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RODENTS FROM THE CHADRONIAN (LATEST EOCENE) MEDICINE POLE HILLS LOCAL FAUNA, NORTH DAKOTA. PART 2. ISCHYROMYIDAE, SCIURAVIDAE, APLODONTIDAE, SCIURIDAE AND HELISCOMYIDAE

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ABSTRACT

The Medicine Pole Hills local fauna is a diverse earlier Chadronian fauna. The material described here includes *Ischyromys junctus*, *Ischyromys* sp., cf. *I. veterior*, *Metaparamys* sp., cf. *M. dawsonae*, *Prolapsus* sp., *Prosciurus vetustus*, a larger uncertain prosciurine species, *Douglassciurus jeffersoni*, and *Heliscomys* sp., cf. *H. vetus*. The rodents, not including the eomyids, include at least 13 species, making the rodent fauna among the most diverse early to mid-Chadronian faunas yet described. The Medicine Pole Hills rodent fauna shows the greatest similarity to the middle Chadronian Calf Creek rodent fauna. This may not be entirely due to similarity in age, as there is less similarity to other middle Chadronian rodent faunas. Instead, some level of similarity may be due to a somewhat similar ecologic setting. The presence of *Ischyromys junctus*, *Metaparamys* and *Prolapsus* all represent geographic range extensions for these taxa. The occurrence of *Prolapsus* is the first record of a sciuravid rodent from the Chadronian.

INTRODUCTION

This is the fourth in series of papers that describes the mammalian fauna of the Medicine Pole Hills local fauna of southwestern North Dakota. Previous papers have dealt with the multituberculates (Schumaker and Kihm, 2006), soricids (Kihm and Schumaker, 2008) and a portion of the rodent fauna (Kihm, 2011). The current study is the second on the rodent fauna with the most abundant group, the Family Eomyidae, to be completed at a later date. In addition to the mammalian fauna, Smith (2006, 2011a and b) has described a high diversity lizard fauna from the same site.

The specimens from the Medicine Pole Hills local fauna noted in this study come from a single quarry, Pioneer Trails Regional Museum (PTRM) Locality V89002, in Bowman County, North Dakota. The quarry sample was taken from a series of mudball conglomerate and sandstone units (see Schumaker and Kihm, 2006 for details) that can probably be included within the Chadron Formation, although not clearly correlatable with any of the named members in the region (Webster and Kihm, 2009). These rocks lie unconformably on the Paleocene Tongue River Member of the Fort Union Formation and are not overlain in any known outcrop by other sedimentary units.

Abbreviations used in the text are given in Table 1. All measurements are in millimeters.

SYSTEMATIC PALEONTOLOGY

Family Ischyromyidae Alston 1876
Genus *Ischyromys* Leidy, 1856
Ischyromys junctus Russell, 1972
(Figure 1A-H, Table 2)

Referred Specimens —All PTRM: RdP4,14972; RM1 or 2, 7945, 8001; LM1 or 2, 8325; RM3, 4738, 7387; Ldp4, 7713 (cf); Rp4, 2625; Lp4, 2008, 10928; Rm1 or 2, 5104, 8008, 11045; Lm1 or 2, 11042, 11043; Lm3, 8321, 11050, 11053.

Description —Overall, the teeth of this species are low crowned with distinct cusps that are taller than the lophs.

PTRM 14972 (Figure 1A) is very similar to SMNH P661.46 described by Storer (1978) as a RP4 of *I. junctus*. It is also similar to the dP4 figured by Wood (1937) for *I. veterior*. Based on the expanded parastyle, PTRM 14972 is interpreted as a dP4, and rather than a P4.

On the upper molars the hypocone is relatively large, in contrast to the weak hypocone described by Storer (1978) for *I. junctus* and more similar to the condition described for *I. douglassi* (Black, 1968).

PTRM 7945 (Figure 1B) is an unworn M1 or 2; the anterior cingulum continues as a low ridge along the buccal margin of the tooth enclosing a shallow anterior basin that differs from the open valley described for *I. douglassi*. The metaconule is a large cusp, and the metaloph is not complete to the hypocone. The posterior valley is enclosed by the posterior cingulum and there is a strong mesostyle. PTRM 8325 (Figure 1C) has a metaconule that connects to both the hypocone and the protocone. Some of the differences between the Medicine Pole Hills specimens may be related to tooth position.

TABLE 1. Abbreviations used in this paper

Museums	
PTRM	Pioneer Trails Regional Museum, Bowman, North Dakota
SMNH	Saskatchewan Museum of Natural History, Regina, Saskatchewan
USNM	US National Museum of Natural History, Washington, D.C.
Measurements in mm	
AP	Anteroposterior length
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

The M3 is variable. In PTRM 4738 the protoloph is low, but complete, and the anterior cingulum is shelf-like. There is no distinct hypocone or metacone and the tooth is generally triangular. In PTRM 7387 (Figure 1D), the anterior cingulum and protoloph are complete and more ridge-like. There is a small hypocone, a low metaloph and a small metacone, more similar to some of the variants described by Black (1968) for *I. douglassi*.

PTRM 7713 (Figure 1E) is interpreted to be a Ldp4 because of its low crown height and somewhat smaller size compared to the p4 specimens. The only morphologic difference is the posterior cingulum, that reaches the lingual border of the tooth. This feature ends before reaching the lingual border of the p4 specimens. PTRM 10928 matches the description of the p4 of *I. junctus* given by Russell (1972). PTRM 2008 (Figure 1F) is an unworn p4 with a well developed, cuspate hypoconulid. The hypolophid would only be complete to the entoconid after considerable wear as there is a deep notch near its connection to the ectolophid. These features of PTRM 2008 are similar to the condition described for some specimens of *I. douglassi* by Black (1968). The significance of these features is not known because of the low number of specimens available.

The m1 and m2 specimens are similar to those described for *I. junctus* by Russell (1972). In all specimens preserving the features, both the anterolophid and metalophid connect to the metaconid and enclose the trigonid basin. The hypolophid is complete. Russell (1972) described the posterior cingulum of *I. junctus* as uniting with the entoconid after moderate wear. In the PTRM specimens the posterior cingulum would only unite with the entoconid after the teeth are very worn. PTRM 11043 (Figure 1G), the only unworn m1 or 2 in the sample, has a well developed, cuspate hypoconulid.

The m3 (Figure 1H) has the anterolophid and metalophid attached to the metaconid. The hypolophid is complete and the same elevation as the ectolophid. On PTRM 8321 there is a low, but distinct hypoconulid.

Discussion—The upper molars of *I. junctus* differ from those of *I. douglassi* in having the anterior cingulum attached to the paracone and in lacking a deep lingual notch between the protocone and hypocone. In *I. blacki* (Wood, 1974) the anterior cingulum does not attach to the paracone. *Ischyromys veterior* and *I. typus* are larger than *I. junctus*, upper molars of *I. veterior* have a deep lingual notch and conules are absent in *I. typus* (Black, 1968).

The lower molars of *I. junctus* differ from those of *I. douglassi* in having the anterolophid complete, the trigonid basin enclosed and in having lower molars approximately 20% shorter. Heaton (1996) reviewed the lower dentition of *Ischyromys* and noted the difficulty associated with assigning isolated teeth to species. However, he did think that the Chadronian species could be distinguished by features of the m3. In particular he noted that *I. douglassi* has an elongate m3 and that *I. junctus* has a short m3. The Medicine Pole Hills specimens show the characteristic short m3 of *I. junctus* (Table 2). *Ischyromys veterior*, although similar in size to *I. junctus*, has taller crowned teeth (Heaton, 1996) and differs from *I. junctus* in the development of the m3 talonid. In *I. veterior*, the hypoconid is more posteriorly placed than the entoconid and the posterior cingulum curves posterolingually and ends before reaching the lingual border; the posterior valley remains open. In *I. junctus*, the hypoconid is almost directly opposite the entoconid and the posterior cingulum is parallel to the hypolophid and reaches the lingual border enclosing a narrow posterior valley. *Ischyromys blacki* is larger than *I. junctus* and has a weak anterior cingulum on the lower molars (Wood, 1974).

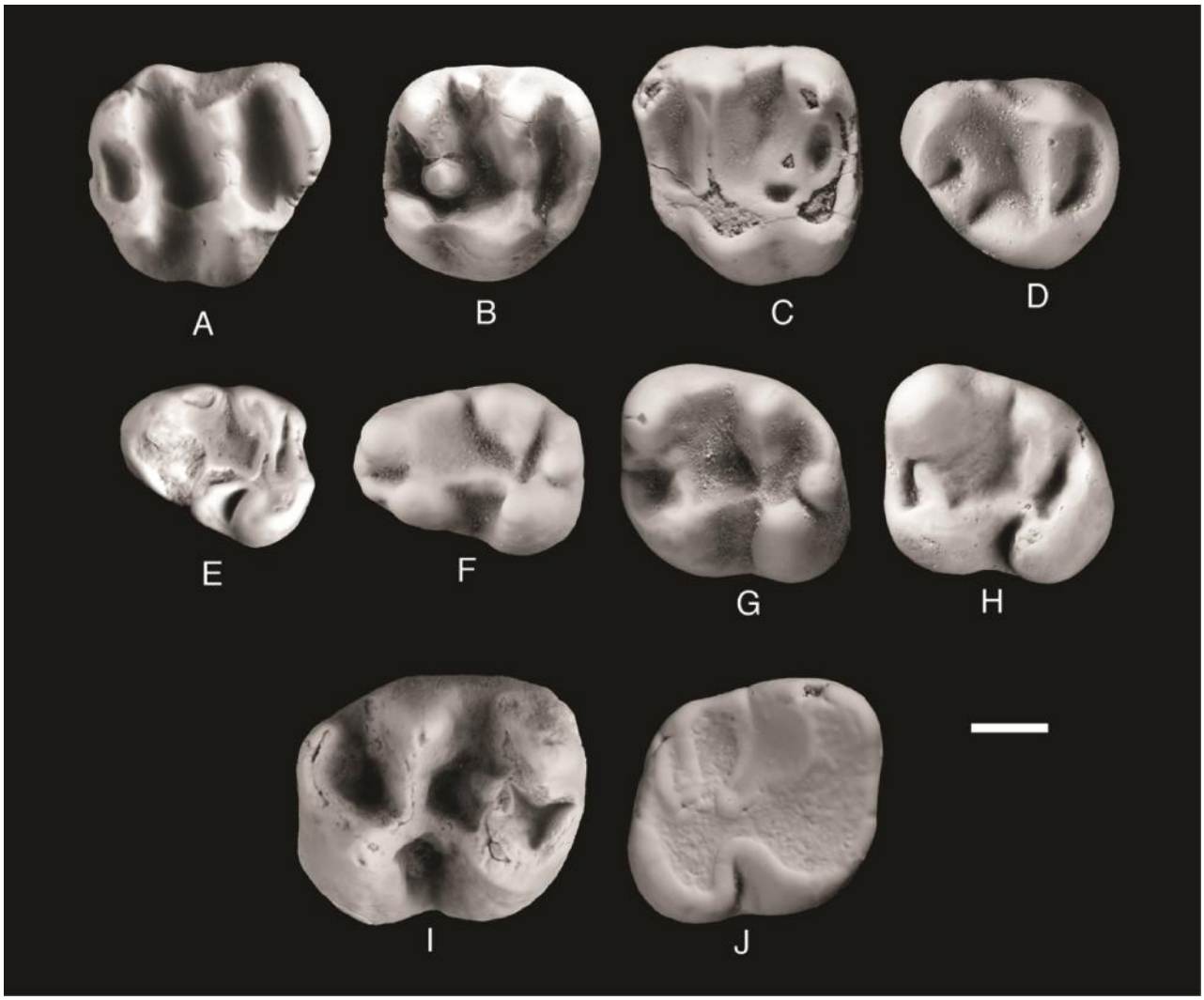

FIGURE 1. *Ischyromys* from the Medicine Pole Hills local fauna. A-H, *I. junctus*; A, PTRM 14972 RdP4; B, PTRM 7945 RM1 or 2; C, PTRM 8325 LM1 or 2; D, PTRM 7387 RM3; E, PTRM 7713 Ldp4; F, PTRM 2008 Lp4; G, PTRM 11043 Lm1 or2; H, PTRM 11050 Lm3. I-J, *Ischyromys* sp., cf. *I. veterior*, I, PTRM 4905 Rm1 or 2; J, PTRM 7428 Rm3. Bar scale is approximately 1 mm.

Ischyromys sp., cf. *I. veterior* Matthew, 1903
(Figure 1I-J, Table 2)

Referred Specimen—PTRM LM1 or 2, 11038; Rm1 or 2, 4905; Rm3, 7428.

Discussion—PTRM 11038 is a very worn upper molar that is distinctly larger than upper molars of *I. junctus*. PTRM 4905 (Figure 1I) is an unworn lower molar that is larger and taller crowned than specimens assigned to *I. junctus*. The anterolophid and metalophid are complete, but both crests slope down toward the metaconid, unlike specimens of *I. junctus* where these crests are essentially horizontal. There is a small cusp where the metalophid joins the metaconid. The posterior valley is not closed and the posterior cingulum curves and slopes down posterobuccally, but does not reach the lingual border. This specimen is very similar to *I. veterior* from the Pipestone Springs local fauna. PTRM 7428 (Figure 1J) is a worn m3 which is somewhat longer than m3 specimens of *I. junctus* and differs in having the posterior cingulum not attached to the entoconid.

Genus *Metaparamys* Korth and Emry, 2007
Metaparamys sp., cf. M. dawsonae Korth and Emry, 2007
(Figure 2A-D, Table 3)

Referred Specimens—All PTRM: RM3, 11041; Rp4-m1, 7920; Lm1 or 2, 8349; Rm3, 7440.

Description—The only upper molar in this sample is a worn M3 (Figure 2A). The tooth is broadly

TABLE 2. Measurements of *Ischyromys*

Ischyromys junctus							
Tooth	Number of Specimens	AP OR	AP Mean	W OR	W Mean		
dP4	1	3.10		2.67			
M1or 2	3	2.74-3.02	2.93	2.63-3.37	2.99		
M3	2	2.78-3.00	2.89	2.51-3.14	2.82		
		AP OR	AP Mean	Wa OR	Wa Mean	Wp OR	Wp Mean
dp4	2	2.51-2.86	2.68	1.72		1.96-2.12	2.04
p4	2	2.82-3.02	2.92	1.84-1.88	1.86	2.16-2.27	2.22
m1 or 2	5	2.78-2.98	2.88	2.66-3.06	2.86	2.70-3.02	2.78
m3	3	2.98-3.10	3.02	2.74-2.94	2.83	2.55-2.94	2.71
Ischyromys sp., cf. *I. veterior*							
PTRM Specimen Number	Tooth	AP	W				
11038	M1 or 2	3.45	3.95				
		AP	Wa	Wp			
4905	m1 or 2	3.76	3.29	3.18			
7428	m3	3.25	2.94	2.82			

triangular in occlusal outline. The protocone is the largest cusp and there is a complete anterior cingulum that connects to a moderately developed parastyle. The paracone is conical and is the tallest cusp. The protoloph is low, but complete and there is no indication of a parastyle. The metaloph was either incomplete, not developed, or has been completely eliminated by wear (the same holds true for the condition of a posterior cingulum). The metacone is not present as a distinct cusp, but is an enlargement on a buccal ridge that extends from the posterobuccal corner of the tooth to the paracone.

The p4 matches the description of the species given by Korth and Emry (2007). The only difference noted is that the hypoconulid is twinned in PTRM 7920 with the buccal cusp being slightly larger (Figure 2B). The m1 trigonid differs somewhat from the holotype (USNM 521359) in that the metalophid is complete and there is a small anteroconid anterolingual to the protoconid. The anteroconid is weakly connected to the metaconid and the trigonid basin is present as a narrow crescentic valley. The talonid is as seen in the holotype. PTRM 8349 (Figure 2C) is an isolated m1 or 2. On this specimen, the trigonid opens posteriorly but is closed anteriorly by a narrow anterolophid. In addition, there is a short cingulum low on the anterior wall of the anterolophid which encloses a small pit. PTRM 7440 is an isolated m3 (Figure 2D). The trigonid has a strong, low anteroloph connecting the protoconid and metaconid. The metaloph is not complete and the trigonid basin opens posteriorly. There is a very distinct conical metastylid on the posterior slope of the metaconid, separated by a deep valley from the entoconid. The mesoconid is larger than the metastylid, but is a low rounded cusp. There is only a very weak hypolophid that ends before reaching the ectolophid.

TABLE 3. Measurements of *Metaparamys* sp., cf. *M. dawsonae*

PTRM Specimen Number				
	Tooth	AP	W	
11041	M3	4.67	4.34	
		AP	Wa	Wp
7920	p4	4.54	3.40	4.67
7920	m1	4.40	3.94	4.40
8349	m1or 2	5.27	4.40	4.34
7440	m3	5.37	4.20	3.87

Discussion—The upper dentition of *Metaparamys dawsonae* is not known, and PTRM 11041 is tentatively assigned to this species because it is the only appropriately sized rodent in the fauna.

There are some differences in the lower dentitions between the Medicine Pole Hills specimens and the holotype and referred specimen of *M. dawsonae* described by Korth and Emry (2007). The teeth are comparable in size, except for PTRM 8349 which is larger. In morphology, the Medicine Pole Hills specimens are generally very similar to the holotype, with the differences noted above. The only morphologic feature which may prove to be of significance is the development of the mesoconid. This cusp is lacking in lower molars of *Metaparamys* (Korth and Emry, 2007), but is present in both PTRM 8349 and 7440. It is potentially possible that these two specimens represent a species other than *M. dawsonae*, but the overall similarity makes this unlikely.

Given the small sample size of the hypodigm and specimens referred here, together with the variability

typical of ischyromyids, these differences are not considered to be of specific importance.

Family Sciuravidae Miller and Gidley, 1918
Genus *Prolapsus* Wood, 1973
Prolapsus sp. uncertain
(Figure 2E)

Referred Specimen—PTRM 7298, RM1 or 2.

Description and Discussion—The tooth is rectangular in occlusal outline, with four major subequal cusps (Figure 2E). The protocone is connected by a high protoloph to the paracone. The protoloph curves anteriorly and does not have a protoconule. The anterior cingulum is a crest, lower than the protoloph that connects to the anterobuccal slope of the paracone and encloses an anterior basin. There is no distinct anterocone or protostyle. The hypocone is crescentic and connected to the protocone only by a very low narrow crest. Two crests diverge from the hypocone. The posterior cingulum curves posteriorly and connects to the posterior face of the metacone. The anterior crest (pseudomesoloph of Wood, 1973) curves anteriorly and extends buccally towards the mesostyle but does not join this cusp. The metaloph extends from the metacone towards the hypocone but ends at a small metaconule. The metaloph is connected low on the tooth to the pseudomesoloph. The metastyle is expanded lingually.

This specimen can be assigned to *Prolapsus* because of the development of the pseudomesoloph, a feature not developed on other sciuravids. The Medicine Pole Hills specimen is very close to the average size for *P. sibilatoris* with an anterior-posterior length of 2.36 mm, an anterior width of 2.33 mm and a posterior width of 2.23 mm. As noted by Wilson and Runkel (1991), the primary difference between *P. sibilatoris* and *P. junctus* is size which suggests the Medicine Pole Hills specimen is more closely related to *P. sibilatoris*. But because the material is a single isolated tooth, no specific assignment is suggested.

The identification of *Prolapsus* in the Medicine Pole Hills local fauna extends the known range of this genus from the Uintan into the Chadronian, and from southern Texas to North Dakota. It also represents the first record of a sciuravid from the Chadronian.

Family Aplodontidae Trouessart, 1897
Genus *Prosciurus* Matthew, 1903
Prosciurus vetustus Matthew, 1903
(Figure 3, Table 4)

Referred Specimens—All PTRM: LdP4, 11046; RP4, 14177; R M1 or 2, 5572, 8339, 11047, 11051; LM1or 2, 7392, 8010, 11039, 14607, 15022; RM3, 5052, 5074; Rdp4, 6212; Rp4, 10950; Lp4 7921; Rm1 or 2, 7720, 8340, 11035, 11037; Lm1 or 2, 5037, 5571, 11040, 11048, 11049, 14175; Rm3, 2630, 8005, 11044; Lm3, 7293, 7659 (cf).

Description—PTRM 11046 (Figure 3A) is probably a dP4 as it is very similar to the specimen figured by Wood (1937) for this species. The only noted differences are the complete metaloph and a metastyle in the PTRM specimen. The upper dentition has been adequately described by Wood (1937) with the only noted difference being that the metaloph is consistently complete on the P4, M1 and M2, although it is often constricted at its fusion at the base of the protocone. This is similar to the condition described by Black (1965) and Storer (1978) for *P. vetustus*. The M3 is more variable. The protoconule is not well developed, and on PTRM 5052 (Figure 3E) there is a short accessory crest from the protocone into the anterior basin. The anterior cingulum is complete to the anterobuccal corner of the tooth, but the parastyle is not as large as on M1 or M2. The metaloph is incomplete in one specimen (Figure 3F) with a single metaconule separated from the protocone. In the other specimen (PTRM 5052) there is no distinct metacone. A curved crest attaches to the posterior cingulum and terminates at a single metaconule near the protocone creating a small pit. The mesostyle is present on one specimen and indistinct on the other.

The p4 has an anteroconid, variable in size from small on PTRM 6212 to large on PTRM 10950 (Figure 3G). Ostrander (1980) suggested that the presence of an anteroconid on Raben Ranch specimens was indicative of dp4. PTRM 6212 may be a dp4, but both PTRM 7921 and 10950 have well developed roots. In PTRM 7921 the trigonid basin is open anteriorly (Figure 3H), but on PTRM 10950 the large anteroconid closes the trigonid basin. The m1 and m2 (assuming both teeth are represented in the sample) are typical of the species. The trigonid basin is shallow and closed on most specimens, with the metalophid connecting to the anterior cingulum on the buccal half of the tooth. In PTRM 11048 (Figure 3I) the trigonid basin is deeper because of a taller metalophid and in PTRM 11035 the metalophid does not connect to the anterior cingulum. In all specimens the mesoconid is large and expanded buccally, and the metastylid is central between the metaconid and entoconid. The hypolophid is short and connects to the posterior cingulum. In PTRM 11037 the posterior cingulum is separated from the entoconid by a broad notch. On all other specimens the posterior cingulum is complete to the entoconid. The m3 is similar to the anterior molars, but the trigonid basin is typically not closed or only weakly closed by the metalophid. The hypolophid is either very short or indistinct. The mesoconid is consistently large. The metastylid is doubled on most specimens and the

FIGURE 2. *Metaparamys* and *Prolapsus* from the Medicine Pole Hills local fauna. A-E, *Metaparamys* sp., cf. *M. dawsonae*; A, PTRM 11041 RM3; B, PTRM 7920, Rp4-m1; C, PTRM 8349 Lm1 or 2; D, PTRM 7440 Rm3. E, *Prolapsus* sp., PTRM 7298 RM1 or 2. Upper bar scale for 2A-D and lower bar scale for 2E are approximately 1 mm.

entoconid is variable, from equal to the metastylid to distinctly larger.

Discussion—The Medicine Pole Hills sample is assigned to *P. vetustus* on the basis of the doubled metaconules on the upper dentition, together with the size of the specimens. *Prosciurus relictus* is similar in size, but has single metaconules on the upper molars (Korth, 1989b). The Medicine Pole Hills specimens are somewhat smaller than other samples of *P. vetustus*, showing overlap with *P. parvus*, but the latter species has single metaconules and reduced protoconules (Korth, 1989b). The Medicine Pole Hills sample shows some variation from previously described samples of *P. vetustus*, but none of the variation presents a strong case for recognition of a distinct species. The dimensions of lower molars are on the smaller end of the size range reported for the species, but because of the difficulty in consistently orienting isolated m1 and m2 specimens, any apparent size difference may be artificial. The m3 which can be more consistently oriented is very similar in size to the samples from both the Pipestone Springs (Black, 1965) and Calf Creek (Storer, 1978) local faunas.

Prosciurine, genus and species uncertain
(Figure 4)

Referred Specimens—All PTRM: LdP4, 4962 (cf); RM1 or 2, 5051; Rm1 or 2, 4901.

Description and Discussion—The three specimens included here are unlikely to represent the same species. They are larger than comparable teeth of *P. vetustus* and are grouped here only for convenience.

PTRM 4962 (Figure 4A) is an almost complete dP4, missing a small portion of the buccal margin. The protocone is the largest cusp although the paracone is taller. The protoloph is complete with a single large protoconule. The anterior cingulum is complete to the triangular parastyle that is not as enlarged as the parastyle in *P. vetustus*. The metaloph is complete with a very low connection to the protocone. There are two metaconules, the lingual one being larger. There is a low, but distinct hypocone and a posterior cingulum complete to the posterior slope of the metacone. The metastyle is central. This tooth appears to be a prosciurine, and the doubled metaconule would suggest affinity with *Prosciurus*, particularly *P. vetustus*. However, the parastyle is smaller, the hypocone is better developed and the specimen is about 15-20% larger (AP 1.93, W 2.00) than *P. vetustus*. The tooth is somewhat smaller than *Prosciurus albiclivus* (however only P4 is known, Korth 1994) and has a better developed hypocone. These characters are more similar to *Pelycomys* (Korth, 1986), but the Medicine Pole Hills specimen lacks the anterior crest from the protocone. The specimen is unlikely to represent a sciurid. *Hesperopetes thoringtoni* is approximately the same size and lacks the degree of crenulation seen

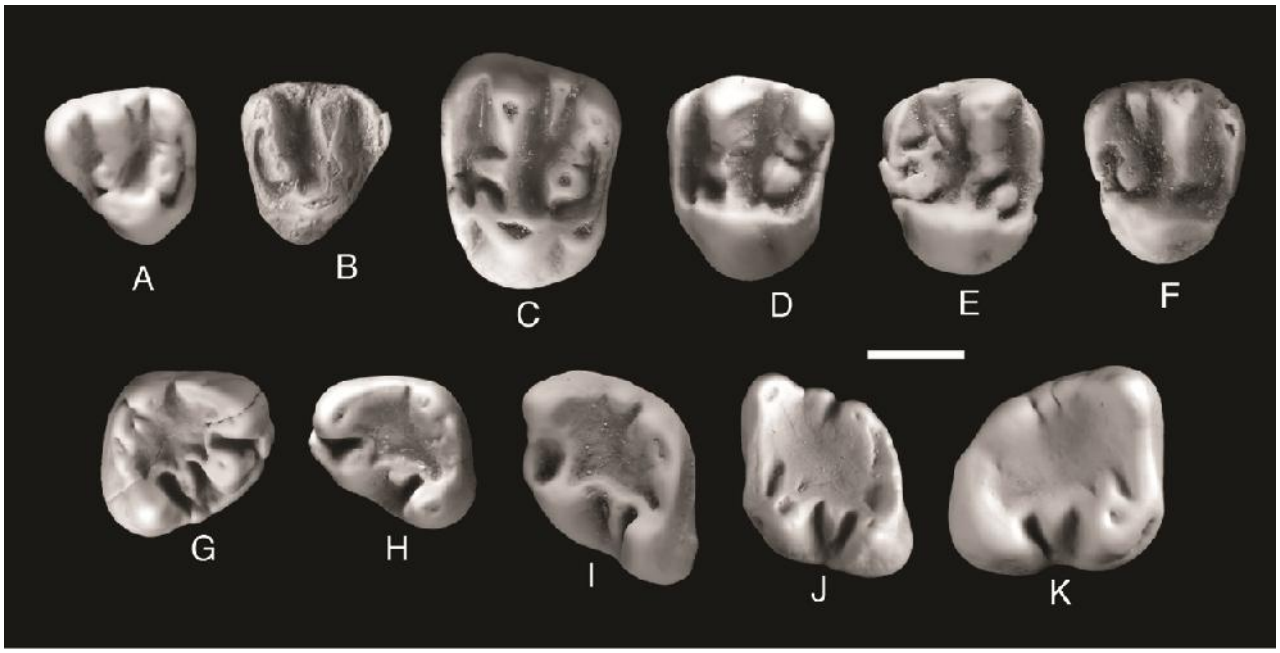

FIGURE 3. *Prosciurus vetustus* from the Medicine Pole Hills local fauna. A, PTRM 11046, LdP4; B, PTRM 14177 RP4; C, PTRM 15022 LM1 or 2; D, PTRM 8010 LM1 or 2; E, PTRM 5052 RM3; F, PTRM 5074 RM3; G, PTRM 10950 Rp4; H, PTRM 7921 Lp4; I, PTRM 11048 Lm1 or 2; J, PTRM 11040 Lm1 or 2; K, PTRM 2630 Rm3. Bar scale is approximately 1 mm.

TABLE 4. Measurements of *Prosciurus vetustus*

Tooth	Number of Specimens	AP OR	AP Mean	W OR	W Mean		
dP4	1	1.56		1.73			
P4	1	1,56		1.81			
M1or 2	7	1.49-1.88	1.68	1.97-2.16	2.10		
M3	2	1.68-1.71	1,70	1.97	1.97		
		AP OR	AP Mean	Wa OR	Wa Mean	Wp OR	Wp Mean
dp4	1	1.51		1.20		1.37	
p4	2	1.73-1.81	1.77	1.34-1.44	1.39	1.68-1.81	1.75
m1 or 2	9	1.46-1.95	1.76	1.39-2.03	1.74	1.44-1.95	1,75
m3	4	2.20-2.27	2.25	1.81-2.02	1.88	1.56-1.73	1.65

in other species of the genus; however, the dP4 of this species lacks distinct conules and has a flaring anterior cingulum (Emry and Korth, 2012)

PTRM 5051 is an M1 or 2 (Figure 4B). The protocone is the largest cusp with a complete, low protoloph. There is no evidence of a protoconule. The anterior cingulum forms a wide shelf to a large anteroposteriorly compressed parastyle. The metaloph is complete with two subequal conules. The posterior cingulum is very low on the tooth but is complete to the metacone. There is no metastyle. This specimen differs from *P. vetustus* in lacking a protoconule and a metastyle. In addition, the tooth is larger (AP 2.16, W 2.55) than *P. vetustus*. The reduction, but not loss, of the protoconule is seen in *Campestrallomys*, but in this genus the metastyle is present and expanded buccally (Korth, 1989b). The lack of a hypocone, metastyle and protoconule make it unlikely that this specimen represents the same species as PTRM 4962.

PTRM 4901 is an m1 or 2 (Figure 4C). It is very similar to the lower molars of *P. vetustus* in the Medicine Pole Hills sample, differing only in size, most notably in being distinctly wider (AP 1.98, Wa 2.20, Wp 2.20). The trigonid basin is enclosed by a low metalophid. The mesoconid is large. The hypolophid is short and close to the posterior cingulum. The metastylid is large and central between the metaconid and entoconid. It is possible that this specimen represents *P. vetustus*, but including it with the other specimens would create a highly variable (in tooth size) population. The specimen does not appear to represent *Pelycomys* which has the metastylid connected to the metaconid (Galbreath, 1953). It is somewhat smaller than both *Pelycomys rugosus* and *P.*

placidus and differs from the former species in having a better developed mesoconid that extends buccally.

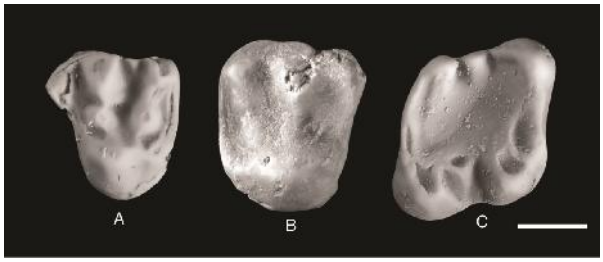

FIGURE 4. Prosciurine, genus and species uncertain from the Medicine Pole Hills local fauna. A, PTRM 4962 LdP4; B, PTRM 5051 RM1 or 2; C, PTRM 4901 Rm1 or 2. Bar scale is approximately 1 mm.

Family Sciuridae Fischer de Waldheim, 1817
Genus *Douglassciurus* Emry and Korth, 2001
Douglasscirurus jeffersoni (Douglass, 1901)
(Figure 5, Table 5)

Referred Specimens—All PTRM: RdP4, 6203; LP4, 5025; RM1 (cf), 2607, 2628; LM2 (cf) 7932; Lp4-m1, 11034; Lp4, 1943; Rm1 or 2, 11036.

Description and Discussion—The dentition of *Douglassciurus jeffersoni* has been described and figured (Black, 1965; Storer, 1978; Emry and Korth, 1996). However, the Medicine Pole Hills sample shows some additional variation. PTRM 6203 (Figure 5A) is a dP4 with complete protoloph and metaloph. There is a small protoconule and doubled metaconules. The parastyle is large and forms an expanded anterobuccal corner to the tooth. There is a distinct, conical mesostyle. PTRM 5025 (Figure 5B) is a P4 that has three metaconules, with the central one being the smallest. The protocone ridge connects to the paracone and encloses a basin between this ridge and protoloph. On the specimens interpreted as M1 there is a large parastyle (Figure 5C). The protocone is the largest cusp, with the paracone and metacone somewhat compressed anteroposteriorly. The protoloph is low, a small protoconule is present on PTRM 2628. There is a weak crest trending from the protocone anterobuccally into the shelf created by the anterior cingulum. The metaloph is complete with a single metaconule. A small hypocone is present. The posterior cingulum is complete to the metacone. PTRM 7932 (Figure 5D) is interpreted as an M2 and is similar to the M1 with some differences. The parastyle is not as large as on the M1, there are two metaconules and the mesostyle is better developed (Figure 5D).

The specimens of the lower dentition show very weakly developed and short hypolophids.

PTRM 1943 and 11034 are smaller than the published data for the species (Black, 1965; Storer, 1978; Emry and Korth, 1996), but do not approach the size of *Hesperopetes* (Emry and Korth, 2007) and, unlike *Hesperopetes* lower molar specimens, have a moderately developed anteroconid and a weak hypolophid.

TABLE 5. Measurements of *Douglassciurus jeffersoni*

PTRM Specimen Number				
	Tooth	AP	W	
6203	dP4	2.31	2.63	
5025	P4	2.63	3.45	
2607	M1 (cf)	3.02	3.68	
7932	M2 (cf)	2.82	3.68	
		AP	Wa	Wp
1943	p4	2.43	1.65	2.05
11034	p4	2.39	2.04	2.27
11034	m1	2.63	2.43	2.43
11036	m1 or 2	3.13	3.00	3.20

Family Heliscomyidae Korth, Wahlert and Emry, 1991
Genus *Heliscomys* Cope, 1873
Heliscomys vetus Cope, 1873
Heliscomys sp., cf. *H. vetus*
(Figure 6, Table 6)

Referred Specimens—All PTRM: RP4, 4898, 11063; RM1 or 2, 5452, 5459, 5540, 7727, 10290, 10296, 11061, 14157, 14159, 14161, 14168, 14693, 14697, 14699; LM1 or 2, 4881, 4961, 5588, 5595, 10208, 10294, 10298, 11054, 11055, 11058, 11064, 11066, 14155, 14166, 14167, 14171, 14692, 14696, 14698, 14700; Rm1 or 2 4880, 5065, 5094, 5457, 5818, 5848, 6157, 10292, 10297, 10444, 11067, 14150, 14153, 14154, 14158, 14160, 14164, 14170, 14173, 14701, 14702; Lm1 or 2, 4971, 5013, 5490, 5744, 5875, 6276, 7426, 8013, 8014, 10293, 10295, 11056, 11057, 11059, 11060, 11062, 14151, 14152, 14156, 14162, 14163, 14165, 14169, 14172, 14694, 14695, 14703, 14704.

Description—Only two P4 specimens have been recovered. PTRM 4898 (Figure 6A) has a small entostyle and lacks a paracone. PTRM 11063 (Figure 6B) has a large entostyle and a small paracone.

The upper molar sample consists entirely of isolated teeth, so there is uncertainty about assigning specimens to the correct tooth position. The sample contains 34 upper molars, so it is likely that both the M1 and M2 are represented. None of the specimens appear to be the M3.

The upper molars all have four distinct, subequal cusps. In addition to these, there is typically an entostyle (24 of 32 specimens where the condition can be determined) as a distinct cusp on the lingual cingulum. On eight of the specimens, the lingual cingulum forms a large loph without any distinct stylar

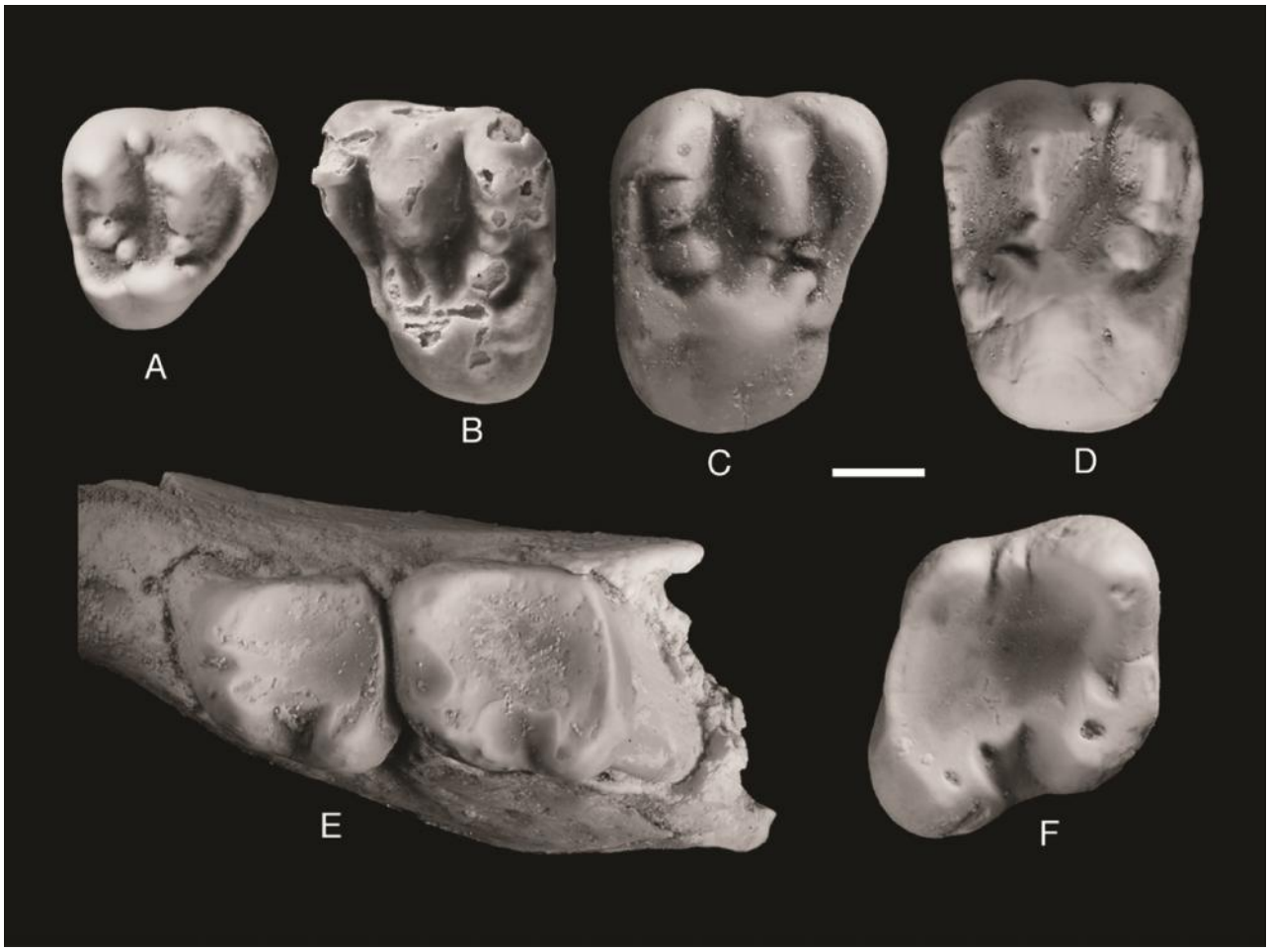

FIGURE 5. *Douglassciurus jeffersoni* from the Medicine Pole Hills local fauna. A, PRM 6203 RdP4; B, PTRM 5025 LP4; C, PTRM 2607 RM1 (cf); D, PTRM 7932 LM2 (cf); E, PTRM 11034 Lp4-m1; F, PTRM 11036 Rm1 or 2. Bar scale is approximately 1 mm.

cusp (Figure 6C). The specimens lacking a distinct entostyle are probably M2, but some of the specimens with an entostyle may also represent the M2. Eight of the specimens have some development of cusps on the lingual cingulum anterior to the entostyle (6D). In PTRM 11061, there are two cusps on the lingual cingulum anterior to the entostyle and it is the more anterior of these that is larger (Figure 6E). In other specimens, the cusps on the lingual cingulum are very small. Only one specimen, PTRM 14699 (Figure 6F) has a distinct groove in the lingual cingulum. Several other specimens have a shallow groove in the cingulum, most often in those specimens with a well developed entostyle. Most of the specimens (13 of 20) show some development of a cusp (anterocone?) on the anterior cingulum in line with the valley between the protocone and paracone. The anterior cingulum is continuous with the lingual cingulum and extends to the anterior face of the paracone, or less often to the anterobuccal corner of the tooth. Most specimens (24 of 28) have a short posterior cingulum.

The lower molar sample consists of 49 isolated teeth, all representive of either the m1or m2. There are four main cusps with the protoconid and metaconid subequal. On 34 specimens the hypoconid and entoconid are subequal; on 14 specimens the entoconid is smaller than the hypoconid. There are two stylar cusps on all specimens. On 27 of the 47 specimens where the condition can be determined, the protostylid and hypostylid are subequal in size. On 18 specimens, the protostylid is distinctly larger than the hypostylid and on two specimens (PTRM 5875 and 11060) the hypostylid is the larger cusp (Figure 6G). On 28 specimens, the protostylid is in line with the metaconid and protoconid; on the remaining 19 specimens it is posterior to a line through the metaconid and protoconid (Figure 6H). The hypostylid is on a line extending through the entoconid and hypoconid. The anterior cingulum is complete from the protostylid to

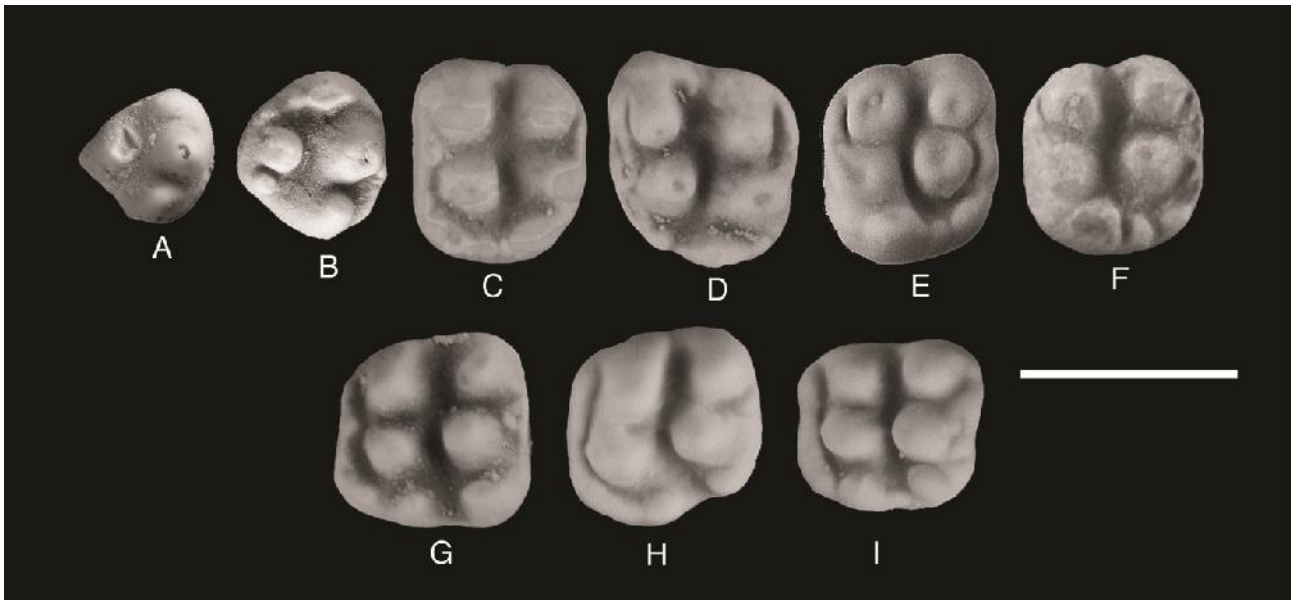

FIGURE 6. *Heliscomys* sp., cf. *H. vetus* from the Medicine Pole Hills local fauna. A, PTRM 4898 RP4; B, PTRM 11063 RP4; C, PTRM 10298 LM1 or 2; D, PTRM 10208 LM1 or 2; E, PTRM 11061 RM1 or 2; F, PTRM 14699 RM1 or 2; G, PTRM 5875 Lm1 or 2; H, PTRM 14162 Lm1 or 2; I, PTRM 10293 Lm1 or 2. Bar scale is approximately 1 mm.

TABLE 6. Measurements of *Heliscomys* sp. cf. *H. vetus*

Tooth	Number of Specimens	AP OR	AP Mean	Wa OR	Wa Mean	Wp OR	Wp Mean
P4	2	0.61-0.68	0.65	0.44-0.54	0.59	0.68-0.76	0.72
M1 or 2	34	0.73-9.02	0.82	0.76-1.00	0.89	0.76-1.00	0.91
m1 or 2	49	0.73-0.92	0.85	0.73-0.98	0.84	0.69-0.94	0.80

the anterolingual corner of the tooth. The posterior cingulum is typically present from the hypostylid to at least between the hypoconid and entoconid. On two specimens it is complete to the posterolingual corner of the tooth (Figure 6I). There is a hypoconulid developed on the posterior cingulum on 32 of the 42 specimens where the condition can be determined.

Discussion—The only species of *Heliscomys* reported from the Chadronian are *H. vetus* (Ostrander, 1980) and *H. ostranderi* (Korth et al., 1991). Ostrander provided no detailed description of the material he referred to *H. vetus*. Lower molars in the Medicine Pole Hills sample show considerable overlap in size with both *H. ostranderi* and *H. vetus* (Figure 7). The upper molars of the Medicine Pole Hills sample are somewhat larger than *H. ostranderi* but smaller than *H. vetus* (Figure 8). The lack of a consistent groove in the lingual cingulum of the upper molars indicates that the Medicine Pole Hills species represents the lineage containing *H. vetus* rather than the one containing *H. ostranderi* (Korth et al., 1991). The P4, based on a very limited sample, has a width 79% of the M1 or 2. This is within the range of *H. ostranderi*, but because all of the molars are isolated teeth, this numerical comparison is suspect. Within the *H. vetus* lineage, *H. mcgrewi* has a much simplified P4 and is not represented by this sample (Korth, 1989a). *Heliscomys woodi* is larger than the comparable teeth in the Medicine Pole Hills sample (McGrew, 1941).

The Medicine Pole Hills sample of *Heliscomys* lacks any specimens of the third molar (either upper or lower) or of the p4. This absence from the sample, and the few specimens of the P4, is likely caused by sampling bias. The screen size used to concentrate the Medicine Pole Hills sample was 0.84 mm, small enough to capture the first and second molars, but apparently too coarse to capture the smaller teeth.

RODENT DIVERSITY, BIOCHRONOLOGY AND PROVINCIALITY

The assemblage of rodents described here brings the total for the Medicine Pole Hills local fauna to at least 13, with the study of the eomyids yet to be completed. This diversity is among the greatest yet reported from an early or middle Chadronian locality. Emry and Korth (2012) reported 16 rodent species from both the early Chadronian and middle Chadronian

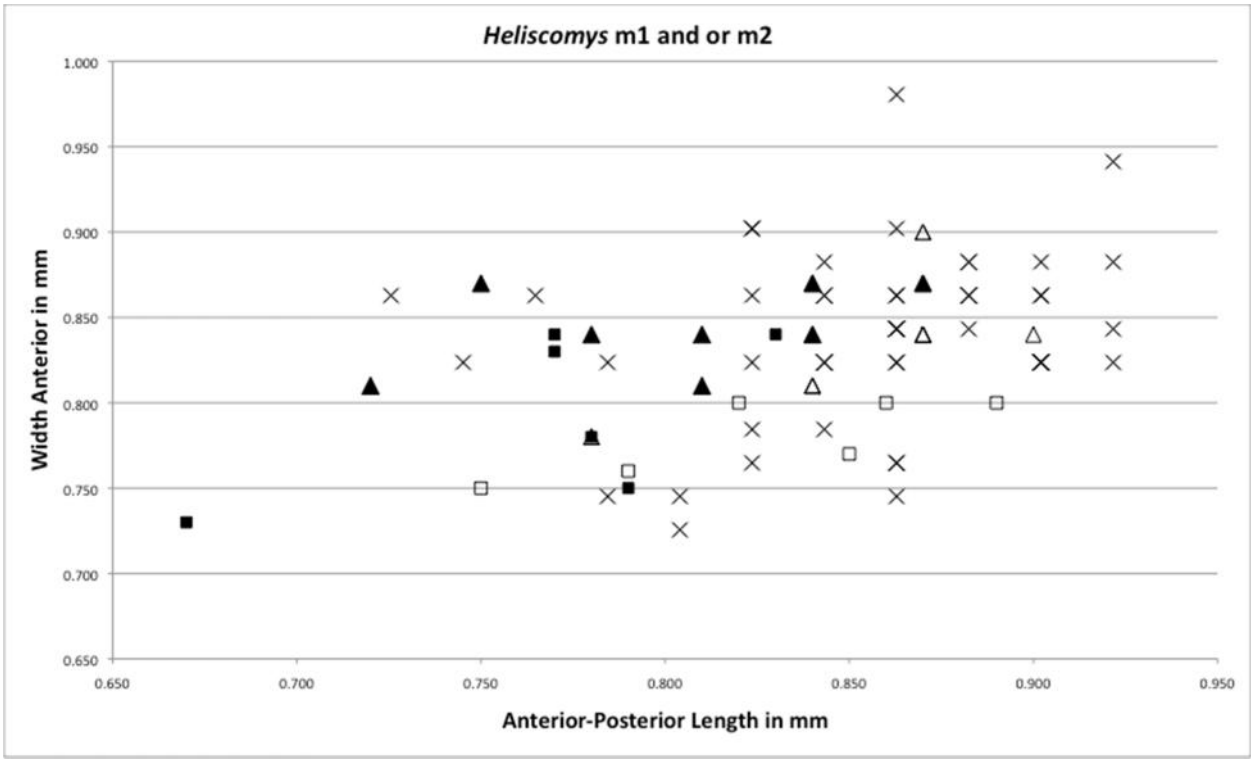

FIGURE 7. Length versus width of lower molars of *Helicomys ostranderi*, *H. vetus* and *H.* sp., cf. *H. vetus*. Open squares are *H. ostranderi* m1, black squares are *H. ostranderi* m2 from Korth et al. (1991). Open triangles are *H. vetus* m1, black triangles are *H. vetus* m2 from Galbreath (1953). X's represent m1 or m2 specimens from the Medicine Pole Hills local fauna.

at Flagstaff Rim, Wyoming. Storer (1978) reported 17 rodent species from the Calf Creek local fauna. Tabrum et al. (1996) reported 7 and 16 rodent species from the McCarty's Mountain and Pipestone Springs local faunas, respectively. The eomyid rodents represent the largest fraction of specimens in the Medicine Pole Hills local fauna and once their study is complete, the total rodent diversity will likely equal or surpass that of any other early or middle Chadronian fauna.

The Medicine Pole Hills rodent fauna shows the greatest similarity to middle Chadronian faunas. None of the taxa yet described are in common with the McCarty's Mountain local fauna (Tabrum et al., 1996). Three species occur in both the early Chadronian of the Flagstaff Rim and the Medicine Pole Hills faunas, *Douglassciurus jeffersoni*, *Ischyromys veterior* and *Metaparmys dawsonae* (with the material of the latter two species tentatively referred here). Of these, only *M. dawsonae* is restricted to the early Chadronian at Flagstaff Rim (Emry and Korth, 2012), and this species is only represented by two specimens out of the thousands from Flagstaff Rim (Korth and Emry, 2007). Four species occur in both the middle Chadronian Flagstaff Rim fauna and the Medicine Pole Hills fauna, *I. veterior*, *D. jeffersoni*, *Eutypomys parvus* and *Prosciurus vetustus*, of which the latter two are restricted to the middle Chadronian portion of the Flagstaff Rim fauna (Emry and Korth, 2012). Table 7 shows results of calculating the similarity index (Simpson, 1960) for selected Chadronian rodent faunas. Of note is the McCarty's Mountain local fauna that shows no similarity to any other fauna except the Pipestone Springs, and the calculated value is based on material only tentatively referred to the species. The early and middle Chadronian Flagstaff Rim faunas provides a baseline for comparison because there is no additional variable of geographic provinciality. The Medicine Pole Hills and Calf Creek local faunas show the greatest overall similarity, but all comparisons of the Medicine Pole Hills local fauna will likely change when the eomyid rodents are included. The value calculated for the Medicine Pole Hills fauna compared to the early Chadronian Flagstaff Rim fauna perhaps exemplifies this issue. The 43% similarity is biased by two variables. First, the early Chadronian rodent fauna from Flagstaff Rim is more than 50% eomyid rodents (reducing the N value to 7). Second, and this variable influences several of the other values, two of the three

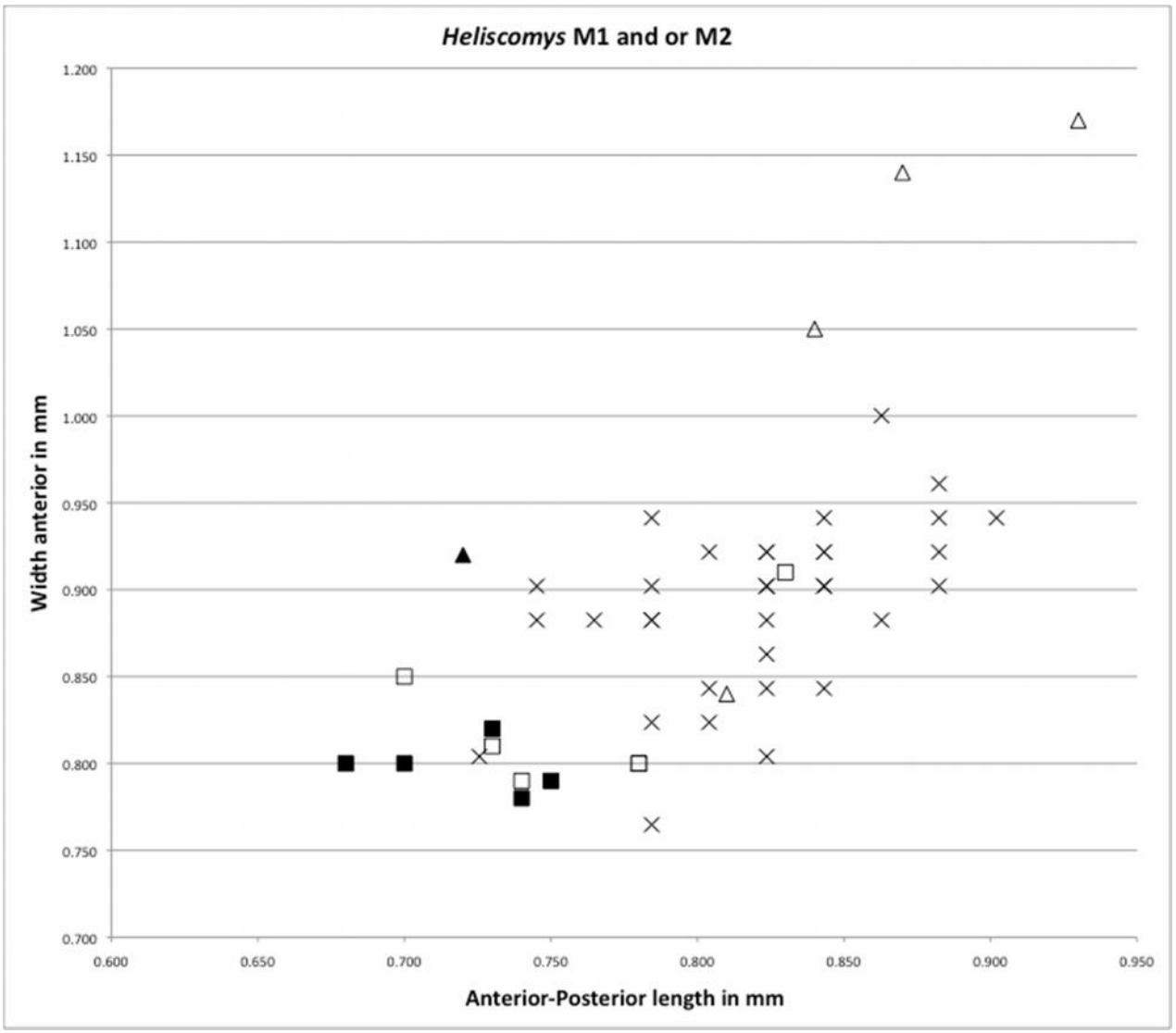

FIGURE 8. Length versus width of upper molars of *Helicomys ostranderi*, *H. vetus* and *H.* sp., cf. *H. vetus*. Symbols as in Figure 7.

species in common occur in both the early and middle Chadronian faunas.

The biochronologic data from the rodent fauna suggests that the Medicine Pole Hills local fauna is more likely middle Chadronian than early Chadronian. This apparently contradicts the interpretation based on the occurrence of *Leptomeryx yoderi* (Heaton and Emry,1996) and considered by Prothero and Emry (2004) to be an index fossil for the late early Chadronian. The presence of *Prolapsus*, known elsewhere only from the Uintan of Texas, would suggest an older age for the fauna. These conflicting data are yet to be resolved.

Storer (1989) attempted to characterize rodent faunal provinces for the Paleogene. Among his conclusions were that there was greater provinciality during the Duchesnean and less during the Chadronian, although this conclusion may have been affected by his inclusion of several early Chadronian faunas, such as McCarty's Mountain and the Yoder local faunas in the Duchesnean.

The Flagstaff Rim sequence can be utilized as a proxy for estimating the influence of time on rodent faunal change, without the confounding factors of uncertain correlation or geographic provinciality. The four sequential faunas given by Emry and Korth (2012), Lower Red Quarry, Dry Hole Quarry, B-44 feet

TABLE 7. Similarity index values for selected Chadronian rodent faunas.

		Local Fauna					
Local Fauna		McCarty's Mtn	Flagstaff Rim (early)	Flagstaff Rim (middle)	Calf Creek	Pipestone Springs	Medicine Pole Hills[1]
	McCarty's Mtn	100	0	0	0	43[2]	0
	Flagstaff Rim (early)	0	100	44	25	25	43
	Flagstaff Rim (middle)	0	44	100	31	44	37.5
	Calf Creek	0	25	31	100	37.5	64
	Pipestone Springs	43[2]	25	44	37.5	100	56
	Medicine Pole Hills[1]	0	43	37.5	64	56	100

Values were calculated using (C/N_1) X100, where N_1 is the number of species in the smaller fauna. Species were taken from Tabrum et al. (1996) for the McCarty's Mountian and Pipestone Springs local faunas, Emry and Korth (2012) for the Flagstaff Rim faunas, and Storer (1978) for the Calf Creek local fauna.

[1] For all comparisons involving the Medicine Pole Hills local fauna, only non-eomyid rodent species were used.

[2] All three of the common species are only tentatively referred to the species level.

Quarry and Above Ash B produce the following similarity data (see Table 7 for the formula): Lower Red Quarry to Dry Hole Quarry 43%, Dry Hole Quarry to B -44 feet Quarry 64%, B -44 feet Quarry to Above Ash B 64%. It is interesting to note that there is a greater faunal similarity between the Dry Hole and B -44 feet Quarries than between the Lower Red Quarry and the Dry Hole Quarry, although these latter two samples are both considered early Chadronian. Relatively high similarity values, therefore may not necessarily signify age similarity (as per the discussion above), but rather other factors such as ecologic (provincial) or taphonomic influences. The increasing similarity values may support Storer's contention that provinciality decreased over time.

The Medicine Poles Hills locality is approximately equidistant from both the Flagstaff Rim and Calf Creek areas, and somewhat further from Pipestone Springs. The greater similarity between the Calf Creek and Medicine Pole Hills rodent faunas, compared to either to the Flagstaff Rim or Pipestone Springs middle Chadronian faunas may result from some ecologic differences. Both the Calf Creek and Medicine Pole Hills localities are relatively distant from the margins of the Cordilleran mountain front, compared to a more intermontane setting for the Pipestone Springs and Flagstaff Rim localities.

Several of the rodent species reported here represent geographic range extensions. *Ischyromys junctus* was previously only reported from the Calf Creek local fauna of Saskatchewan (Russell, 1972; Storer, 1978). *Metaparamys* was previously only reported from the Flagstaff Rim area of Wyoming and northeastern Utah (Korth and Emry, 2007), and *Prolapsus* was only known from Texas (Wood, 1973; Wilson and Runkel, 1991).

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