



Phylogeny of New Earliest Paleocene (Puercan) Peripitychid 'Condylarths' from the Great Divide Basin, WY

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Abstract

An earliest Paleocene (Puercan) fauna discovered by the late James Honey and Malcolm McKenna in the lower China Butte Member of the Fort Union Formation in Wyoming's Great Divide Basin (GDB) contains a diverse mammalian faunal assemblage, including a number of 'condylarth' taxa. Preliminary studies by others have suggested that this faunal assemblage may be correlative with the early Puercan Littleton fauna in the Denver Basin, due to multiple shared taxa. The fauna from UCM locality 2011035 includes at least three new peripitychid 'condylarth' genera. One new genus (referred here to Gen. et sp. nov. A) is based on a left dentary containing p3 – m3, is 10-12% larger than *Conacodon delphae* (the largest documented species of *Conacodon*) and appears similar in morphology to *Auraria urbana* but differs in having more inflated cusps. A second new genus (Gen. et sp. nov. B) is based on left and right dentaries containing Lp3 – m3 and Rp4 – m3, respectively. This new taxon appears close in molar morphology to species of *Conacodon*, differing primarily in its larger size and morphology of the p4. Finally, the third new genus of peripitychid from the GDB (Gen. et sp. nov. C) is based on two right dentaries containing p4 – m3 and p3 – m3, as well as a left dentary containing p4 – m2. This new taxon appears close in morphology to *Oxyacodon archibaldi*, sharing a distinct paraconulid but differing in the placement of the paraconid. To examine the relationships between these new taxa and other Puercan peripitychids from the Western Interior of North America, a phylogenetic analysis was performed using 20 'condylarth' taxa and 56 dental characters. Characters were aggregated from previous phylogenetic analyses of 'condylarth' taxa and scored based on comparative study with specimens from several museum collections as well as descriptions of teeth from the literature. The preliminary phylogenetic analysis suggests that Gen. et sp. nov. A appears closely related to *Auraria urbana* and *Ampliconus browni*, while Gen. et sp. nov. B appears to be a sister group to the *Conacodontines*, and Gen. et sp. nov. C forms a clade with *Oxyacodon archibaldi*. If prior estimates of an early Puercan age for UCM locality 2011035 are correct, then the occurrence of three new peripitychid taxa suggest that mammalian diversity is higher than previously thought for the earliest Paleocene.

Geologic Setting

Decades of paleontological fieldwork in the eastern Great Divide Basin (GDB) by James Honey and Malcolm McKenna produced a large and diverse assemblage of fossil mammals (3,200+ specimens). The research locality, UCM loc. 2011035 is early Puercan in age and has produced over 350 mammalian fossils, dominated by dentaries and a small percentage of upper dentitions. UCM loc. 2011035 lies ~50 m (166 ft) above the base of the Fort Union Formation in the China Butte Member (Hettinger *et al.*, 2008) in the GDB. Using the North American Land Mammal Ages (NALMA) as the biochronological framework, the fauna is hypothesized to represent the early Puercan Interval Zone (Pu1). This is based upon the presence of *Protungulatum donnae*, which marks the earliest Puercan boundary as well as the absence of *Ectoconus* which marks the middle Puercan boundary (Pu2) (McComas & Eberle, 2015).

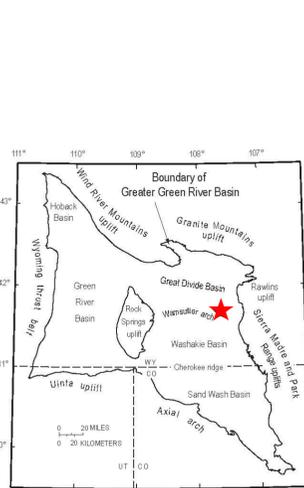
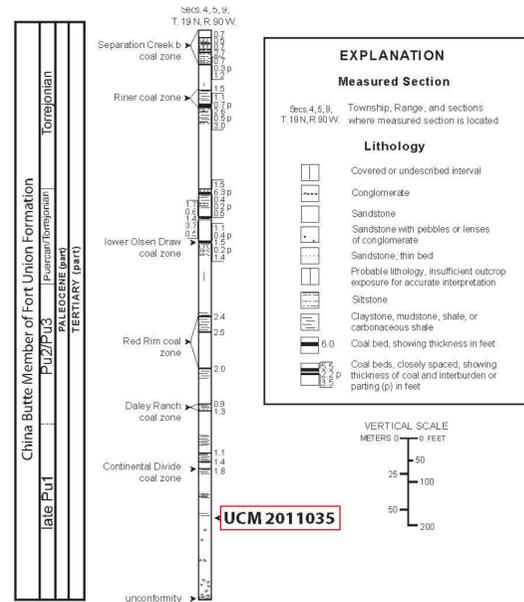


Figure 7. Map of the Greater Green River Basin showing UCM loc. 2011035, indicated by star (modified from Hettinger *et al.* 2008).

Figure 6. Stratigraphic section showing the position of UCM loc. 2011035 (modified from Hettinger *et al.* 2008).

Three New Peripitychids

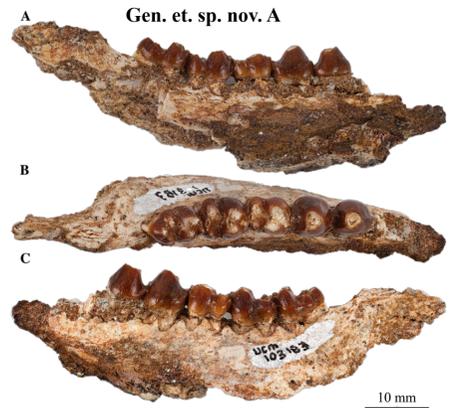


Figure 1. Gen. et sp. nov. A from UCM loc. 2011035. UCM 103183 left mandible with p3 – m3, in A, lingual; B, occlusal; and C, labial views. Inset images provide detailed views of diagnostic and descriptive features, as labeled.

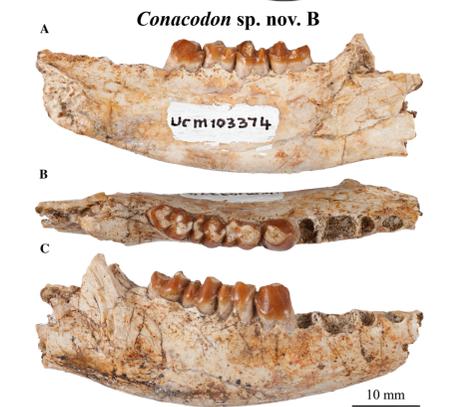
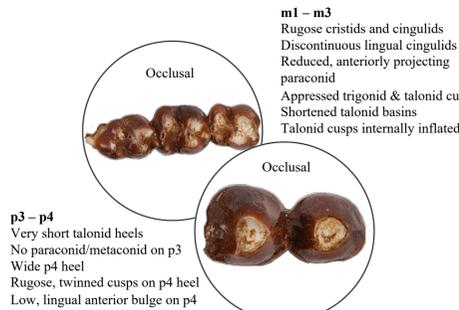


Figure 2. *Conacodon* sp. nov. B from UCM loc. 2011035. UCM 103374 right mandible with p4 – m3, in A, lingual; B, occlusal; and C, labial views. Inset images provide detailed views of diagnostic and descriptive features, as labeled.

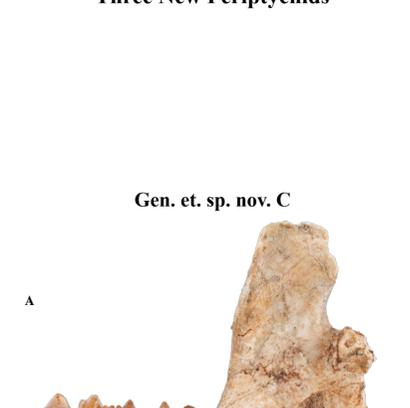
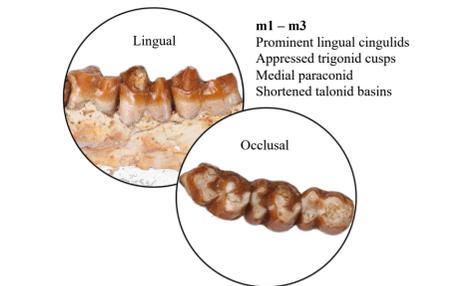


Figure 3. Gen. et sp. nov. C from UCM loc. 2011035. UCM 103181 right mandible with p4 – m3, in A, lingual; B, occlusal; and C, labial views. Inset images provide detailed views of diagnostic and descriptive features, as labeled.

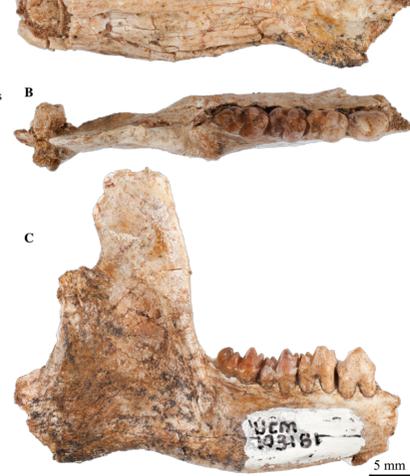


Figure 5. Gen. et sp. nov. C from UCM loc. 2011035. UCM 103171 left mandible with p4 – m2, in A, lingual; B, occlusal; and C, labial views. Inset images provide detailed views of diagnostic and descriptive features, as labeled.

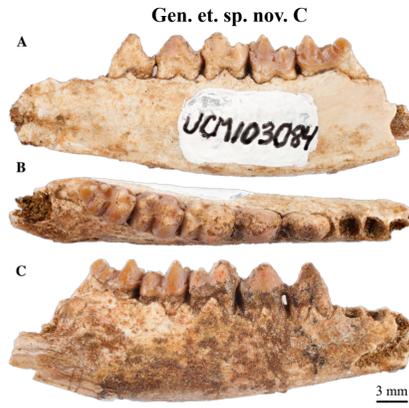
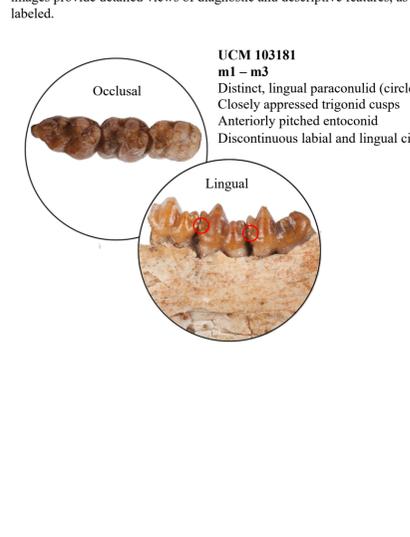


Figure 4. Gen. et sp. nov. C from UCM loc. 2011035. UCM 103084 right mandible with p3 – m3, in A, lingual; B, occlusal; and C, labial views. Inset images provide detailed views of diagnostic and descriptive features, as labeled.

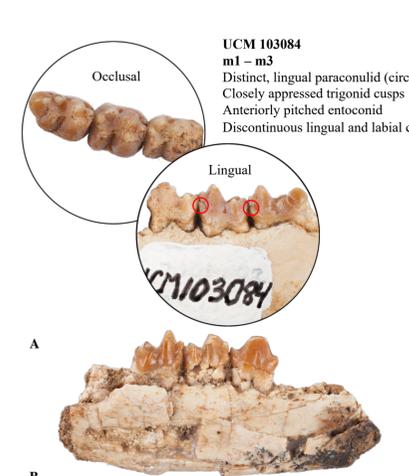


Figure 5. Gen. et sp. nov. C from UCM loc. 2011035. UCM 103171 left mandible with p4 – m2, in A, lingual; B, occlusal; and C, labial views. Inset images provide detailed views of diagnostic and descriptive features, as labeled.

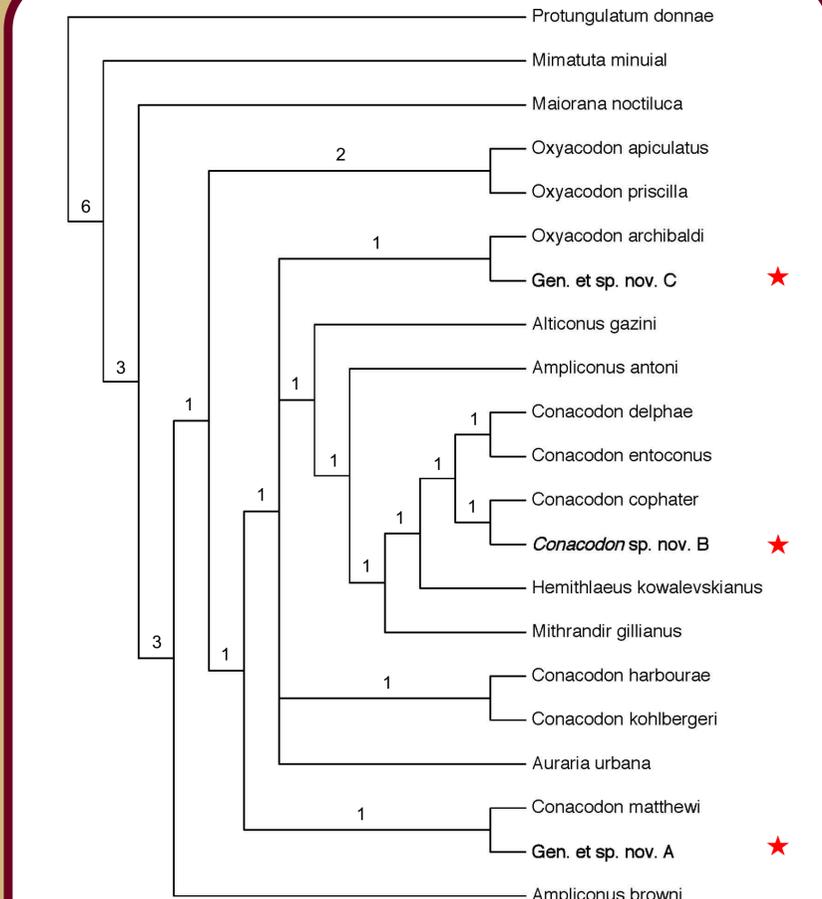
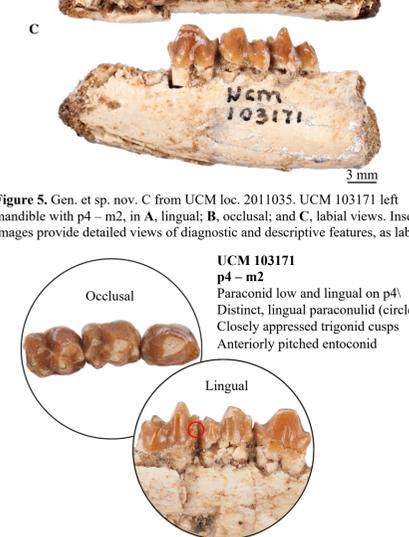


Figure 8. Phylogenetic relationships obtained using PAUP* v.4.0 beta 10 Win (Swofford 1998), based on 56 dental characters and performed on 21 'condylarth' taxa, with *P. donnae* as the outgroup. Strict consensus of 2 most parsimonious trees (159 steps, Consistency Index = 0.40, Retention Index = 0.55), with Bremer decay indices above the branches. It is important to note that decay indices are low due to the quantity of taxa and characters, as well as the absence of upper dental characters for 8 of the taxa analyzed.

Conclusions

The three new taxa from the GDB increase the known diversity of early Puercan peripitychid 'condylarths'. Gen. et sp. nov. A appears to be a sister taxon to *Conacodon matthewi*. *Conacodon* sp. nov. B appears to belong among the *Conacodontines*. Gen. et sp. nov. C forms a clade with *Oxyacodon archibaldi*. Our phylogenetic analysis suggests that Puercan conacodontines are paraphyletic, and future discovery in the Great Divide Basin should resolve the diversity of this family. This hypothesis will continue to be tested through the incorporation of more complete material and additional 'condylarth' taxa.

Acknowledgements
Without the tremendous collecting and mapping efforts by the late James Honey and Malcolm McKenna, this window into a new Puercan fauna would not exist. Jeannine Honey provided valuable insight and logistical assistance with fossil collection. Chrissy McCain and Ben Burger served on MA's Master's thesis committee. Toni Culver (CU) provided collection, map, and database assistance, and Virginia Scott provided access to the UCM Imaging System for high-resolution specimen images. Funding for fieldwork was provided by a grant to JE from the David B. Jones Foundation. MA was also supported by a grant from the Institute of Museum and Library Services (IMLS) awarded to JE. The Department of Geological Sciences at the University of Colorado Boulder awarded MA with a travel grant to attend the Geological Society of America (GSA) Rocky Mountain and Cordilleran Joint Section Meeting (2018) and the GSA Annual Meeting (2018), alongside a grant provided by the University of Colorado UGGS. The University of Colorado Graduate School also awarded MA with a domestic travel scholarship to attend the GSA Annual Meeting (2018).

References
Hettinger, R. D., Honey, J. G., Ellis, M. S., Barclay, C. S. V., & East, J. A. 2008. Geologic map of Upper Cretaceous and Tertiary strata and coal stratigraphy of the Paleocene Fort Union Formation, Rawlins-Little Snake River area, South-Central Wyoming. *US Geol. Surv. Denver*.
Lillegraven, J. A., Sooker, A. W., & McKenna, M. C. 2004. Tectonic and paleogeographic implications of late Laramide geologic history in the northeastern corner of Wyoming's Hanna Basin. *Rocky Mountain Geology*, 39(1), 7-64.
Kirschbaum, M. A., Andersen, D. W., Helm, R. L., & Baldwin, R. J. 1994. Paleocene Drainage Systems, Rock Springs Uplift, Wyoming. *The Mountain Geologist*.
Love, J. D. 1961. Definition of Green River, Great Divide, and Washakie basins, southwestern Wyoming. *AAPG Bulletin*, 45(10), 1749-1755.
McComas, K. M., & Eberle, J. J. 2015. A new earliest Paleocene (Puercan) arctocyonid mammal from the Fort Union Formation, Great Divide Basin, Wyoming, and its phylogenetic position among early 'condylarths'. *Journal of Systematic Palaeontology*, 14(6), 445-459.
McKenna, M. C., 1960. Fossil Mammals from the early Wasatchian Four Mile Fauna, Eocene of northwest Colorado. *University of California Publications in Geological Sciences* 37, 130 pp.
Swofford, D. L., 1998. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods).
Version 4. Sinauer Associates, Sunderland, Massachusetts.
Taylor, L. H. 1984. Review of Tertiary mammals from the San Juan Basin, New Mexico.

Figure 9. Photo of UCM field crew (from left to right): Nicole Neu-Yagle, Maddy Atteberry, Bob Hettinger, Wendy Hettinger, and Jeannine Honey. Taken by Jaelyn Eberle, 2017.