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The Bridger Formation,
Southern Green River Basin,
Southwestern Wyoming. Part 4.
The Geolabididae (Mammalia, Insectivora)**

Leonard Krishtalka and Robert M. West

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**Paleontology and Geology of
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The Geolabididae (Mammalia, Insectivora)**

Leonard Krishtalka
Section of Vertebrate Fossils
Carnegie Museum of
Natural History
Pittsburgh, Pennsylvania 15213

Robert M. West
Department of Geology
Milwaukee Public Museum
Milwaukee, Wisconsin 53233

Abstract. Two species of *Centetodon*, *C. pulcher* and *Centetodon* sp. B. (new, Lillegraven and McKenna, MS) comprise the geolabidid record from the Green River Basin, Wyoming. Previously unknown elements of the upper dentition of *C. pulcher* are described along with a reconstruction of the lower antemolar teeth. *C. pulcher*, *Batodon* and *Batodonoides* appear to be the most primitive known geolabidids, and the family seems most closely related to palaeoryctids.

INTRODUCTION

Small insectivores of the Family Geolabididae are poorly represented in most collections of Eocene mammals. Ongoing collecting by the junior author in the Bridger Formation has yielded a modest sample that increases our knowledge of the dental anatomy and evolution of the genus *Centetodon*.

The systematics of *Centetodon* is currently being revised (Lillegraven and McKenna, MS). Reference to this work was published elsewhere (Krishtalka and Setoguchi, 1977), including an informal designation of new species named in Lillegraven and McKenna's manuscript that will likewise be used here.

Lillegraven and McKenna recognize three Eocene species of *Centetodon*: *C. pulcher* Marsh, 1872 and *Centetodon* sp. B (new) occur in Bridgerian deposits, whereas, *Centetodon* sp. U (new) is known from Uintan horizons of California. Krishtalka and Setoguchi (1977) added *C. magnus* (Clark, 1936) and *Centetodon* sp. C (new) from the Uintan and Duchesnean sediments of the Badwater Creek area to the Eocene record of the genus. Both of these species had previously been reported only from the Oligocene. The earliest known record of *C. pulcher* is from the Wasatchian Huerfano Formation

(Huerfano A, Garcia Canyon locality), Colorado (Krishtalka, 1975). Three of these species (*C. magnus*, *Centetodon* sp. U, *Centetodon* sp. C) are known from elements of the upper and lower dentition, whereas *C. pulcher* and *Centetodon* sp. B are reported by Lillegraven and McKenna (MS) from the lower dentition alone. Isolated upper molars of *Centetodon* sp. B have been recovered from the Bridgerian Powder Wash locality, Utah (Krishtalka, 1975). P⁴ and upper molars of *C. pulcher* have, until this study, never been identified or described.

The *Centetodon* material from the Bridger Formation represents two species: *C. pulcher* and *Centetodon* sp. B. Analysis of remains of their upper dentitions improves our understanding of their relationships to other species of *Centetodon* and other geolabidids. Well-preserved partial dentaries of *C. pulcher* allow some reconstruction of the number and structure of antemolar teeth.

Specimens of both *C. pulcher* and *Centetodon* sp. B have been found at localities in the Bridger B (Black's Fork Member of the Bridger Formation) and Bridger C (Twin Buttes Member). A Bridger D locality (MPM locality number 1128) yielded additional *C. pulcher* material and Gazin (1976) reported this species from the lower and upper Bridger. The occurrence of both species throughout much of the Bridger Formation is coincident with other examples (West, 1973 for apatemyids; Krishtalka and West, 1977 for erinaceids; West, 1979 for *Hyopsodus*) of the apparent slow rate of evolutionary change in these mammalian taxa during the Bridgerian.

Because of Lillegraven and McKenna's (MS) forthcoming work, only those aspects of the morphology and evolution of *Centetodon* not broached by them are discussed and figured below.

Abbreviations in this paper are as follows: AMNH, American Museum of Natural History; MPM, Milwaukee Public Museum; L, length; W, width. All measurements in the text and tables are in millimeters. The figures are scanning electron microscope stereomicrographs.

FAMILY GEOLABIDIDAE (McKENNA, 1960)

***CENTETODON* MARSH, 1872**

***CENTETODON PULCHER* MARSH, 1872**

(Figs. 1-3; Table 1)

Referred material: partial dentary with: P₃-M₁, AMNH 91870; P₃₋₄, AMNH 91874; P₄-M₁, AMNH 91873; M₁₋₃, MPM 3943; M₁₋₂, AMNH 91869, 91875, MPM 3924; M₂₋₃, AMNH 91876, 91878; P₄, AMNH 91334, 91877, MPM 3825; M₂, AMNH 91871, MPM 3936; isolated M₁, AMNH 91881, 91883, MPM 3941; M₂, AMNH 91879, MPM 3938; P⁴, AMNH 91885, 91886, MPM 3927, 3944, 3949; M¹, AMNH 91843-91849, 91851, MPM 3920, 3937; M², AMNH 91850, 91853.

Localities: MPM locality numbers 1129, 2145, 2215, 2401, 2413 (all Bridger B); 1102, 1125, 1098, 2187, 2228, 2827 (all Bridger C); 1128 (Bridger D); with coordinates on file in the Department of Geology, Milwaukee Public Museum.

Known distribution: Late Wasatchian, Colorado; Bridgerian, Wyoming.

Description: Lillegraven and McKenna (MS) present a full account of the morphology of P_3 - M_3 . Teeth anterior to P_3 are unknown in *C. pulcher*, but MPM 3943, a partial right dentary, preserves M_{2-3} , the talonid of M_1 and twelve alveoli anterior to the alveolus for the M_1 trigonid. P_3 and P_4 in other specimens of *C. pulcher* are two-rooted, accounting for the posterior four antemolar alveoli. The four alveoli anterior to those for P_3 on MPM 3943 are slightly inclined anteriorly, but are otherwise similar to those for P_{3-4} and probably contained two-rooted P_1 and P_2 . Of the remaining four alveoli anterior to those for P_1 , the posterior three are inclined anteriorly at more than a 45 degree angle to the vertical. The size, position and shape of these four alveoli imply that they contained a single-rooted canine and three incisors. Sequentially, from I_1 to C, the alveoli are: tiny and nearly vertical (I_1); large and circular (I_2); smaller than that for I_2 and circular (I_3); slightly larger than that for I_2 but elliptical longitudinally (C). If the alveolar morphology is an indication of the size, shape and inclination of the teeth, I_1 was tiny, I_{2-3} and C markedly procumbent and I_2 much larger than I_1 or I_3 ; the canine was larger than I_2 and laterally compressed.

Isolated P^4 s, M^1 s and M^2 s of *C. pulcher* were identified on the basis of their resemblance to comparable teeth of other species of *Centetodon* and similarity in size and abundance to remains of the lower dentition of *C. pulcher*.

P^4 , T-shaped in occlusal view, is much longer labially than lingually. The paracone, tall and spire-like, dominates the buccal half of the crown. The parastyle is a small cusp, completely separated from the paracone, and forms the anterolabial spur of the crown. A short ridge runs from the parastyle to the anterior part of the base of the paracone. The metastyle, not a discernible cuspule, forms the sharp posterolabial end of the high, dorsally sloping postparacrista. In buccal view the metastyle is much higher on the crown than the parastyle and the two are connected by a weak, sinuous ectocingulum. Two tiny accessory cuspules occur irregularly on the ectocingulum. When discernible, the anterior one is just posterior to the apex of the parastyle and the posterior one occurs a short distance anterior to the metastyle. The protocone is anteroposteriorly compressed, crescentic and about one-third as high as the paracone. A metaconule is absent but a swelling on the preprotocrista may be interpreted as a paraconule. On unworn P^4 s faint paraconulecristae are evident. The postprotocrista is short but the preprotocrista extends along the anterior margin of the crown to the parastyle. Weak pre- and postcingula occur on either side of the protocone but

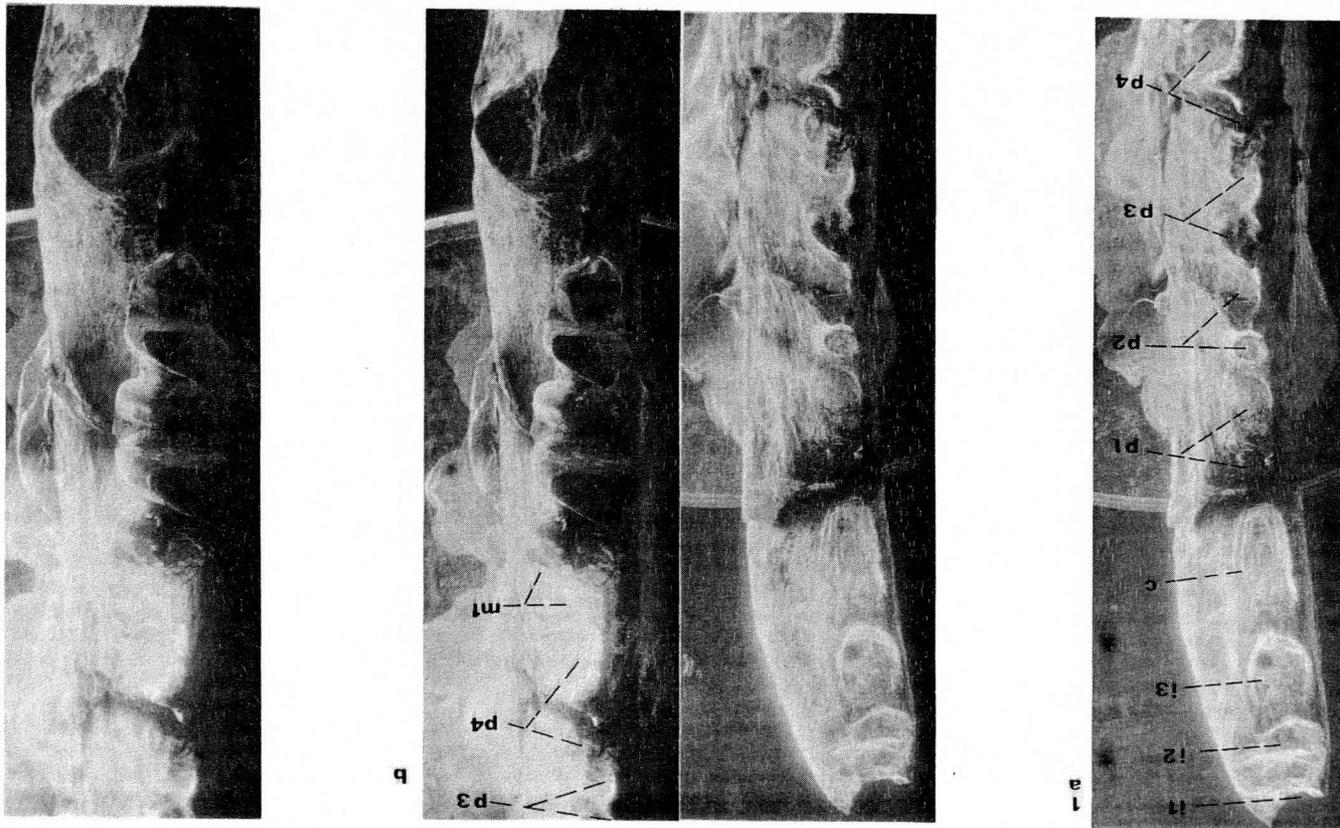


Figure 1. *Centetodon pulcher*, MPM 3943, showing partial right dentary with (a) alveoli for I₁-P₄; (b) M₁ talonid, M_{2,3}, and alveoli for P₃-M₁.

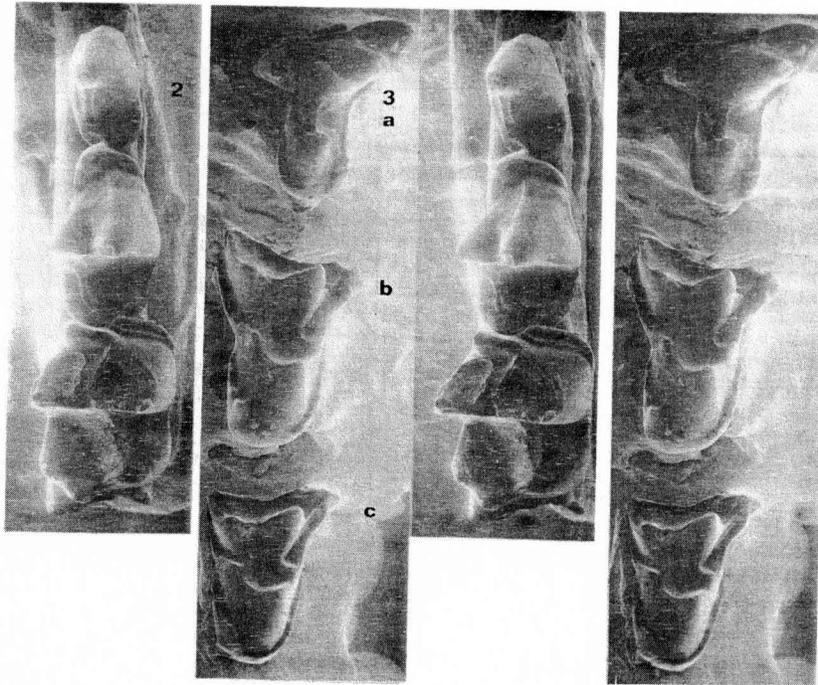


Figure 2. *Centetodon pulcher*, AMNH 91870, partial right dentary with P₃-M₁.

Figure 3. *Centetodon pulcher* (a) MPM 3944, LP₄; (b) AMNH 91843, RM₁; (c) AMNH 91850, RM₂.

are not continuous lingually. The postcingulum ends lingually in a tiny hypocone and extends labially along the base of the high postparacrista. The precingulum, narrower and shorter than the postcingulum, is limited to the anterior part of the base of the protocone. The lingual root of P₄ is not divided.

M¹ and M² are essentially triangular in occlusal aspect and transverse, with flaring styler lobes. The paracone and metacone, connate along the first one-third of their height, occur internally, so that the styler shelf is broad. The paracone is tall, nearly vertical and conical, whereas the metacone, shorter than the paracone, leans posteriorly and is crescentic. On M¹ the metastyler salient is larger than and extends buccally beyond the parastyler one. On M² the parastyler area is more expanded labially and the ectoflexus is deeper than on M¹. The preparacrista on both upper molars extends to a small stylocone, just posterior to the parastyle. The postmetacrista, a high trenchant crest, slopes posterolabially and dorsally to the tip of the metastyler wing.

Table 1. Dimensions of teeth of *Centetodon pulcher* and *Centetodon* sp. B from the Bridger Formation, Green River Basin, Wyoming.

	<i>Centetodon pulcher</i>			<i>Centetodon</i> sp. B		
	Range	N	Mean	Range	N	Mean
P ⁴ : L	2.1-2.3	3	2.2	—	—	—
W	2.5-2.8	4	2.6	—	—	—
M ¹ : L	1.8-2.1	10	2.0	—	—	—
W	2.6-3.0	10	2.8	1.9	1	—
M ² : L	1.6-1.8	2	1.7	1.3	1	—
W	2.6-2.7	2	2.6	1.9	1	—
M ³ : L	—	—	—	1.0	1	—
W	—	—	—	1.7	1	—
P ⁴ : L	1.7-1.8	6	1.8	1.2-1.6	6	1.4
W	1.0-1.2	6	1.1	0.7-0.9	6	0.8
M ¹ : L	1.8-2.1	7	2.0	1.4-1.7	6	1.5
W	1.4-1.5	6	1.4	0.9-1.1	6	1.0
M ² : L	1.8-2.0	10	1.8	1.3-1.4	4	1.3
W	1.4-1.5	5	1.5	0.9-1.0	4	0.9
M ³ : L	1.7-1.8	3	1.7	1.2-1.4	8	1.3
W	1.0-1.3	3	1.2	0.8-0.9	8	0.8

The protocone, about one-half the height of the paracone, is subcrescentic, with well developed protocristae. Acute V-shaped conules occur on these cristae with the paraconule slightly larger than the metaconule and closer to the protocone. The preparaconulecrista runs to the stylocone and the postmetaconulecrista to the tip of the metastylar salient. These crests demarcate a broad paracingulum and metacingulum along the base of the paracone and metacone, respectively. Narrow pre- and postcingula occur along the lingual half of the base of the crown and, although they may extend weakly around most of the lingual base of the protocone, they are not usually continuous. The two cingula do meet lingually on the two referred M²s. The cingula end labially at a point basal to the conules where, consequently, the crown is shortest and most emarginate. The postcingulum, wider than the precingulum, bears a tiny hypocone. The single lingual root of M¹ and M² is broad anteroposteriorly, but is not divided into anterior and posterior columns. M³ and teeth anterior to P⁴ have as yet not been identified.

Remarks: Diagnostic features of the lower dentition of *C. pulcher* are discussed by Lillegraven and McKenna (MS). Compared to other species of *Centetodon*, P⁴ of *C. pulcher* has a more medial rather than anteriorly dis-

placed protocone. M^{1-2} of *C. pulcher* are distinct and more primitive in four specific features: (1) the lingual root is a single, broad, undivided column; (2) the pre- and postcingula are narrower lingually; (3) the pre- and postvallum walls of the trigon form a more obtuse V; and (4) the stylar shelves are somewhat wider. In contrast, among the four other known Eocene species of *Centetodon* (Krishtalka and Setoguchi, 1977): (1) the lingual root of M^1 and M^2 is either divided by a groove into anterior and posterior columns or is partially bifurcate (*Centetodon* sp. B, *Centetodon* sp. U) or two separate roots occur (*C. magnus*, *Centetodon* sp. C); (2) the cingula are much wider lingually and more shelf-like, so that, in occlusal view, the lingual half of the crown is more nearly rectangular than triangular; (3) the anterior and posterior walls of the trigon form a more acute-angled V; and (4) the stylar shelves are narrower. Consequently, M^{1-2} of these species are more transverse than those of *C. pulcher*.

CENTETODON SP. B LILLEGRAVEN AND McKENNA (MS)
(Fig. 4; Table 1)

Referred specimens: partial dentaries with: P_{3-4} , AMNH 91864; P_4 - M_1 , AMNH 91857, 91860; M_{1-3} , AMNH 91855, MPM 3919; M_{2-3} , AMNH 91862, 91863, 91856, MPM 3917; P_4 , AMNH 91865; M_1 , AMNH 91858; M_3 , AMNH 91854, 91861, 91859; isolated P_4 , AMNH 91866, 91880; M_1 , AMNH 91867, 91882; M^1 , AMNH 91852; partial maxilla with M^{2-3} , MPM 3918.

Localities: MPM locality numbers 1129, 2215, 2401, 2409 (all Bridger B); 1098 (Bridger C); with coordinates on file in the Department of Geology, Milwaukee Public Museum.

Known distribution: Bridgerian of Wyoming and Utah.

Description and remarks: Lower teeth anterior to P_4 of this species are unknown. Lillegraven and McKenna (MS) thoroughly describe and diagnose *Centetodon* sp. B on the basis of P_4 and molar morphology.

Isolated upper molars of this species have been recovered from the Bridgerian Powder Wash locality in the Green River Formation, Utah (Krishtalka, 1975; Krishtalka and Setoguchi, 1977) and are reported here from the Bridger Formation Green River Basin, Wyoming. M^1 and M^2 are similar to those of *C. pulcher* described above with the following distinctions: the crowns are more transverse, with broader, more shelf-like lingual cingula that do not continue around the lingual base of the protocone; the protocone and trigon are more compressed anteroposteriorly and the lingual root is either bifurcate or divided by a lingual groove into two columns. These distinctions imply that *Centetodon* sp. B is derived with respect to *C. pulcher* and more closely related to other known species of the genus—a conclusion also reached by Lillegraven and McKenna (MS) on the basis of the lower dentition. M^3 resembles M^{1-2} except that the metastylar

area is not developed, the lingual cingula are reduced and the lingual root is not divided.

DISCUSSION AND CONCLUSIONS

The newly recovered upper molars of *C. pulcher* and the additional material of *Centetodon* sp. B appear to confirm an earlier conclusion (Krishtalka, 1975; Krishtalka and Setoguchi, 1977) concerning the evolution of *Centetodon* during the Eocene. One apparent morphocline is the division of the lingual root of the upper molars into two vertical columns (*Centetodon* sp. B, *Centetodon* sp. U) and then into two separate roots (*Centetodon* sp. C, *C. magnus*). All post-Eocene species of *Centetodon* have a separate protoconal and hypoconal root on the upper molars. This morphocline seems to be correlated with the expansion of the postcingulum into a hypoconal shelf in the evolution of these species. *C. pulcher* is primitive in these features. The lingual root on the upper molars is single and undivided, and the postcingulum is narrow.

Other genera of the Geolabididae are *Batodon*, from the late Cretaceous of Alberta, Wyoming and Montana (Lillegraven, 1969; Clemens, 1973), and *Batodonoides*, from the Uintan of California (Novacek, 1976). *Batodonoides*, differs dentally from *Batodon* and *Centetodon* as described by Novacek (1976). *Batodon* is distinguished from *Centetodon* as follows: presence of an incipient metacone on P⁴; larger conules and absence of a hypocone on M²; and a longer talonid relative to the trigonid on M₂₋₃. M¹ of *Batodonoides* and M² of *Batodon* most closely resemble those of *C. pulcher* among the known species of *Centetodon* in having a single, undivided lingual root, but this is a primitive feature that is not indicative of a special relationship among these taxa.

Before *Batodon* was recently recognized as a geolabidid (McKenna, per-

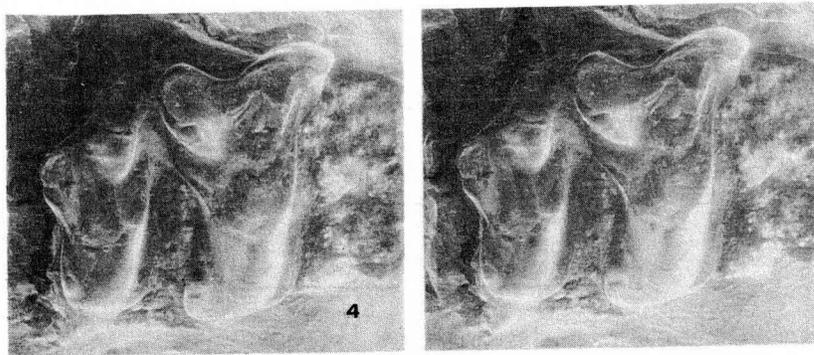


Figure 4. *Centetodon* sp. B, MPM 3918, partial right maxilla with M²⁻³.

sonal communication; Novacek, 1976), the genus was identified as a palaeoryctid with close affinities to *Cimolestes incisus* (Lillegraven, 1969; Clemens, 1973). The sparse material referred to *Batodon* differs from *Cimolestes* but shares with *Centetodon* and *Batodonoides* the following derived geolabidid features: a metaconid and narrow, lingually displaced talonid basin on P₄; much stronger cingula on M². Other features shared by *Batodon*, *Batodonoides* and *Centetodon* are also present in *Cimolestes*: the upper molars are transverse, with connate paracone and metacone, broad, flaring styler areas, high, bladelike postmetacrista, strong conulecristae and anteroposteriorly compressed trigons and protocones. On the lower molars the trigonids are wider than the talonids and about three times as high, with tall, shearing protoconids and metaconids. Many of these similarities may, as Novacek (1976) also suggested, indicate a close phylogenetic relationship between the geolabidids *Batodon*, *Batodonoides* and *Centetodon* and at least some palaeoryctids, such as *Cimolestes*.

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