

New earliest Tiffanian (late Paleocene) mammals from Cochrane 2, southwestern Alberta, Canada

CRAIG S. SCOTT, RICHARD C. FOX, and GORDON P. YOUZWYSHYN



Scott, C.S., Fox, R.C., and Youzwyshyn, G.P. 2002. New earliest Tiffanian (late Paleocene) mammals from Cochrane 2, southwestern Alberta, Canada. *Acta Palaeontologica Polonica* 47 (4): 691–704.

New mammalian fossils at Cochrane 2, Paskapoo Formation, Alberta, Canada, document five new species and two new combinations: *Ptilodus gnomus* sp. nov. and *Baiotomeus russelli* sp. nov. (Multituberculata), *Thryptacodon orthogonius* comb. nov. and *Litomylus grandaletes* sp. nov. (“Condylarthra”), *Pararyctes rutherfordi* sp. nov., *Bessoecetor septentrionalis* comb. nov., and *Paleotomus junior* sp. nov. (Eutheria *incertae sedis*). These new taxa supplement a taxonomically diverse Cochrane 2 local fauna, representing one of the most species rich Paleocene mammalian localities in the world. An earliest Tiffanian age is estimated for the locality based on the presence of the index taxa *Plesiadapis praecursor*, *Nannodectes intermedius*, and *Ectocion collinus*. The Cochrane 2 local fauna fails to demonstrate a decrease in species number relative to those of late Torrejonian localities from the United States, as would be predicted by current paleoclimate scenarios; the rarity of earliest Tiffanian localities in North America suggests sampling error as a partial explanation for the apparent incongruity.

Key words: Multituberculata, “Condylarthra”, Eutheria, Paleocene, Paskapoo Formation, Canada.

Craig S. Scott [cscott@ualberta.ca] and Richard C. Fox [richard.fox@ualberta.ca], Laboratory for Vertebrate Paleontology, Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E9; Gordon P. Youzwyshyn [youzwyshyn@admin.gmcc.ab.ca], Grant MacEwan Community College, Edmonton, Canada, T5J 4S2.

Introduction

Mammals from the Cochrane 2 locality, southwestern Alberta, Canada (this locality has also been referred to in earlier literature as Cochrane “II” and Cochrane “11”, see Fox 1990), were first described by Russell (in Rutherford 1927). A more comprehensive treatment of the mammalian fauna appeared in a series of papers by Russell in 1929, 1932, and 1958. Later, Krause (1978) described the plesiadapiforms known from the locality, and Gingerich (1982) reinterpreted aspects of the Cochrane 2 fauna, suggesting that it is earliest Tiffanian in age (Archibald et al. 1987) and that “*Meniscotherium semicingulatum*” Russell, 1929 pertains to the phenacodontid “condylarth” *Ectocion collinus* Russell, 1929. Consequently, the only valid new species of mammal to be described by Russell from the Cochrane 2 locality is the arctocyonid “*Chriacus*” *orthogonius* Russell, 1929, represented by a single upper molar (Gingerich 1982). Van Valen (1966), in his description of the palaeoryctid eutherian *Pararyctes pattersoni*, mentioned its probable occurrence at Cochrane 2, based on an upper molar illustrated by Russell (1932), later confirmed by Youzwyshyn (1988). Since that time, only two new taxa from Cochrane 2 have been formally described: the non-mammalian cynodont *Chronoperates paradoxus* Fox, Youzwyshyn, and Krause,

1992, and the primitive carnivoran *Pristiniactis connata* Fox and Youzwyshyn, 1994.

Research begun by Youzwyshyn in 1983 distinguished Cochrane 2 as containing the most speciose mammal local fauna known from the Paleocene (Youzwyshyn 1988; Fox 1990), and his work resulted in the discovery of several new mammalian taxa. The following is an account of the new species from Cochrane 2 that can be formally named at this time; others may well be recognized in the future, with the advent of better-preserved material of taxa presently represented in the UALVP collections from the locality. Among the latter are two additional species of the multituberculate *Ptilodus*, awaiting description by D.W. Krause, and two new microcosmodontid multituberculates included in a review of microcosmodontids in preparation by Fox.

Geological setting and stratigraphic position.—The Cochrane 2 locality is located 0.5 km east of the village of Cochrane, Alberta, at an outcrop in SE1/4S1, T26, R4, W5, approximately 1059 m above sea level (Fox 1990). The sediments preserving the Cochrane 2 fossils were originally referred to the Paskapoo Formation (Russell 1929, 1932, 1958; Tozer 1956), but were reinterpreted as pertaining to the Porcupine Hills Formation by Carrigy (1970, 1971). Recent stratigraphic analysis of Paleocene continental sedi-

ments in the Calgary and Foothills regions (Lerbekmo and Sweet 2000) has reinforced Russell and Tozer's original identification of these beds as part of the Paskapoo Formation, and this identification is followed here. Youzwyshyn (1988) determined the age of the Cochrane 2 fauna as earliest Tiffanian (the Tiffanian is a North American Land Mammal Age that is approximately late Paleocene; see Archibald et al. 1987), based on the occurrences of the plesiadapids *Plesiadapis praecursor* Gingerich, 1975 and *Nannodectes intermedius* (Gazin, 1971), the carpolestid *Elphidotarsius russelli* Krause, 1978, and the phenacodontid *Ectocion collinus* Russell, 1929, with the local fauna correlating most closely with that of Douglass Quarry, Montana (Youzwyshyn 1988; Fox 1990).

Material and methods.—The dental specimens described from Cochrane 2 were collected by quarrying. The residual matrix was then sacked and transported to the laboratory for screen washing, using the method of D.W. Krause (Johnson et al. 1994). Particularly resistant matrix was immersed in 10–20% acetic acid solution to break down the calcareous component, and re-screened. After drying, the screened concentrates were sorted under a dissecting microscope at 10 \times , and identifiable dental elements were removed for identification and study. Multituberculate dental nomenclature and measurements follow Krause (1977, 1982, 1987). Therian dental nomenclature follows Van Valen (1966) as modified by Szalay (1969). Therian dental measurements follow Clemens (1966).

Terminology and conventions

Institutional abbreviations.—Acronyms of institutions referred to in this paper are: AMNH, American Museum of Natural History, New York; SMM, Science Museum of Minnesota, St. Paul; UALVP, Laboratory for Vertebrate Paleontology, University of Alberta, Edmonton; UMVP, Vertebrate Paleontology Collection, University of Minnesota, Minneapolis; USNM, United States National Museum of Natural History, Smithsonian Institution, Washington; UW, University of Wyoming, Laramie.

Measurements and statistics.—Measurements and statistics used in this paper are as follows: Height, recorded as the perpendicular distance between the first true serration and the baseline (Krause 1987) (pertaining to multituberculate p4s only); Length 1, a measure along the baseline between perpendiculars drawn from the anterior crown margin and from the first true serration (pertaining to multituberculate p4s only); Length, maximum anteroposterior length of tooth; TaWidth, maximum labiolingual width of talonid; TrWidth, maximum labiolingual width of trigonid; Width, maximum labiolingual width of tooth; CV, coefficient of variation; M, mean; N, sample size; OR, observed range; P, parameter; SD, standard deviation. All measurements are in millimeters.

Systematic palaeontology

Order Multituberculata Cope, 1884a

Suborder Cimolodonta McKenna, 1975

Superfamily Ptilodontoidea Sloan and Van Valen, 1965

Family Ptilodontidae Cope, 1887

Genus *Ptilodus* Cope, 1881a

Ptilodus gnomus sp. nov.

Fig. 1A–C; Table 1.

cf. *Ectypodus hazeni* (Jepsen, 1940); Gazin 1956a: 13, pl. 1: 2.

Holotype: UALVP 45145, isolated right P4, Fig. 1A₁–A₃.

Etymology: *Gnomus*, New Latin, meaning “diminutive fabled being” or “dwarf”, in reference to the diminutive size of the species.

Type locality and horizon: Cochrane 2, Paskapoo Formation, southwestern Alberta.

Age and distribution: Earliest Tiffanian of Alberta (type locality); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]).

Table 1. Measurements and descriptive statistics for the dentition of *Ptilodus gnomus* sp. nov., from the Cochrane 2 locality, Paskapoo Formation, Alberta.

Element	P	N	OR	M	SD	CV
P1	Length	14	1.8–2.2	1.99	0.15	7.35
	Width	14	1.2–1.8	1.60	0.15	9.17
P2	Length	11	1.8–2.2	2.06	0.11	5.30
	Width	11	1.6–2.0	1.80	0.13	7.20
P3	Length	18	1.8–2.2	2.07	0.14	6.80
	Width	18	1.4–1.7	1.55	0.09	5.80
P4	Length	25	3.2–3.9	3.56	0.17	4.74
	Width	30	1.5–1.9	1.75	0.10	5.50
M1	Length	3	3.8–4.0	3.93	0.12	3.10
	Width	6	1.7–1.8	1.77	0.05	2.80
M2	Length	11	1.7–2.1	1.91	0.12	6.30
	Width	11	1.8–2.1	1.94	0.09	4.60
p4	Length	14	4.8–5.6	5.31	0.24	4.60
	Length 1	16	1.2–1.7	1.38	0.14	10.46
	Height	15	1.9–2.1	2.06	0.06	3.07
m1	Length	7	2.7–3.0	2.77	0.11	4.01
	Width	8	1.3–1.4	1.36	0.05	3.80
m2	Length	8	1.8–2.1	1.89	0.10	5.25
	Width	8	1.5–1.7	1.61	0.08	5.18

Material.—UALVP 18742, 18743, 18746, 18748, 18749, 18751, 18763, 18765, 18770, 18771, 18776, 18779, 45133, 45134, P1s (total: 14); UALVP 18512, 18745, 18747, 18753, 18755, 18756, 18761, 18762, 18769, 18772, 18783, P2s (total: 11); UALVP 18740, 18741, 18744, 18750, 18752, 18754, 18757–18759, 18764, 18766–18768, 18773, 18774, 18780, 18782, 18784, P3s (total: 18); UALVP 18413, 18502, 18669, 18686, 18688, 18689, 18690–18697, 18699, 18700–18702, 18704, 18705, 45135–45144, P4s (total: 30); UALVP 18425, 18514, 18666, 18731, 18734, 18736, M1s (total: 6); UALVP 426, 18416, 18653, 18723–18730, M2s (total: 11); UALVP

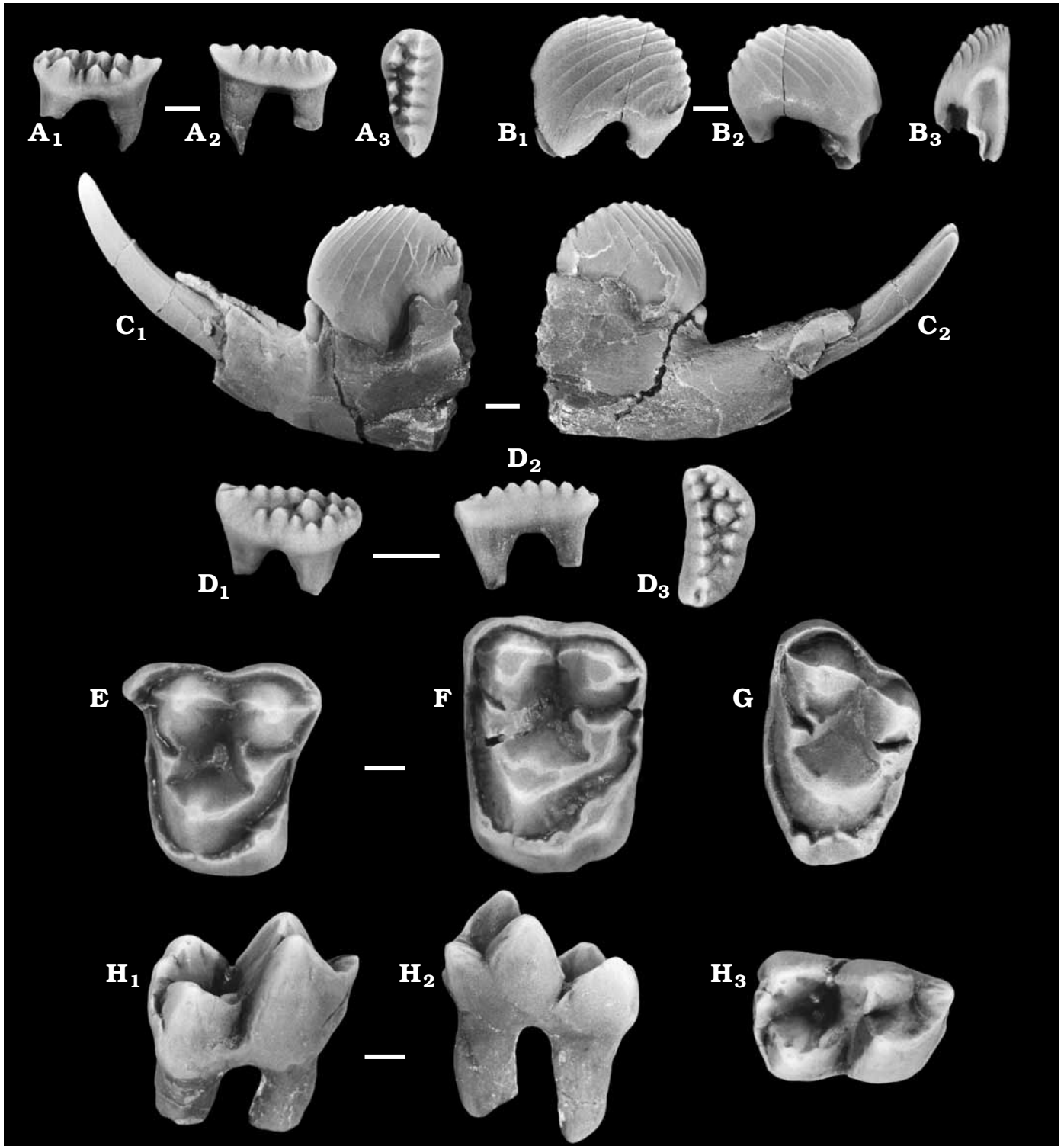


Fig. 1. A–C. *Ptilodus gnomus* sp. nov., Cochrane 2 locality, Alberta. A. Holotype, right P4, UALVP 45145 in labial (A₁), lingual (A₂), and occlusal (A₃) views. B. Left p4, UALVP 45148 in labial (B₁), lingual (B₂), and anterior (B₃) views. C. Incomplete left dentary having i1, p3–4, UALVP 18670 in labial (C₁) and lingual (C₂) views. D. *Baiotomeus russelli* sp. nov., Cochrane 2 locality, Alberta. Holotype, left P4, UALVP 18787 in labial (D₁), lingual (D₂), and occlusal (D₃) views. E–H. *Thryptacodon orthogonius*, comb. nov., Cochrane 2 locality, Alberta. E. Left M1, UALVP 45099 in occlusal view. F. Holotype, left M2, UALVP 124 in occlusal view. G. Left M3, UALVP 24993 in occlusal view. H. Right m1, UALVP 42872 in labial (H₁), lingual (H₂), and occlusal (H₃) views. Scale bars 1 mm.

130, 18670, 18671, 18673–18675, 18677–18681, 18683, 45146–45149, p4s (total: 16); UALVP 18707–18713, 18717, m1s (total: 8); UALVP 18484, 18486, 18714–18716, 18718–18720, m2s (total: 8).

Diagnosis.—Smallest known species of *Ptilodus*, with p4 length approximately 51 percent less than p4, *Ptilodus mediaevus* Cope, 1881a, 28 percent less than p4, *Ptilodus kummae* Krause, 1977, 15 percent less than p4, *Ptilodus tsoiensis* Sloan, 1981, and 5 percent less than p4, *Ptilodus fractus* Dorr, 1952. Differs further from *P. fractus* in p4 having at least one fewer serration. Differs from all other species of *Ptilodus* in having a teardrop-shaped P4, with the posterior margin narrowing abruptly to a point, and a higher-crowned, more evenly arcuate p4.

Description.—P1, P2, and P3: Except for their smaller size, P1–3 are virtually identical to teeth at these positions in other species of *Ptilodus*, particularly *P. mediaevus*. P3 bears four or five cusps, resembling the condition in P3 of *P. mediaevus* (mean = 4.39 cusps [Krause 1982]).

P4: Cusp formula, (1–2)4–5:6–8:0. P4 of *P. gnomus* is of characteristic ptilodontid morphology, being low-crowned and bearing large, coarse cusps. In occlusal aspect, it is teardrop-shaped: the anterior margin is wide and rounded and the posterior portion narrows to a point. The anterolabial lobe is poorly to moderately developed; occasionally, one or two tiny cusps occur on the labial ridges of the first or second external cusp. The enamel covering the cusps of the medial and external row is wrinkled. The external row of cusps bends weakly towards the medial row anteriorly and posteriorly. Among all P4s at hand, the second external cusp is the largest in either row. The medial row of cusps runs anterolingually-posterolabially and is slightly concave lingually. The cusps of the medial row are nearly equal to one another in size and height, except the first cusp, which is smaller on some specimens.

Upper molars: M1 cusp formula, 9:9:4–5; M2 cusp formula, 1:3:3. These teeth differ from M1 and M2 of other species of *Ptilodus* only in their smaller size (see Krause 1977, 1982).

i1: i1 is elongate, slender, and of characteristic ptilodontid morphology (see Krause 1977, 1982).

p3: p3 is small, peg-like, and has a bulbous, featureless, enamel-covered crown.

p4: Coronal morphology of p4 in *P. gnomus* resembles that in other species of *Ptilodus*: the blade is high and in profile forms a symmetrical arc; its cutting edge has 10–11 serrations. The anterobasal concavity is conspicuous and narrows dorsally; by contrast, in *P. fractus* the anterobasal concavity is flat or rounded dorsally. Just dorsal to the postero-external shelf, the enamel is marked by several irregular, dorsoventrally directed ridges. The exodaenodont lobe is robustly developed: its base is over two-thirds the length of the crown, and deep.

Lower molars: m1 cusp formula, 5–6:4; m2 cusp formula, 4:2. Except for their small size, the lower molars of *P. gnomus* are of characteristic *Ptilodus* morphology (see Krause 1977, 1982).

Remarks.—Although more similar in size to homologous teeth referable to *P. tsoiensis* and *P. fractus*, the upper and

lower ultimate premolars of this new species most closely resemble those of *P. mediaevus* in overall morphology. The crown of p4 in both taxa is high with a low serration number, and both have similar length: height ratios (2.6 in *P. gnomus*, 2.5 in *P. mediaevus*). Additionally, the anterior premolars are more similar to those of *P. mediaevus* than those of other species of *Ptilodus*, differing only in their smaller size.

An isolated left p4 (UALVP 130) collected by R.L. Rutherford from Cochrane 2 in 1926 and identified by Russell as “*Ectypodus* sp.” pertains to *P. gnomus*, as does a single left M2 (UALVP 426) identified by Russell as “*Ectypodus cochranensis*?” in 1929. Neither specimen has been described nor previously reported in the literature. An isolated p4 (USNM 20878) identified by Gazin (1956a) as “cf. *Ectypodus hazeni*”, from the earliest Tiffanian Saddle locality of Wyoming, appears to be referable to *P. gnomus*, both in respect to lateral profile and serration number (GPY personal observation). The specimen is, however, slightly less (L = 5.0) than the mean length of p4s from Cochrane 2.

The recognition of *P. gnomus* sp. nov. at Cochrane 2 demonstrates the presence of three species of *Ptilodus* at the site (Youzwyshyn 1988; Fox 1990). Two new and undescribed species of *Ptilodus* (*P. “T”* and *P. “C”*) are represented by well-preserved material at Cochrane 2; these were first recognized by Krause (1982) from fossils occurring elsewhere, and await naming and description by him. Three sympatric species of *Ptilodus* from a single locality also occur at Douglass Quarry (Fort Union Formation), Montana, and possibly at Shotgun locality (Fort Union Formation), Wyoming, both of which are considered earliest Tiffanian in age (Archibald et al. 1987).

Genus *Baiotomeus* Krause, 1987

Baiotomeus russelli sp. nov.

Fig. 1D; Table 2.

Holotype: UALVP 18787, isolated left P4, Fig. 1D.

Type locality and horizon: Cochrane 2, Paskapoo Formation, southwestern Alberta.

Age and distribution: Earliest Tiffanian of Alberta (type locality).

Etymology: Named after L.S. Russell for his pioneering research on the mammals from Cochrane 2.

Table 2. Measurements and descriptive statistics for the dentition of *Baiotomeus russelli* sp. nov., from the Cochrane 2 locality, Paskapoo Formation, Alberta.

Element	P	N	OR	M	SD	CV
P4	Length	7	2.2–2.4	2.31	0.09	3.89
	Width	9	1.0–1.1	1.07	0.05	4.51

Material.—UALVP 18788, 42866–42871, 45150, 45151, P4s (total: 9).

Diagnosis.—Smaller than other species of *Baiotomeus*; anteroposterior length of P4 approximately 45 percent less than P4, *Baiotomeus douglassi* (Simpson, 1935a), and approximately 40 percent less than P4, *Baiotomeus lamberti* Krause, 1987; differs further from all other species of *Baiotomeus* in

P4 having pronounced curvature of the cusp rows, and a relatively better developed, more cuspsate anterolabial lobe.

Description.—P4: Cusp formula, (3–4)5:7–8:0. P4 is kidney-shaped in occlusal view: its anterior and posterior ends are narrow but rounded, and the anterolabial lobe is poorly to moderately developed. The cusps on the anterolabial lobe may be only tiny cuspules or may be nearly as large as those in the external row. The cusps of the external row curve lingually; the third cusp is the largest in the row and the largest on the crown. The middle row of cusps increases in height posteriorly to the fifth cusp and decreases thereafter; the external cusp row is about two-thirds the length of the middle row. The first and second cusps are smallest in the row. The enamel is weakly wrinkled on all specimens.

Remarks.—In occlusal and lateral aspects, P4 of *B. russelli* strongly resembles that in *B. douglassi* and *B. lamberti*, but is much smaller. Further, P4 of *B. russelli* is distinct in the greater curvature of the cusp rows and in the greater change in cusp height along the middle row.

At present, P4s are the only specimens from Cochrane 2 that we can identify as pertaining to *B. russelli*. Although knowledge of this species is limited, we consider its naming to be justified based on the diagnostic morphology of ultimate fourth premolars in ptilodontids generally (Krause 1982, 1987) and the unique structure of these teeth.

Order “Condylarthra” Cope, 1881b

Family Arctocyonidae Giebel, 1855

Genus *Thryptacodon* Matthew and Granger, 1915

Thryptacodon orthogonius comb. nov. (Russell, 1929)

Fig. 1E–H.

Chriacus orthogonius Russell, 1929: 175–177, fig. 3.

Thryptacodon demari Gazin, 1956a: 28, pl. 6: 2, 3.

Thryptacodon belli Gazin, 1956a: 29, pl. 6: 1–4.

Holotype: UALVP 124, isolated left M2, Fig. 1F.

Type horizon and locality: Cochrane 2, Paskapoo Formation, southwestern Alberta.

Age and distribution: Earliest Tiffanian of Alberta (type locality [Russell 1929]) and Montana (Douglass Quarry, Melville Formation, Sweetgrass County [Krause and Gingerich 1983]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]); middle Tiffanian of Wyoming (Ledge locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]); late Tiffanian of Wyoming (Rock Springs localities V-77006, V-77007, and V-78052, Fort Union Formation, eastern Rock Springs Uplift, Sweetwater County [Winterfeld 1982]).

Material.—UALVP 24991, 45112, DP4; UALVP 45099, M1; UALVP 24990, 24993, 24994, 45103, 45107, 45109, 45110, M3s (total: 7); UALVP 24996, 45101, p4s; UALVP 24998, 24999, 42872, 42874, 45102, 45105, m1s (total: 6); UALVP 24997, 42873, 45108, 45111, m2s (total: 4); UALVP 24995, 42875, 45100, 45104, 45106, m3s (total: 5).

Revised diagnosis.—Smaller than *Thryptacodon australis* Simpson, 1935b and *Thryptacodon antiquus* Matthew and Granger, 1915, with upper molars more transverse and rect-

angular in occlusal outline, with weaker hypocones; paracone and metacone subequal in size.

Remarks.—The lower molars from Cochrane 2 that we refer to *T. orthogonius* closely resemble those of *T. “demari”* Gazin, 1956a from the Ledge locality, and *T. “belli”* Gazin, 1956a from the Saddle locality, Bison Basin, Wyoming (Gazin 1956a) differing only in m1 having a more prominent hypoconulid. Moreover, UALVP 24997, an m2, and the type specimen of “*Chriacus*” *orthogonius* (Russell, 1929) from Cochrane 2 fit tightly when manually occluded. Van Valen (1978) considered *T. “belli”* and *T. “demari”* to be synonymous, and recognized “*C.*” *orthogonius* as the senior synonym of “*Metachriacus*” *punitor* Simpson, 1935a.

“*C.*” *orthogonius* was founded on a single tooth from Cochrane 2, UALVP 124, a left M2 that Russell (1929) described. Sloan (1987) concluded that “*C.*” *orthogonius* was descended from *C. baldwini* (Cope, 1882) (= “*Metachriacus provocator*” Simpson, 1935a and “*C. truncatus*” Cope, 1884b [Van Valen 1978]), yet *C. baldwini* differs significantly from “*C.*” *orthogonius* in the structure of its upper molars. The holotype of “*C.*” *orthogonius* can be readily distinguished from M2, *C. baldwini*, in its more symmetrical and rounded occlusal outline, weakly convex anterior and posterior sides, shallower ectoflexus, larger, more anterolabial hypocone, concave postprotocrista, and in being smaller overall. The upper molar morphology of “*C.*” *orthogonius* is otherwise known only from *Thryptacodon*, differing significantly from the upper molar features of *Chriacus*, which include a robust, posterolingually-projecting hypocone, a rectangular occlusal outline with concave anterior and posterior sides, and a weakly convex postprotocrista that joins with a straight, posterolabially directed postmetacrista; they differ further from those of *C. baldwini* in M1 having a more salient parastylar area and larger paracone, and M3 having a better-developed lingual cingulum.

Until the recent UALVP collections were made from Cochrane 2, the holotype was the only specimen from the locality referable to “*C.*” *orthogonius*, and the affinities of the species have been uncertain (see, for example, Krause and Gingerich 1983). However, UALVP 124 is virtually identical to M2s of *T. “demari”* from the Ledge locality, and of *T. “belli”* from the Saddle locality (GPY personal observation), supporting referral of the Cochrane 2 specimen to *Thryptacodon*. From these comparisons, *T. “demari”* (including *T. “belli”*) is herein considered a junior synonym of *T. orthogonius*.

Family Hyopsodontidae Trouessart, 1879

Subfamily Tricuspidodontinae Simpson, 1929

Genus *Litomylus* Simpson, 1935a

Litomylus grandaletes sp. nov.

Fig. 2; Table 3.

Holotype: UALVP 25000, incomplete right maxilla containing M2 and alveoli for M1 and M3, Fig. 2C.

Type horizon and locality: Cochrane 2, Paskapoo Formation, south-western Alberta.

Age and distribution: Earliest Tiffanian of Alberta (type locality).

Etymology: *Grandis*, Latin, meaning “large, great, grandparent”, *alates*, Greek, meaning “grinder”, in reference to the large size of the species, primitive dental morphology, and possible ancestry to *Aletodon*.

Table 3. Measurements and descriptive statistics for the dentition of *Litomytus grandaletes* sp. nov., from the Cochrane 2 locality, Paskapoo Formation, Alberta.

Element	P	N	OR	M	SD	CV
P4	Length	1	3.3	3.30	–	–
	Width	1	4.4	4.40	–	–
M1	Length	3	4.0–4.2	4.07	0.12	3.00
	Width	3	5.5–5.8	5.67	0.15	2.70
M2	Length	3	4.3–4.4	4.33	0.06	1.40
	Width	3	6.0–6.3	6.17	0.15	2.40
M3	Length	2	3.4–3.5	3.45	0.07	2.00
	Width	2	4.6–5.1	4.90	0.26	5.30
m1	Length	5	3.9–4.4	4.10	0.19	4.56
	TrWidth	7	2.8–3.1	2.96	0.13	4.40
	TaWidth	4	2.8–3.4	3.03	0.26	8.69
m2	Length	6	4.2–4.5	4.38	0.12	2.67
	TrWidth	5	3.4–3.8	3.66	0.17	4.57
	TaWidth	4	3.4–4.0	3.63	0.26	7.26
m3	Length	2	4.1–4.7	4.40	0.42	9.64
	TrWidth	2	2.7–3.3	3.00	0.42	14.14
	TaWidth	2	2.4–3.1	2.75	0.49	18.00

Material.—UALVP 18405, P4; UALVP 340, 25003, 25005, M1s; UALVP 45119, 45122, M1s or M2s; UALVP 25001–25002, M2s; UALVP 45092, 45120, M3s; UALVP 25010, 25015, 45113, 45115, 45121, 45124, 45125, m1s (total: 7); UALVP 25008, 25009, 25012, 25013, 45093, 45116–45118, 45123, m2s (total: 9); UALVP 25014, 45114, m3s.

Diagnosis.—Differs from other *Litomytus* species except *?Litomytus ishami* Gazin, 1956b in size (molar teeth approximately 25 percent larger than those of *Litomytus orthronepius* Johnston and Fox, 1984, *Litomytus dissentaneus* Simpson, 1935a, or *Litomytus scaphicus* Gazin, 1956a, and 13 percent larger than those of *Litomytus osceolae* Van Valen, 1978); differs further from *Litomytus osceolae* in having less inflated molar cusps and a better developed, more lingual paraconid on m1. Differs from *?Litomytus ishami* Winterfeld, 1982 in possessing stronger crests and taller, less-inflated molar cusps, and better-developed paraconids and cingulids on the lower molars.

Description.—P4: UALVP 18405 is similar to P4, *L. dissentaneus*, in its overall structure, but the crown is more inflated. It is rounded in occlusal view and displays two cusps, a paracone and protocone, both of which are bulbous. The parastylar and metastylar areas, and the ectocingulum are greatly reduced. The parastylar lobe is bluntly rounded. A short crest extends posteriorly from the paracone; the tip of the paracone and the summit of the crest are heavily worn.

The paracone crest ends at a tiny metastyle, which is more posterolingual in position than in *L. dissentaneus*. No evidence of a metacone is present. The ectocingulum is very weakly developed labial to the paracone, but is conspicuous more posteriorly. The preprotocrista is weak, while the post-protocrista is robust and runs labially to the metastyle. A short, poorly developed crest connects the bases of the paracone and protocone; neither pre- nor postcingulum is developed.

M1: The crown is slightly wider than long and sub-rectangular in occlusal view, with stout cusps. The anterolabial corner of the crown is rounded and no separate parastylar lobe is developed; the metastylar corner is more acute, projecting further labially, and has a flat posterior side. The ectocingulum is robust and the ectoflexus fairly deep. The paracone and metacone are low, stout, subconical, and sub-equal in height. The postmetacrista bends abruptly labially and meets the ectocingulum at the acute posterolabial corner of the crown; the postmetaconule crista turns labially as well, meeting the postmetacrista posterolabial to the metacone. The protocone and hypocone are robust and swollen. The precingulum, and especially the postcingulum, are prominent; on UALVP 25005, a weak “accessory” cingulum arises posterobasal to the postcingulum. Small cusps are present on the ectocingulum and precingulum.

M2: Compared to M1, M2 is substantially wider and its cusps are more massive in construction. The anterolabial margins of the crown protrude labially and anteriorly. The posterolabial corner is flattened labially and less strongly developed than the comparable parts on M1. The paraconule is nearer to the apex of the protocone than on M1, and the postmetaconule crista terminates labial to the postmetacrista. The bases of the hypocone and protocone are more swollen, and these cusps are larger overall than on M1. The postcingulum is deeply notched between the protocone and hypocone, especially on UALVP 340, in which a small cuspsule arises from the posterolingual side of the protocone.

M3: The M3 of *L. grandaletes* is more transverse than that of *L. dissentaneus*, but is otherwise similar; in both, the conules are weak, the conule cristae are absent, and there is no hypocone. The pre- and postcingulum are conspicuous on all M3s of the species from Cochrane 2. On UALVP 25004 and 25006, a crest extends between the postprotocrista and postcingulum, slightly lingual to the metaconule.

m1: In occlusal view, the crown of m1 is hourglass-shaped, with stout trigonid and talonid cusps. The trigonid and talonid are nearly equal in width. The paraconid is robust, with a distinct apex that projects anteriorly. The paracristid extends labially and then swings sharply posteriorly to the apex of the protoconid. The metaconid and protoconid are inflated at their bases, but these cusps are acute apically. The cusps of the talonid are swollen as well, but have high, sharp apices and well-defined crests. On UALVP 25010 and 25015, a small mesoconid arises from the cristid obliqua. The talonid basin and notch are deep; the basin is deepest at the apex of the notch. The pre- and postcingulid are well devel-

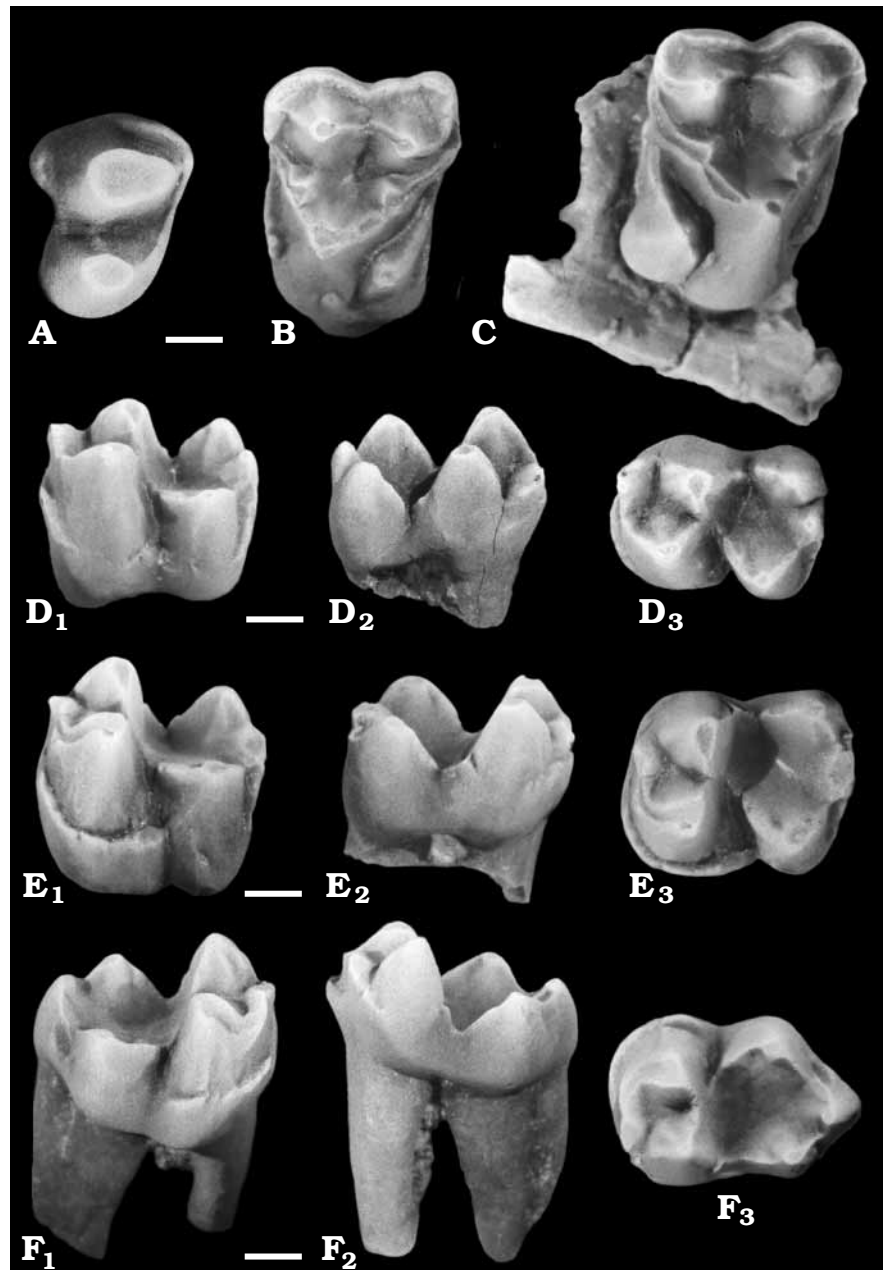


Fig. 2. *Litomylus grandaletes* sp. nov., Cochrane 2 locality, Alberta. **A.** Left P4, UALVP 18405 in occlusal view. **B.** Left M1, UALVP 25005 in occlusal view. **C.** Holotype, incomplete right maxilla with M2, UALVP 25000 in occlusal view. **D.** Left m1, UALVP 25015 in labial (**D**₁), lingual (**D**₂), and occlusal (**D**₃) views. **E.** Left m2, UALVP 45093 in labial (**E**₁), lingual (**E**₂), and occlusal (**E**₃) views. **F.** Right m3, UALVP 25014 in labial (**F**₁), lingual (**F**₂), and occlusal (**F**₃) views. Scale bars 1 mm.

oped. A weak labial cingulid crosses the hypoflexid; its enamel is wrinkled on the surfaces of the protoconid and hypoconid.

m2: The m2 of *L. grandaletes* is substantially wider than m1, and its paraconid is more labial and closer to the metaconid than on the more anterior molar. On UALVP 25008, a crest between the apex of the metaconid and the posterolingual corner of the paraconid encloses the trigonid basin. A broad labial cingulid joins the pre- and postcingulid to each other. A lingual cingulid sometimes extends from the paraconid past the metaconid and talonid notch; it is best developed on UALVP 25009 and 25013. The talonid resembles that of m1, except that it is larger and has a prominent mesoconid on the cristid obliqua.

m3: The m3 of *L. grandaletes* is less transverse than m2, with a low trigonid and short, broad talonid. The paraconid and metaconid are as closely appressed as on m2, and a crest from the paraconid extends to the metaconid, joining it anteromedially. The precingulid is robust and curves labially around the base of the trigonid to the hypoflexid. The hypoconulid projects posteriorly but is not as large overall as the entoconid. A short postcingulid extends between the hypoconid and hypoconulid.

Remarks.—Although comparable parts of the dentition of *L. grandaletes* sp. nov., and the genotypic species, *L. dissentaneus*, are similar, they differ significantly in several features. For example, the trigonid is higher in *L. grandaletes*, and the paraconid more cuspidate and more lingual in posi-

tion, the trigonid and talonid cusps are not as swollen, the talonid cusps are higher, and the labial cingulid is prominent, especially on m2. The lower molars of *L. grandaletes* closely approximate those of *L. orthronepius* from the Puercan Medicine Hat Brick and Tile Quarry (Rav W-1 horizon) of southwestern Saskatchewan (Johnston and Fox 1984), but differ in their larger size, more swollen cusps, and medial paraconid, especially on m2. In regards upper molar morphology, *L. grandaletes* most closely resembles *L. orthronepius*, but the upper molars of *L. grandaletes* are more transverse, and have a stronger ectocingulum and wider styler shelf; both species possess a prominent parastylar area on M2. The molar structure of *L. grandaletes* is also similar to that of *Aletodon* Gingerich, 1977, from the middle Tiffanian to the late Clarkforkian of Colorado, Wyoming, and North Dakota (Gingerich 1977; Rose 1981a; Gingerich 1983). A transition from *L. grandaletes* to *A. quadravus*, the earliest species of the genus, would require further inflation of the molar cusps, reduction of the molar crests, slight reduction of the paraconid, and a decrease in crown height.

Infraclass Eutheria *incertae sedis*

Order Uncertain

Family Palaeoryctidae (Winge, 1917)

Genus *Pararyctes* Van Valen, 1966

Pararyctes rutherfordi sp. nov.

Fig. 3A–C; Table 4.

Holotype: UALVP 45094, incomplete right maxilla with P4, M2–3, Fig. 3A₁, A₂.

Type horizon and locality: Cochrane 2, Paskapoo Formation, southwestern Alberta.

Age and distribution: Earliest Tiffanian of Alberta (type locality).

Etymology: Named after R.L. Rutherford, for his early work on the geology of the Cochrane region and his participation in the discovery of the Cochrane 2 locality.

Table 4. Measurements and descriptive statistics for the dentition of *Pararyctes rutherfordi* sp. nov., from the Cochrane 2 locality, Paskapoo Formation, Alberta.

Element	P	N	OR	M	SD	CV
P4	Length	1	3.4	3.40	—	—
	Width	1	2.8	2.80	—	—
M2	Length	2	2.8–3.3	3.05	0.35	11.59
	Width	2	4.4–4.7	4.55	0.21	4.66
M3	Length	1	2.6	2.60	—	—
	Width	1	4.3	4.30	—	—
m1 or m2	Length	2	2.8–2.9	2.85	0.07	2.48
	TrWidth	3	1.8–2.4	2.17	0.32	14.84
	TaWidth	2	1.9–2.1	2.00	0.14	7.07

Material.—UALVP 25180, M2; UALVP 25178, 25179, 45095, m1s or m2s.

Diagnosis.—Differs from *P. pattersoni* Van Valen, 1966 in much larger size (with molars approximately 40 percent

larger than in *P. pattersoni*), in having a relatively broader postcingulum on M2, and having more transverse lower molars.

Description.—P4: P4 is triangular in occlusal outline and three-rooted. The paracone dominates the crown and is labiolingually compressed. The parastylar lobe is slightly damaged on the holotype, but projects strongly anteriorly from the base of the paracone. No metacone is developed. The metastyle is of similar morphology with respect to the parastyle, but more labiolingually compressed and extends posterolabial to the paracone. An ectocingulum is faintly developed. The protocone is half the height of the paracone and subcrescentic in occlusal view; strong wear is present along the posterior face of the protocone and along the postcingulum. The preprotocrista is strongly developed, connecting the apex of the protocone to a point just below the parastylar lobe.

M2: These teeth are similar to M2, *P. pattersoni*, albeit substantially larger. The paracone and metacone are closely appressed, being connate at their bases. The protocone is large and projects anteriorly. The postmetaconule crista and postprotocrista form a long, uninterrupted crest along the posterior labiolingual margin of the crown. The pre- and postcingulum are both well developed; the postcingulum differs from that in *P. pattersoni* in being anteroposteriorly wider at its labial extent.

M3: M3 is strongly compressed anteroposteriorly, forming a scalene triangle in occlusal outline. The hook-like parastylar lobe is especially prominent, projecting anterolabially from the trigon and over the metastylar area of M2. No stylocone is developed; a large, somewhat worn parastylar cusp is positioned on the anterolabial corner of the parastylar lobe. The paracone is tall and spire-like, and is connected to the parastylar lobe by a weakly developed preparacrista. The metacone is low, about one-third the height of the paracone, and projects anteriorly. The centrocrista is shallow, with the paracone and metacone being joined at their bases. The metastylar lobe is reduced; as a result, the ectoflexus is shallow, and the ectocingulum is poorly developed. The paraconule, although present, is weak and is located more lingually than the even weaker metaconule; the preparaconule crista is moderately developed, while the postmetaconule crista is absent. Although post-mortem abrasion has reduced the original proportions of the lingual face of the protocone, the cusp appears to have been low, about the same height as the metacone. The pre- and postprotocrista are moderately developed, and faint pre- and postcingulum are present.

m1 or m2: The lower molars of *P. rutherfordi* resemble teeth of *P. pattersoni*, but are proportionally much larger in size, longer, and wider. The paraconid is conical and medial in position; the metaconid and protoconid are nearly equal in size and height, and lean slightly posteriorly. The talonid is short and twisted labially; its cusps are tall and conical, and the talonid basin shallow. No entocristid is developed, leaving the talonid open lingually.

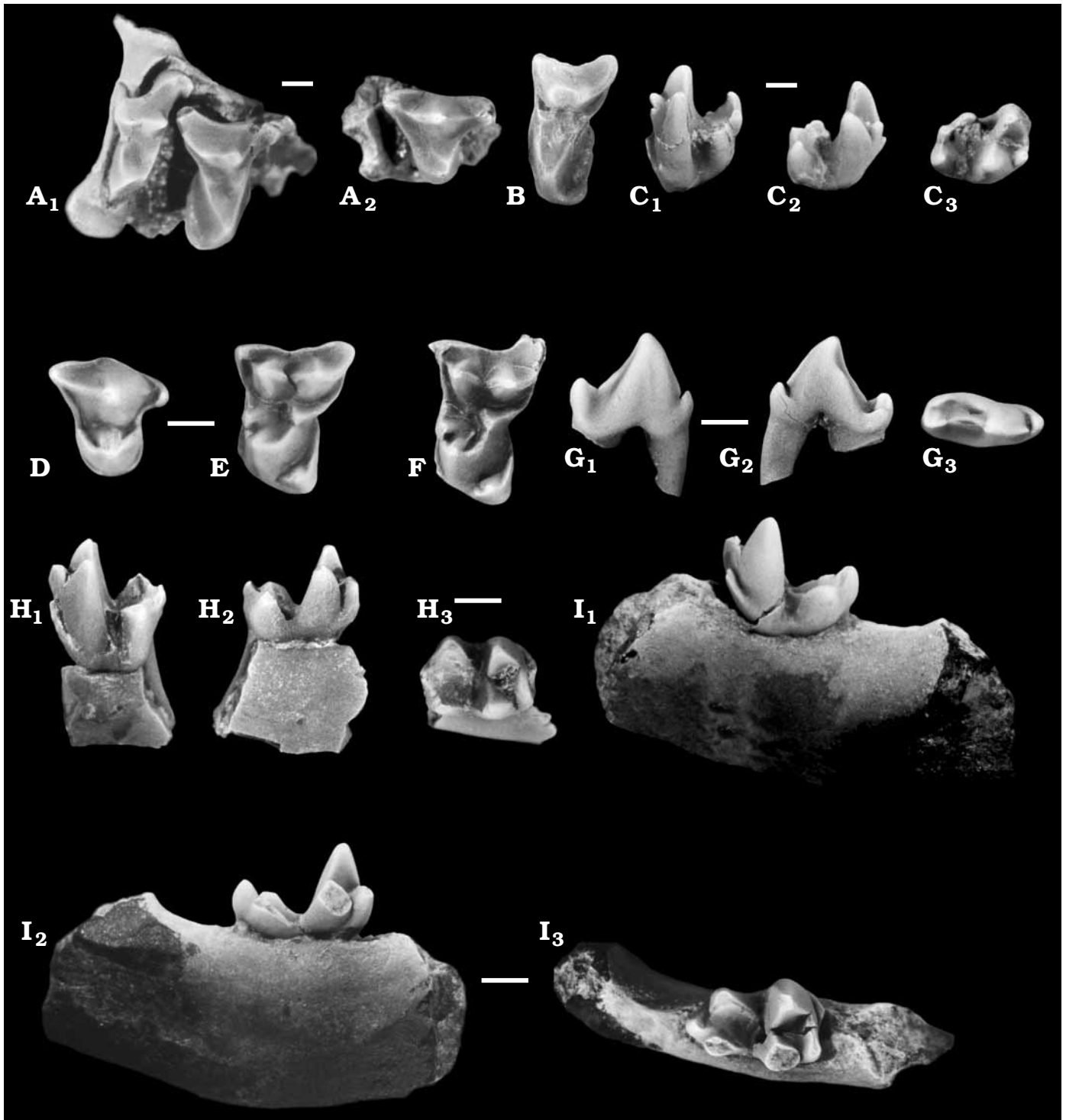


Fig. 3. **A–C.** *Pararyctes rutherfordi* sp. nov., Cochrane 2 locality, Alberta. **A.** Holotype, incomplete right maxilla with P4, M2–3, UALVP 45094 in occlusal view (A₁, A₂). **B.** Left M2, UALVP 25180 in occlusal view. **C.** Left m1 or m2, UALVP 45095 in labial (C₁), lingual (C₂), and occlusal (C₃) views. **D–I.** *Bessoecetor septentrionalis* comb. nov., Cochrane 2 locality, Alberta. **D.** Right P4, UALVP 25119 in occlusal view. **E.** Left M1, UALVP 28423 in occlusal view. **F.** Left M2, UALVP 28412 in occlusal view. **G.** Right p4, UALVP 28438 in labial (G₁), lingual (G₂), and occlusal (G₃) views. **H.** Left m2, UALVP 28414 in labial (H₁), lingual (H₂), and occlusal (H₃) views. **I.** Holotype, left m3, UALVP 126 in labial (I₁), lingual (I₂), and occlusal (I₃) views. Scale bars 1 mm.

Remarks.—Van Valen (1966) based the genus *Pararyctes* on *P. pattersoni* from the early Tiffanian Saddle locality (Fort Union Formation, Bison Basin), Wyoming. From Russell's

(1932) fig. 10, a probable right P4 of “*Diacodon*” *septentrionalis*, Van Valen (1966) correctly concluded that *P. pattersoni* was present at Cochrane 2, as well. The teeth of *P.*

rutherfordi from Cochrane 2 are much larger than those of *P. pattersoni*; they are also larger than the teeth of an undescribed new species of *Pararyctes* from the Torrejonian Diss locality, Alberta (Fox 1983; Fox 1990), but smaller than those of a second undescribed new species of *Pararyctes* from the middle Tiffanian DW-2 locality, Alberta (Fox 1990).

Family Pantolestidae Cope, 1884a

Genus *Bessoecetor* Simpson, 1936

Propalaeosinopa Simpson, 1927: 2, figs. 2, 3.

Thylacodon (Matthew and Granger, 1921) (in part); Russell in Rutherford 1927: 41.

Palaeosinopa Matthew, 1901 (in part); Simpson 1935a: 230.

Palaeictops Matthew, 1899 (in part); Van Valen 1967: 232.

Remarks.—Simpson erected "*Propalaeosinopa*" in 1927 for "*Propalaeosinopa albertensis*" from the middle Tiffanian Erickson's Landing locality, Alberta. Van Valen (1967) and Dorr (1977) suggested that "*Propalaeosinopa diluculi*" and "*Propalaeosinopa thomsoni*" (both previously placed in the genus *Bessoecetor* by Simpson [1936, 1937]) were junior synonyms of "*P. albertensis*". This hypothesis was followed by Holtzman (1978), but has been rejected by most other workers. There is now general agreement that "*P. thomsoni*" is conspecific with "*P. diluculi*", a view we accept here, with the holotype of "*P. albertensis*" being too poorly preserved for assessment (see Rose 1981a, and Krause and Gingerich 1983). Indeed, we conclude that AMNH 15543B, an incomplete left dentary containing a severely worn p4, retains no diagnostic characters, and that "*Propalaeosinopa albertensis*", the genotypic species, is therefore a *nomen dubium*, with the generic name "*Propalaeosinopa*" having no status. As such, "*P. diluculi*" and "*P. thomsoni*" are here returned to *Bessoecetor* Simpson, 1936, with *B. septentrionalis* (Russell, 1929) as the genotypic species (see below).

Bessoecetor septentrionalis comb. nov. (Russell, 1929)

Fig. 3D–I.

Thylacodon sp. nov. Russell in Rutherford, 1927: 41.

Diacodon septentrionalis Russell, 1929: 173.

Palaeosinopa diluculi Simpson, 1935a: 230.

Bessoecetor thomsoni Simpson, 1936: 9, figs. 3, 4.

Bessoecetor diluculi Simpson, 1937: 122, figs. 20, 21.

Propalaeosinopa albertensis Simpson, 1927; Van Valen 1967: 226.

Propalaeosinopa thomsoni (Simpson, 1936); Rose 1981a: 150.

Propalaeosinopa diluculi (Simpson, 1935a); Rose 1981a: 150.

Propalaeosinopa septentrionalis Fox, 1990: 58.

Holotype: UALVP 126, incomplete left dentary with m3, Fig. 3I₁–I₃.

Type horizon and locality: Cochrane 1, Paskapoo Formation, southwestern Alberta (see Fox [1990] for description and history of the Cochrane 1 locality).

Age and distribution: Late Torrejonian of Alberta (type locality [Fox 1990]), Montana (Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County [Simpson 1937]; Silberling Quarry, upper Lebo Formation, Crazy Mountain Basin, Sweetgrass County [Simpson 1937]), and Wyoming (Cedar Mountain localities [UW V-82004, 82006, 82015, 82040], Polecat Bench Formation, southern Bighorn Basin, Hot Springs/Washakie counties [Hartman 1986]; Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County

[Szalay 1968; Rigby 1980]); earliest Tiffanian of Alberta (Cochrane 2, Paskapoo Formation, Alberta Basin [Youzwysyn 1988; Fox 1990]) and Montana (Douglass Quarry, Crazy Mountain Basin, Sweetgrass County [Krause and Maas 1990]); early Tiffanian of Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Maas 1990]); middle Tiffanian of Alberta (Burbank locality, Paskapoo Formation, Alberta Basin, confluence of Red Deer and Blindman rivers [Fox 1990]; Hand Hills West Upper Level, Paskapoo Formation, Alberta Basin [Fox 1990]; Joffre Bridge Roadcut Lower Level, Paskapoo Formation, Alberta Basin, near Red Deer [Fox 1990]; DW-2 locality, Paskapoo Formation, Alberta Basin, near Blackfalds [Fox 1990]), Wyoming (Cedar Point Quarry, Polecat Bench Formation, Bighorn Basin, Big Horn County [Rose 1981a]; Chappo Type locality, Chappo Member, Wasatch Formation, Lincoln County [Gunnell 1994]; Hallelujah Hill [locality UW V-77005], Fort Union Formation, east flank Rock Springs Uplift, Sweetwater County [Winterfeld 1982]), and North Dakota (Brisbane locality, Slope Formation, Grant County [Holtzman 1978]; Judson locality, Tongue River Formation, Morton County [Holtzman 1978]).

Material.—UALVP 25119, 28413, P4s; UALVP 18408, 28423, 28425, M1s; UALVP 28427, 28429, 28430, 28432, 28433, 28439, 28551, M1s or M2s (total: 7); UALVP 28411, 28412, 28416, 28420, 28421, M2s (total: 5); UALVP 28422, M3; UALVP 28415, incomplete dentary with p2–3; UALVP 28435, 28437, p2s; UALVP 28428, p3; UALVP 28546–28549, 28552, dp4s (total: 5); UALVP 28434, 28438, 28440, 28441, p4s; UALVP 25092, 28417, 45130, 45131, m1s; UALVP 28414, 28444, 45132, m2s; UALVP 28445, 28450, 45129, m3s.

Remarks.—Russell (in Rutherford 1927) identified an incomplete dentary containing m3 from the Torrejonian Cochrane 1 locality, Alberta, as a new species of *Thylacodon* (Marsupialia, Didelphidae). He subsequently designated the specimen, UALVP 126, as the holotype of a new species of the leptictid *Diacodon* Cope, 1875, which he named *Diacodon septentrionalis* (Russell, 1929). Russell also designated two additional lower molars, catalogued together as UALVP 333, from Cochrane 2, as paratypes; subsequently, he (1932) tentatively referred three complete upper molars from Cochrane 2 to this same species. Van Valen (1966) referred one of these upper molars (UALVP 428, thought by Russell to possibly be a P4) to his new palaeoryctid, *Pararyctes pattersoni*. Soon after, Van Valen (1967) included "*D.*" *septentrionalis* in the leptictid *Palaeictops* Matthew, 1899. Novacek (1977) in his review of North American early Tertiary leptictids consigned all Paleocene species (with the exception of *Myrmecoboides* Gidley, 1915) to *Prodiacodon* Matthew, 1929. He did not recognize "*Palaeictops*" *septentrionalis* (*vide* Van Valen 1967) because of the fragmentary nature of the material, and noted the difficulty in determining if the teeth were better referred to a leptictid or pantolestid taxon.

Comparisons made by Youzwysyn (1988) imply that Russell's "*D.*" *septentrionalis*, even when UALVP 428 is removed, is a composite taxon. If compared to teeth of "*Propalaeosinopa diluculi*" from the late Paleocene of Canada and the United States, as well as with the original material of "*P. diluculi*" from Gidley Quarry (Simpson 1937), the holo-

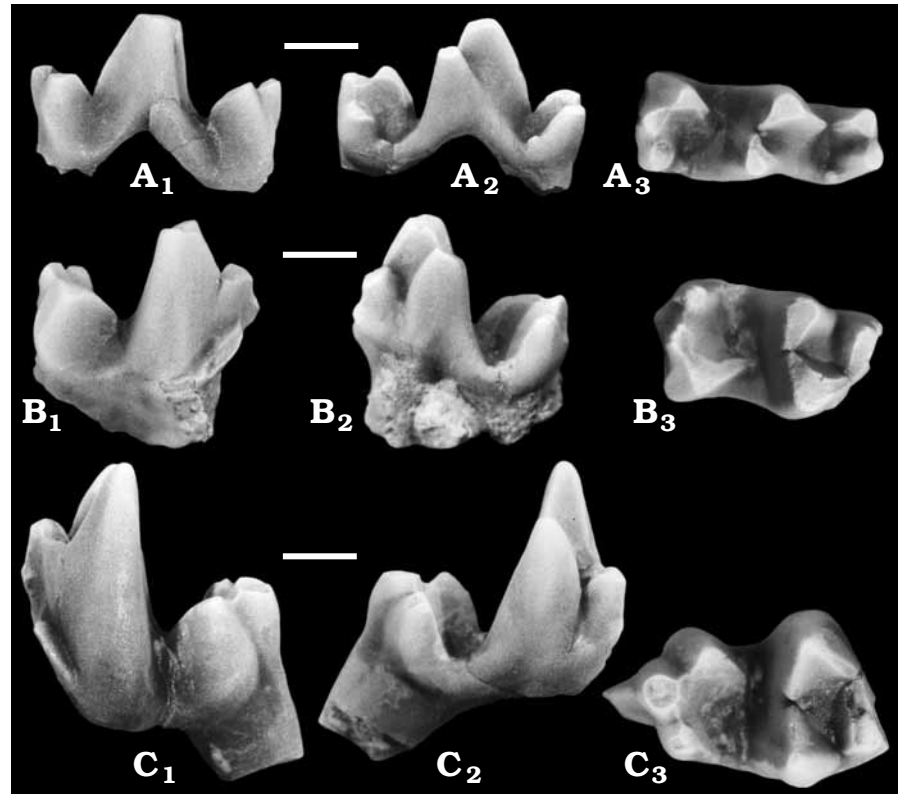


Fig. 4. *Paleotomus junior* sp. nov., Cochrane 2 locality, Alberta. **A.** Left dp4, UALVP 28566 in labial (A₁), lingual (A₂), and occlusal (A₃) views. **B.** Right m1, UALVP 45096 in labial (B₁), lingual (B₂), and occlusal (B₃) views. **C.** Holotype, left m3, UALVP 28556 in labial (C₁), lingual (C₂), and occlusal (C₃) views. Scale bars 1 mm.

type of “*Diacodon*” *septentrionalis* (UALVP 126) is found to be virtually identical with the m3s of this pantolestid taxon. Russell’s “*Diacodon*” *septentrionalis*, then, has priority over Simpson’s “*P.* *diluculi*”. As noted above, the genus *Proplaeosinopa* has no taxonomic status; we therefore refer UALVP 126 to *Bessoecetor septentrionalis* comb. nov., and designate it as the holotype. “*P. diluculi*” and “*P. thomsoni*” are here considered junior synonyms of *B. septentrionalis*.

Russell’s (1929) paratypes of “*Diacodon*” *septentrionalis* (UALVP 333) from Cochrane 2 do not belong to the same species as the holotype, but instead are lower molars of an unidentified genus and species of palaeoryctid. The upper molars tentatively referred in 1932 by Russell and illustrated in his figs. 8 and 9 pertain to two different species of *Prodiacodon*, *Prodiacodon furor* and *Prodiacodon* sp., cf. *P. puercensis*, respectively. Accordingly, the only specimen of *B. septentrionalis* from Russell’s 1932 hypodigm is the holotype.

The dentition of *B. septentrionalis* from Cochrane 2 is virtually identical to that described by Simpson in 1936 (as *Bessoecetor thomsoni*) and in 1937 (as *Bessoecetor diluculi*), differing only in minor respects: the protocone of P4 is larger and the metastylar area more pronounced, the ectoflexus of M1 and M2 is shallow, and the parastylar lobe less prominent. Additionally, the talonid of p4 is somewhat reduced, and the m2 paraconid more internal. The Cochrane 2 specimens are well within the size ranges for other samples of *Bessoecetor septentrionalis* from the Torrejonian and Tiffanian of western North America, and provide no supplemental descriptive information to that provided by Simpson and others.

Family Uncertain

Genus *Paleotomus* Van Valen, 1967

Paleotomus junior sp. nov.

Fig. 4; Table 5.

Holotype: UALVP 28556, left m3, Fig. 4C₁–C₃.

Type horizon and locality: Cochrane 2, Paskapoo Formation, southwestern Alberta.

Etymology: In reference to the small size of this species and to its occurrence with *P. senior* at Cochrane 2.

Age and distribution: Earliest Tiffanian of Alberta (type locality).

Table 5. Measurements and descriptive statistics for the dentition of *Paleotomus junior* sp. nov., from the Cochrane 2 locality, Paskapoo Formation, Alberta.

Element	P	N	OR	M	SD	CV
P4	Length	1	3.4	3.40	–	–
	Width	1	3.1	3.10	–	–
p3	Length	1	3.3	3.30	–	–
	Width	1	1.2	1.20	–	–
dp4	Length	2	3.5–3.7	3.60	0.14	3.90
	Width	3	1.5–1.6	1.57	0.06	3.80
m1	Length	1	3.1	3.10	–	–
	TrWidth	2	1.7–1.8	1.75	0.07	0.04
	TaWidth	1	1.4	1.40	–	–
m3	Length	3	3.5–3.6	3.53	0.06	1.63
	TrWidth	3	2.4–2.5	2.47	0.06	2.34
	TaWidth	3	1.6–1.9	1.77	0.15	8.65

Material.—UALVP 28564, P4; UALVP 28558, p3; UALVP 28566–28568, dp4s; UALVP 126, 45096, m1s; UALVP 28557, 28559, m3s.

Diagnosis.—Smallest species of the genus; differs from *Paleotomus senior* (Simpson, 1937), *Paleotomus milleri* Rigby, 1980, *Paleotomus radagasti* (Van Valen, 1978), and *Paleotomus carbonensis* Secord, 1998 in its significantly smaller dental dimensions (approximately 40 percent less than *Paleotomus senior*, 20 percent less than *Paleotomus milleri*, 50 percent less than *Paleotomus radagasti*, and 35 percent less than *Paleotomus carbonensis*); differs further from *P. milleri* in m1 lacking an entoconulid and mesoconid.

Description.—p3: The crown of p3 is dominated by the large protoconid; a small, unicusate heel is developed posteriorly. A small, conical paraconid arises from the anterolingual base of the protoconid and projects anteriorly. No metaconid is developed. Two prominent crests, one anterior, the other posterior, descend from the apex of the protoconid; the posterior crest continues posteriorly to the heel. A short crest runs anterolingually from the apex of the talonid cusp and meets the posterobasal part of the protoconid to form a shallow talonid basin.

dp4: dp4 is molariform, with a well-developed trigonid and talonid. The crown is dominated by a tall, subconical protoconid and a slightly shorter and smaller metaconid. The paraconid is positioned well anterior to both the metaconid and protoconid. A large secondary cusp arises anterolingual to the paraconid; the size and position of this cusp creates the appearance of a “twinned” paraconid. The metaconid is positioned posterolingual to the protoconid, and the two are joined for almost half their heights. The paracristid and protocristid are notched medially. The talonid is large and robust, slightly wider than the trigonid, with three distinct, well-separated cusps: the hypoconid is the largest talonid cusp, followed by a smaller entoconid and hypoconulid. The hypoconid and hypoconulid are subcrescentic in occlusal view, whereas the entoconid is more nearly circular. A tiny entoconulid is present on a low entocristid, and a swelling interpreted as a mesoconid occurs on the cristid obliqua. The talonid notch is broad and open lingually. The cristid obliqua is high at the hypoconid, but descends anteriorly and strikes the postvallid low and slightly labial to the medial notch in the protocristid. Labial exodaenodonty (Krause 1977) is present over the anterior and posterior roots.

m1: The trigonid is taller and of subequal width compared to the talonid. The protoconid is the largest and tallest trigonid cusp; its lingual face is concave. The metaconid is tall, slightly shorter than the protoconid, and convex along its anterior face. The paraconid is smaller and in a slightly more labial position than the metaconid; in occlusal view, the trigonid cusps form a nearly equilateral triangle. The paracristid is moderately high and notched. The protocristid is broadly V-shaped in labiolingual dimensions, and deeply notched medially, but well above the level of the talonid. The precingulid is prominent and shelf-like. A minor swelling is

sometimes present at the base of the paraconid. The talonid is open lingually, and the cusps are well developed and spaced equidistantly from each other; although wear has reduced the original sizes of the cusps, they appear to have been nearly equal in height, but from the dimensions of its base, the hypoconid was probably more massive than either the entoconid or hypoconulid. The hypoconid is subcrescentic in occlusal view, whereas the entoconid and hypoconulid are more nearly circular. Neither an entoconulid nor mesoconid are developed. The talonid crests are sectorial; the cristid obliqua meets the postvallid ventral to the protocristid notch.

m3: As in other species of *Paleotomus*, the protoconid on m3 is smaller relative to the metaconid than on m1 or m2. The paracristid and protocristid notches are distinct but weakly developed. The talonid cusps are robust and well defined, and both the mesoconid and entoconulid are absent.

Remarks.—Simpson (1937) described the pantolestid “*Palaeosinopa*” *senior* on the basis of an isolated m3 (AMNH 33990) and two upper molars (AMNH 33828 and 33991) from the early Tiffanian Scarritt Quarry, Montana. Van Valen (1967) later erected the genus *Paleotomus*, which he considered to be a didelphodontine palaeoryctid, for the m3, and named a new species, “*Palaeosinopa simpsoni*”, based on the upper molars. Gingerich (1980) subsequently synonymized “*Palaeosinopa simpsoni*” with *Paleotomus senior* and returned this taxon to the Pantolestidae; better-preserved specimens referable to *Paleotomus senior* from Douglass Quarry, Montana, supported this revision (Krause and Gingerich 1983). McKenna and Bell (1997) subsequently returned *Paleotomus* to the Didelphodonta, consistent with Van Valen’s (1967) original classification. It is clear from the repeated taxonomic shuffling that the suprageneric affinities of *Paleotomus* are not well understood; for the present, we consider the taxon best referred to Eutheria, *incertae sedis*.

Until the discovery of *P. junior*, the late Torrejonian *P. milleri* from Swain Quarry, Wyoming, and *P. carbonensis* from Grayson Ridge and Halfway Hill localities, Wyoming, were the smallest recognized species of the genus. *P. junior* occurs with the much larger *P. senior* at Cochrane 2.

Concluding remarks

Youzwshyn (1988) has determined the age of the Cochrane 2 local fauna to be earliest Tiffanian, based on the co-occurrence of the plesiadapid primates *Plesiadapis praecursor* Gingerich, 1975 and *Nannodectes intermedius* (Gazin, 1971), and the phenacodontid “condylarth” *Ectocion collinus* Russell, 1929, a view consistent within the framework of currently accepted North American biozonation schemes (Archibald et al. 1987). Fox (1990) estimated the Cochrane 2 local fauna to be approximately correlative with that of Douglass Quarry, Montana (Krause and Gingerich 1983), also considered earliest Tiffanian in age. The new taxa here documented add to the unusually diverse local fauna

from Cochrane 2; the locality currently includes over 80 mammalian species, an unprecedented number among late Torrejonian and Tiffanian faunas (Fox 1990). The unusual taxonomic diversity at Cochrane 2 and other early and middle Tiffanian localities in Alberta contrasts the results of faunal analyses of coeval localities in the Western Interior of the United States (for example, Rose 1981a, b), which suggest a decline in species numbers, possibly in response to changing climatic conditions (Sloan 1970). The richness of the Cochrane 2 local fauna is approached only by those from well-sampled late Torrejonian localities from Montana and Wyoming (Rose 1981a), and far exceeds that of the earliest Tiffanian Douglass Quarry, Montana (Krause and Gingerich 1983; Krause and Maas 1990). Earliest Tiffanian localities are comparatively rare in North America relative to late Torrejonian and late Tiffanian localities, suggesting at least the possibility of sampling error as an explanation for the apparent decline in species number across the Torrejonian–Tiffanian boundary. A more detailed speculation on the underlying reasons for the incongruence in taxonomic diversity between similarly aged localities from Alberta and the United States seems premature and must await a complete faunal analysis of the Cochrane 2 locality (Scott, Fox, and Youzwyshyn in preparation).

Acknowledgments

We thank Dr. Gregg Gunnell (Museum of Paleontology, University of Michigan, Ann Arbor) and Dr. Judith Schiebout (Museum of Natural Science, Louisiana State University, Baton Rouge) for reading the manuscript and providing very useful comments. John Acorn, Dr. Keqin Gao, Dr. David W. Krause, Andrew Neuman, Gary Stonley, and Dr. Michael Webb provided valuable field and/or laboratory assistance. Mrs. Asta Voss sorted the screened concentrates. Financial support for this study was provided by Natural Science and Engineering Research Council (NSERC) of Canada operating grants to Richard C. Fox, and by Natural Science and Engineering Research Council (NSERC) of Canada Post Graduate Scholarship A to Craig S. Scott.

References

- Archibald, J.D., Gingerich, P.D., Lindsay, E.H., Clemens, W.A., Krause, D.W., and Rose, K.D. 1987. First North American land mammal ages of the Cenozoic Era. In: M.O. Woodburne (ed.), *Cenozoic Mammals of North America, Geochronology and Biostratigraphy*, 24–76. University of California Press, Berkeley.
- Carrigy, M.A. 1970. Proposed revision of the boundaries of the Paskapoo Formation in the Alberta Plains. *Bulletin of Canadian Petroleum Geology* 18: 156–165.
- Carrigy, M.A. 1971. Lithostratigraphy of the uppermost Cretaceous (Lance) and Paleocene strata of the Alberta Plains. *Bulletin of the Research Council of Alberta* 27: 1–161.
- Clemens, W.A. 1966. Fossil mammals of the type Lance Formation, Wyoming. Part II. Marsupialia. *University of California Publications in Geological Sciences* 62: 1–122.
- Cope, E.D. 1875. Report on the geology of that part of northwestern New Mexico examined during the field season of 1874. *Annual Report of the Chief of Engineers for 1875*: 61–97.
- Cope, E.D. 1881a. Eocene Plagiaulacidae. *American Naturalist* 15: 921–922.
- Cope, E.D. 1881b. A new type of Perissodactyla. *American Naturalist* 15: 1017–1018.
- Cope, E.D. 1882. Synopsis of the Vertebrata of the Puerco Eocene Epoch. *Proceedings of the American Philosophical Society* 20: 461–471.
- Cope, E.D. 1884a. The Vertebrata of the Tertiary formations of the West. Book I. *Report of the United States Geological and Geographical Survey Territories, Washington (F.V. Hayden)* 3: 1–1009.
- Cope, E.D. 1884b. Second addition to the knowledge of the Puerco Epoch. *Proceedings of the American Philosophical Society* 21: 309–326.
- Cope, E.D. 1887. The marsupial genus *Chirox*. *American Naturalist* 21: 566–567.
- Dorr, J.A., Jr. 1952. Early Cenozoic stratigraphy and vertebrate paleontology of the Hoback Basin, Wyoming. *Bulletin of the Geological Society of America* 63: 59–94.
- Dorr, J.A., Jr. 1977. Partial skull of *Palaeosinopa simpsoni* (Mammalia, Insectivora), latest Paleocene Hoback Formation, central western Wyoming, with some general remarks on the family Pantolestidae. *Contributions from the Museum of Paleontology, The University of Michigan* 24: 1–26.
- Fox, R.C. 1983. Evolutionary implications of tooth replacement in the Paleocene mammal *Pararyctes*. *Canadian Journal of Earth Sciences* 20: 19–22.
- Fox, R.C. 1990. The succession of Paleocene mammals in western Canada. In: T.M. Bown and K.D. Rose (eds.), *Dawn of the Age of Mammals in the Northern Part of the Rocky Mountain Interior, North America. Geological Society of America, Special Paper* 243: 51–70.
- Fox, R.C. and Youzwyshyn, G.P. 1994. New primitive carnivores (Mammalia) from the Paleocene of western Canada, and their bearing on relationships of the order. *Journal of Vertebrate Paleontology* 14: 382–404.
- Fox, R.C., Youzwyshyn, G.P., and Krause, D.W. 1992. Post-Jurassic mammal-like reptile from Palaeocene. *Nature* 358: 233–235.
- Gazin, C.L. 1956a. Paleocene mammalian faunas of the Bison Basin in south-central Wyoming. *Smithsonian Miscellaneous Collections* 131: 1–57.
- Gazin, C.L. 1956b. The occurrence of Paleocene mammal remains in the Fossil Basin of southwestern Wyoming. *Journal of Paleontology* 30: 707–711.
- Gazin, C.L. 1971. Paleocene primates from the Shotgun member of the Fort Union Formation in the Wind River Basin, Wyoming. *Proceedings of the Biological Society of Washington* 84: 13–38.
- Gidley, J.W. 1915. An extinct marsupial from the Fort Union with notes on the Myrmecobidae and other families of this group. *Proceedings of the United States National Museum* 48: 395–402.
- Giebel, C.G. 1855. *Die Säugetiere in zoologischer, anatomischer und palaeontologischer Beziehung umfassend dargestellt*. 1108 pp. Abel, Leipzig.
- Gingerich, P.D. 1975. New North American Plesiadapidae (Mammalia, Primates) and a biostratigraphic zonation of the middle and upper Paleocene. *Contributions from the Museum of Paleontology, The University of Michigan* 24: 135–148.
- Gingerich, P.D. 1977. *Aletodon gunnelli*, a new Clarkforkian hyopsodontid (Mammalia, Condylarthra) from the early Eocene of Wyoming. *Contributions from the Museum of Paleontology, The University of Michigan* 24: 237–244.
- Gingerich, P.D. 1980. A new species of *Palaeosinopa* (Insectivora: pantolestid) from the late Paleocene of western North America. *Journal of Mammalogy* 61: 449–454.
- Gingerich, P.D. 1982. Paleocene “*Meniscotherium semicingulatum*” and the first appearance of Meniscotheriidae (Condylarthra) in North America. *Journal of Mammalogy* 63: 488–491.
- Gingerich, P.D. 1983. New Adapisoricidae, Pentacodontidae, and Hyopsodontidae (Mammalia, Insectivora and Condylarthra) from the late Paleocene of Wyoming and Colorado. *Contributions from the Museum of Paleontology, The University of Michigan* 26: 227–255.
- Gunnell, G.F. 1994. Paleocene mammals and faunal analysis of the Chappo

- Type locality (Tiffanian), Green River Basin, Wyoming. *Journal of Vertebrate Paleontology* 14: 81–104.
- Hartman, J.E. 1986. Paleontology and biostratigraphy of the lower part of the Polecat Bench Formation, southern Bighorn Basin, Wyoming. *Contributions to Geology, University of Wyoming* 24: 11–63.
- Holtzman, R.C. 1978. Late Paleocene mammals of the Tongue River Formation, western North Dakota. *Report of Investigation, North Dakota Geological Survey* 65: 1–88.
- Jepsen, G.L. 1940. Paleocene faunas of the Polecat Bench Formation, Wyoming. *Proceedings of the American Philosophical Society* 83: 217–340.
- Johnson, G.D., Murry, P.A., and Storer, J.E. 1994. Recovery of vertebrate microfossils. *Proceedings of the South Dakota Academy of Science* 73: 211–230.
- Johnston, P.A. and Fox, R.C. 1984. Paleocene and Late Cretaceous mammals from Saskatchewan, Canada. *Palaentographica A* 186: 163–222.
- Krause, D.W. 1977. Paleocene multituberculates (Mammalia) of the Roche Percée local fauna, Ravenscrag Formation, Saskatchewan, Canada. *Palaentographica A* 186: 1–36.
- Krause, D.W. 1978. Paleocene primates from western Canada. *Canadian Journal of Earth Sciences* 15: 1250–1271.
- Krause, D.W. 1982. *Evolutionary History and Paleobiology of Early Cenozoic Multituberculata (Mammalia), with Emphasis on the Family Ptilodontidae*, 1–555. Unpublished Ph.D. Dissertation, The University of Michigan, Ann Arbor.
- Krause, D.W. 1987. *Baiotomeus*, a new ptilodontid multituberculata (Mammalia) from the middle Paleocene of western North America. *Journal of Paleontology* 61: 595–603.
- Krause, D.W. and Gingerich, P.D. 1983. Mammalian fauna from Douglass Quarry, earliest Tiffanian (late Paleocene) of the eastern Crazy Mountain Basin, Montana. *Contributions from the Museum of Paleontology, The University of Michigan* 26: 157–196.
- Krause, D.W. and Maas, M.C. 1990. The biogeographic origins of late Paleocene–early Eocene mammalian immigrants to the Western Interior of North America. In: T.M. Bown and K.D. Rose (eds.), *Dawn of the Age of Mammals in the Northern Part of the Rocky Mountain Interior, North America. Geological Society of America, Special Paper* 243: 71–105.
- Lerbekmo, J.F. and Sweet, A.R. 2000. Magnetostratigraphy and biostratigraphy of the continental Paleocene in the Calgary area, southwestern Alberta. *Bulletin of Canadian Petroleum Geology* 48: 285–306.
- Matthew, W.D. 1899. A provisional classification of the fresh-water Tertiary of the West. *Bulletin of the American Museum of Natural History* 12: 19–77.
- Matthew, W.D. 1901. Additional observations on the Creodonta. *Bulletin of the American Museum of Natural History* 14: 1–38.
- Matthew, W.D. 1929. Preoccupied names. *Journal of Mammalogy* 10: 171.
- Matthew, W.D. and Granger, W. 1915. A review of the lower Eocene Wasatch and Wind River faunas. *Bulletin of the American Museum of Natural History* 34: 1–103.
- Matthew, W.D. and Granger, W. 1921. New genera of Paleocene mammals. *American Museum Novitates* 13: 1–7.
- McKenna, M.C. 1975. Toward a phylogenetic classification of the Mammalia. In: W.P. Luckett and F.S. Szalay (eds.), *Phylogeny of the Primates*, 21–46. Plenum Press, New York.
- McKenna, M.C. and Bell, S.K. 1997. *Classification of Mammals Above the Species Level*. xii+631 pp. Columbia University Press, New York.
- Novacek, M.J. 1977. A review of Paleocene and Eocene Leptictidae (Eutheria, Mammalia) from North America. *PaleoBios* 24: 1–42.
- Rigby, J.K., Jr. 1980. Swain Quarry of the Fort Union Formation, middle Paleocene (Torrejonian), Carbon County, Wyoming: geologic setting and mammalian fauna. *Evolutionary Monographs* 3: 1–179.
- Rose, K.D. 1981a. The Clarkforkian Land Mammal Age and mammalian faunal composition across the Paleocene–Eocene boundary. *Papers on Paleontology, Museum of Paleontology, The University of Michigan* 26: 1–189.
- Rose, K.D. 1981b. Composition and species diversity in Paleocene and Eocene mammal assemblages; an empirical study. *Journal of Vertebrate Paleontology* 1: 367–388.
- Russell, L.S. 1929. Paleocene vertebrates from Alberta. *American Journal of Science* 17: 162–178.
- Russell, L.S. 1932. New data on the Paleocene mammals of Alberta, Canada. *Journal of Mammalogy* 13: 38–54.
- Russell, L.S. 1958. Paleocene mammal teeth from Alberta. *Bulletin of the National Museum of Canada* 147: 96–103.
- Rutherford, R. L. 1927. Geology along the Bow River between Cochrane and Kananaskis, Alberta. *Scientific and Industrial Research Council of Alberta Report* 17: 1–29.
- Secord, R. 1998. Paleocene mammalian biostratigraphy of the Carbon Basin, southeastern Wyoming, and age constraints on local phases of tectonism. *Rocky Mountain Geology* 33: 119–154.
- Simpson, G.G. 1927. Mammalian fauna and correlation of the Paskapoo Formation of Alberta. *American Museum Novitates* 268: 1–10.
- Simpson, G.G. 1929. Paleocene and lower Eocene mammals of Europe. *American Museum Novitates* 354: 1–17.
- Simpson, G.G. 1935a. New Paleocene mammals from the Fort Union of Montana. *Proceedings of the United States National Museum* 83: 221–244.
- Simpson, G.G. 1935b. The Tiffany fauna, upper Paleocene. III. Primates, Carnivora, Condylarthra and Amblypoda. *American Museum Novitates* 817: 1–28.
- Simpson, G.G. 1936. A new fauna from the Fort Union of Montana. *American Museum Novitates* 873: 1–27.
- Simpson, G.G. 1937. The Fort Union of the Crazy Mountain Field, Montana, and its mammalian faunas. *Bulletin of the United States National Museum, Smithsonian Institution* 169: 1–287.
- Sloan, R.E. 1970. Cretaceous and Paleocene terrestrial communities of western North America. In: *North American Paleontological Convention Proceedings Part E*, 427–453. Allen Press Inc., Lawrence.
- Sloan, R.E. 1981. Systematics of Paleocene multituberculates from the San Juan Basin, New Mexico. In: S.G. Lucas, J.K. Rigby, Jr., and B. Kues (eds.), *Advances in San Juan Basin Paleontology*, 127–160. University of New Mexico Press, Albuquerque.
- Sloan, R.E. 1987. Paleocene and latest Cretaceous mammals, rates of sedimentation and evolution. In: J.E. Fassett and J.K. Rigby, Jr. (eds.), *The Cretaceous–Tertiary Boundary in the San Juan and Raton Basins, New Mexico and Colorado. Geological Society of America, Special Paper* 209: 165–200.
- Sloan, R.E. and Van Valen, L. 1965. Cretaceous mammals from Montana. *Science* 148: 220–227.
- Szalay, F.S. 1968. The Picrodontidae, a family of early primates. *American Museum Novitates* 2329: 1–55.
- Szalay, F.S. 1969. Mixodectidae, Microsyopidae, and the insectivore-primate transition. *Bulletin of the American Museum of Natural History* 140: 193–330.
- Tozer, E.T. 1956. Uppermost Cretaceous and Paleocene non-marine molluscan faunas of western Alberta. *Geological Survey of Canada Memoir* 280: 1–125.
- Trouessart, E.L. 1879. Catalogue des mammifères vivants et fossiles. *Revue et Magasin de Zoologie* 7: 219–285.
- Van Valen, L. 1966. Deltatheridia, a new order of mammals. *Bulletin of the American Museum of Natural History* 132: 1–126.
- Van Valen, L. 1967. New Paleocene insectivores and insectivore classification. *Bulletin of the American Museum of Natural History* 135: 221–284.
- Van Valen, L. 1978. The beginning of the Age of Mammals. *Evolutionary Theory* 4: 45–80.
- Winge, H. 1917. Udsigt over Insektaedernes indbyrdes Slaegtskab. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening* 68: 83–203.
- Winterfeld, G.F. 1982. Mammalian paleontology of the Fort Union Formation (Paleocene), eastern Rock Springs Uplift, Sweetwater County, Wyoming. *Contributions to Geology, University of Wyoming* 21: 73–112.
- Youzwyshyn, G.P. 1988. *Paleocene Mammals From Near Cochrane, Alberta*, 1–484. Unpublished M.Sc. Thesis, University of Alberta, Edmonton.