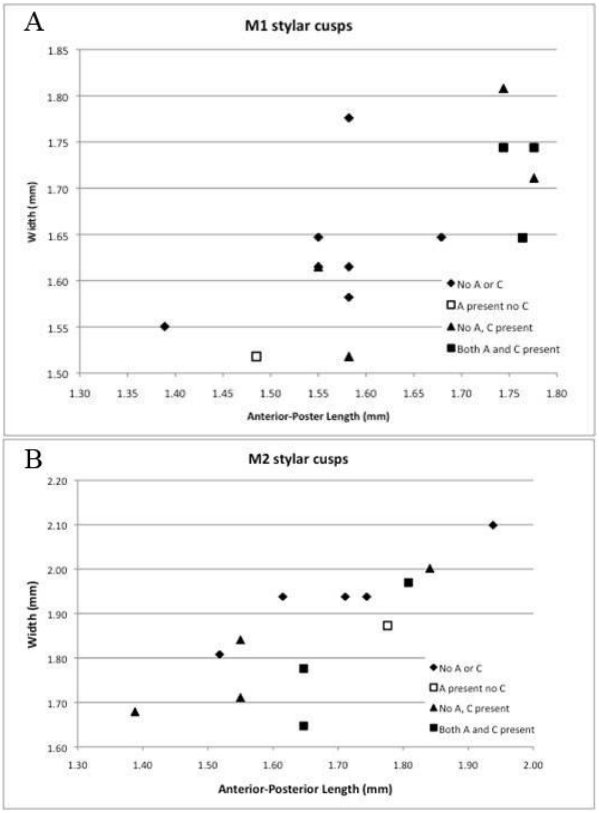

FIGURE 11. *Herpetotherium* sp. cf. *H. fugax* upper molar stylar cusps. A, M1; B, M2.

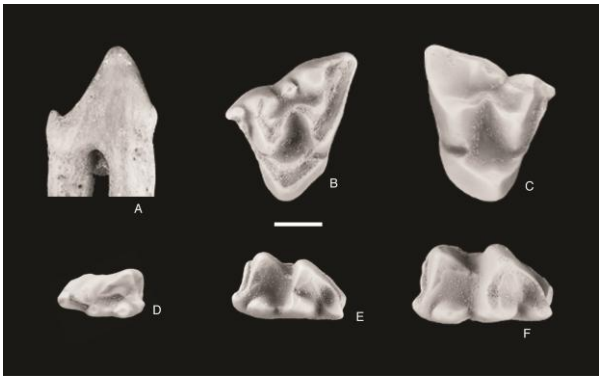

FIGURE 12. *Herpetotherium* sp. cf. *H. marsupium* from the edicine Pole Hills local fauna. A, PTRM 2004 LP3 buccal view; B, PTRM 4802 LM1; C, PTRM 10875 RM2; D, PTRM 14081 Rdp3; E, PTRM 4745 Lm1; F, PTRM 7483 Lm2 or 3. Bar scale is approximately 1mm

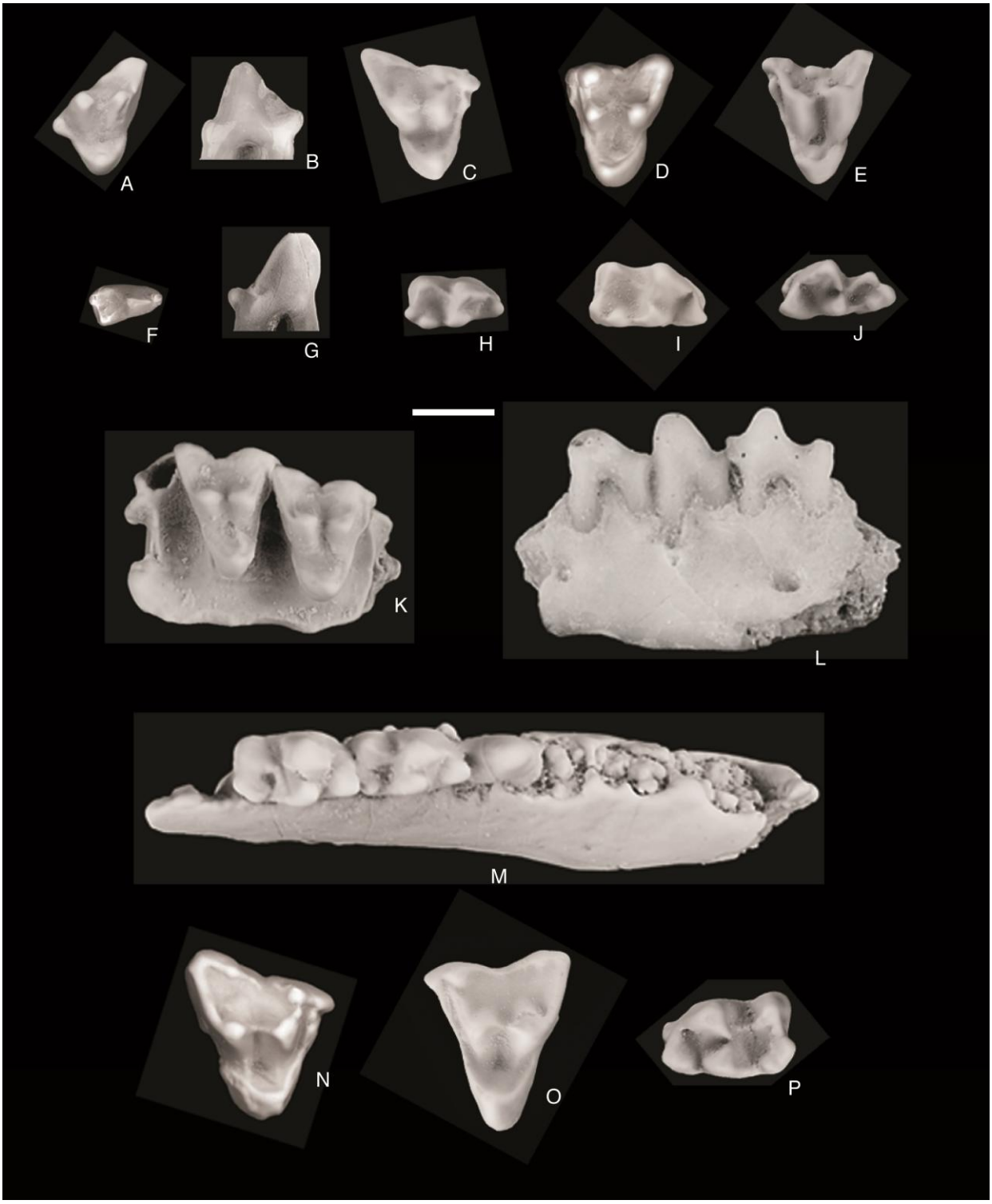

FIGURE 13. Peradectids from the Medicine Pole Hills local fauna. A-M, *Peradectes* sp. cf. *P. californicus*; A, PTRM 10496 LdP3; B, 10797 LP3 lingual view; C, PTRM 5805 RM1; D, PTRM 14665 LM2; E, PTRM 14066 LM3; F, PTRM 10500 Rdp3; G, PTRM 10832 Rp2 or 3 buccal view; H, PTRM 7688 Lm1; I, PTRM 10252 Lm2 or 3; J, PTRM 14669 Rm4; K, PTRM 7265 RM2-3; L, 5787 Lp2-m1 buccal view; M, PTRM 7266 Lp3-m2; N-P *Didelphidectes* sp. cf. *D. pumilis*; N, PTRM 7855 RM1; O, PTRM 7264 LM3; P, PTRM 14067 Rm2 or 3. Bar scale is approximately 1mm.

TABLE 11. Comparison of late Eocene marsupial species diversity from representative localities. Data derived from Korth (2007).

NALMA	Locality	Chron	Didelphidae	Peradectidae
Chadronian	Little Pipestone Springs	Ch3-4	*Herpetotherium fugax* *Herpetotherium valens* *Copedelphys titanelix*	
	Pipestone Spring	Ch3	*Herpetotherium fugax* *Copedelphys titanelix*	*Didelphidectes pumilis*
	Raben Ranch	Ch3	*Herpetotherium fugax*	*Nanodelphys hunti*
	Calf Creek	Ch3[1]	*Herpetotherium valens* *Copedelphys titanelix*	*Didelphidectes pumilis*
	McCarty's Mtn	Ch2	*Herpetotherium valens* *Copedelphys* sp. cf. *C. titanelix*	
Duchesnean	West McCarty's Mtn and Diamond O Ranch	Du	*Herpetotherium valens* *Copedelphys sp. cf. C. titanelix*	
	Hendry Ranch Mbr Wood and Rodent localities	Du	*Herpetotherium* sp. cf. *H. knighti* *Herpetotherium* sp. cf. *H. marsupium* *Copedelphys titanelix*	*Peradectes californicus*
	Lac Pelletier	Du	*Herpetotherium knighti* *Herpetotherium marsupium* *Copedelphys titanelix*	*Peradectes californicus*
Uintan	Hendry Ranch Mbr 5 and associated localities	Ui3	*Herpetotherium* sp. cf. *H. knighti* *Herpetotherium* sp. cf. *H. marsupium* *Copedelphys titanelix*	*Peradectes californicus*
	Swift Current	Ui3	*Herpetotherium knighti* *Herpetotherium marsupium* *Copedelphys titanelix*	*Peradectes californicus* *Nanodelphys* sp. cf. *N. hunti*

[1]The Calf Creek local fauna is identified as Ch1 in the unified locality listing (Janis et al. 2007, p. 728). It is considered Ch3 here.

Discussion—The upper molars referred here are the largest peradectid upper molars in the collection (Figure 7B). The single lower molar is among the largest, but is not the absolute largest peradectid lower molar. However, none of the other large lower molars have the trigonid cusps equal in size. The upper molars fall within the definition of *Nanodelphys*, with cusp B being the dominant stylar cusp with other cusps minor and variable. However, they are tentatively referred to *Didelphidectes* based on the greater confidence in the identification of the lower molar and the similarity in size to that tooth.

CONCLUSIONS

The presence of five species of marsupials is greater than reported for other early or middle Chadronian localities. All other Chadronian localities have a maximum of three reported species, typically two didelphids and a peradectid. Duchesnean and Duchesnean or older faunas. In addition to *Peradectes* sp. cf. *P. californicus* and *Herpetotherium* sp. cf. *H. marsupium* described here, *Prolapsus* sp. (Kihm, 2013), cf. *Ignacius* and a uintasoricine (Kihm and Tornow, 2014) have ~~been~~ previously had their chronologic ranges extended into the Chadronian of the Medicine Pole Hills local fauna. These late Uintan faunas often contain four or five species (Table 11). In addition, no Chadronian localities have a large species comparable to *Herpetotherium* sp. cf. *H. marsupium*, a holdover from the Duchesnean along with *Peradectes* sp. cf. *P. californicus*. *Herpetotherium marsupium* (and *H.* sp. cf. *H. marsupium*) has previously been reported from the Wasatchian to the Duchesnean (Krishtalka and Stucky, 1983a). *Peradectes californicus* has previously been reported from the Uintan to Duchesnean (Krishtalka and Stucky 1983a; Rothecker and Storer, 1996). The only other reported occurrence of *Peradectes* in beds potentially younger than Duchesnean was reported by Walsh and Gutzler (1999) from the Pomerado Conglomerate of California. Their preliminary faunal list included *Peradectes* sp., and their interpretation was that the fauna was near the Duchesnean-Chadronian boundary.

The Medicine Pole Hills mammalian fauna contains a number of taxa otherwise restricted to the occurrences indicate that some species survived later in the Great Plains Province than in the Rocky Mountain Province. In addition, these relict species suggest that the Medicine Pole Hills local fauna is somewhat older than the Calf Creek and Raben Ranch local faunas and probably represents a late early Chadronian (Ch2) fauna.

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