Paludicola 7(3):78-88 October 2009

MAMMALS FROM THE BLUE ASH LOCAL FAUNA (LATE OLIGOCENE), SOUTH DAKOTA. LIPOTYPHLA AND ADDITIONAL MARSUPIALIA

William W. Korth

Rochester Institute of Vertebrate Paleontology, 265 Carling Road
Rochester, NY 14610

ABSTRACT

One additional species of marsupial, *Nanodelphys* sp., and six species of Lipotyphla are identified from an anthill collection of specimens from the Blue Ash local fauna. One new species of erinaceid, *Proterix minimus* is described. The latest occurrence of the proscalopid *Oligoscalops* is recorded also. As has been the case with other groups of mammals described from the Blue Ash, there is a mixture of earlier and later occurring species, making the assignment of the fauna to either the Whitneyan or Arikreean land mammal age uncertain.

INTRODUCTION

The Lipotyphla, or insectivorous mammals, from the Blue Ash anthill faunas is limited to 20 specimens, making it the least well represented group of small mammals other than marsupials (Korth, 2007a). Preliminary faunal lists of the Blue Ash fauna (Table 1) recognized between eight and eleven different species of insectivorans (Martin, 1974; Simpson, 1985). However, the current study only recognizes six different species. In addition, several previously unreported specimens of marsupials are described which has resulted in the recognition of an additional species of the latter. The recognition of these seven additional species increases the number from the Blue Ash fauna to 33 species representing 12 families and four orders.

TABLE 1. Preliminary faunal lists of insectivorous mammals from Blue Ash fauna, South Dakota.

Martin (1974)	Simpson (1985)
Leptictis (=*Ictops*)	*Leptictis* cf. *dakotensis*
Sinclairella cf. *dakotensis*	*Sinclairella* cf. *dakotensis*
Proterix	*Proterix* sp.
	?*Ocajila makpiyahe*
Centetodon (=*Geolabis*)	*Centetodon wolffi*
	C. cf. *magnus*
	?Centetodon sp.
Domnina	*Domnina gradata*
Trimylus	?Heterosoricine gen et sp. nov
Proscalops	*Proscalops tertius*
Arctoryctes	*?Oligoscalops* sp. A

Dental terminology generally follows that of Van Valen (1966) with some modifications for marsupials (Crochet, 1980), soricids (Repenning, 1967), and proscalopids (Barnsoky, 1982). Upper teeth are indicated by capital letters and lower teeth by lower-case letters. CM is the abbreviation used for Carnegie Museum of Natural History.

SYSTEMATIC PALEONTOLOGY

Order Marsupialia Illiger, 1811
Family Didelphidae Gray, 1821
Herpetotherium Cope, 1873
Herpetotherium fugax Cope, 1873

Additional Referred Specimens—CM 76759, right mandibular fragment with worn m2; and CM 76760, right m1.

Measurements—CM 76759 (m2): length = 1.63 mm; width = 1.01 mm. CM 76760 (m1): length = 1.88mm; width = 0.94 mm.

Discussion—Two additional specimens of *Herpetotherium fugax* are recognized from the Blue Ash fauna. The two molars are near the lower end of the size range of the species (Korth, 1994:table 4), as were the previously identified specimens (Korth, 2007a). The new material does not change the previous description or conclusions.

Peradectidae Crochet, 1979
Nanodelphys McGrew, 1937
Nanodelphys sp.
(Figure 1)

Referred Specimens—CM 76288, left maxillary fragment with M2; and CM 76737, left mandibular fragment with m4.

Measurements—CM 76288 (M2): length = 1.34 mm; width = 1.67 mm. CM 76737 (m4): length = 1.28 mm; width = 0.66 mm.

Description—The M2, CM 76288, is heavily abraded and the anterobuccal corner of the tooth is broken. The tooth is triangular in occlusal outline with the posterobuccal corner expanded. The paracone and metacone are subequal in size, the metacone positioned slightly more buccally than the paracone. Because of breakage, the presence of stylar cusp B cannot be determined, however, it is evident that there are no additional stylar cusps along the buccal border of the tooth.

The m4 referred here does not differ from that of the Orellan *N. hunti* described elsewhere (Korth, 1994), with a trigonid wider than talonid and hypoconulid as large as the entoconid. The tooth is slightly smaller than specimens of *N. hunti* (Korth, 1994:table 9).

Discussion—The specimens are referred to *Nanodelphys* based on the morphologies of the upper molars (paracone and metacone equal in size; most stylar cusps reduced or absent) and lower molars (hypoconulid twinned with entoconid and extending dorsally rather than posteriorly). Previously, *Nanodelphys* was only known from the Orellan, *N. hunti* and Arikareean *Nanodelphys* sp. (Korth, 1994). The lack of stylar cusp C is characteristic of a species from the Arikareean of Nebraska described in an unpublished dissertation of Martin (1973). The Blue Ash specimens clearly belong to the previously recognized Arikareean species. Due to the incompleteness of the known material of this species, it will not be named here.

Order Lipotyphla Haeckel, 1866
Family Erinaceidae Fischer de Waldheim, 1817
Proterix Matthew, 1903
Proterix minimus n. sp.
(Figure 2 A-D)

Type Specimen—CM 83710, left M1.

Referred Specimen—CM 83707, right M2; CM 83711, left m1.

Diagnosis—Smallest species of the genus (nearly 50% smaller than *P. loomisi*); M1 wider than long (as in *P. loomisi*); protoconule present on upper molars (absent in other species); minute, central hypoconulid on m1 (lacking in other species).

Measurements—CM 83710 (M1): length = 1.67 mm; width = 2.25 mm. CM 83707 (M2): length = 1.45 mm; width = 2.07 mm. CM 83711 (m1): length = 1.82 mm; width = 1.28 mm.

Etymology—Latin, *minimus*, least.

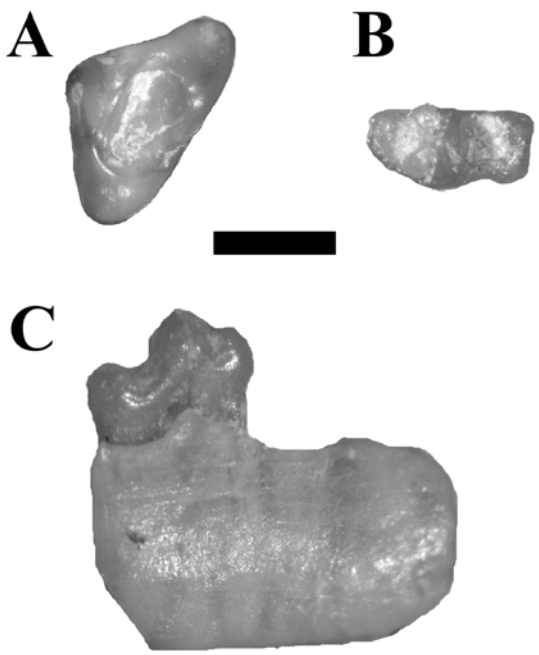

FIGURE 1. Molars of *Nanodelphys* sp. from the Blue Ash fauna. A, CM 76288, left M2. B, CM 76737, left m4. C, medial view of B. Bar scale = 1 mm.

Description—The M1 is nearly rectangular in occlusal outline, much wider than long, the posterobuccal corner extending slightly more buccal than the anterobuccal corner making the tooth wider posteriorly than anteriorly. The major cusps are large, bunodont, and circular in outline. There are no distinct stylar cusps along the buccal border of the tooth. The buccal cingulum forms a low lip along the external side of the tooth. There is virtually no stylar shelf. The paracone and metacone are equal in size and only weakly connected by a very low centrocrista near the bases of the cups. A low, curved postmetacrista extends from the apex of the metacone to the posterobuccal corner of the tooth. The protocone is the same size as the buccal cusps and weakly triangular in shape with a ridge extending buccally along the anterior margin of the tooth, ending with a triangular protoconule. A narrow valley separates the paracone from the protoconule. Similar to the buccal cingulum, the anterior cingulum is a low lip that runs the entire width of the tooth, continuous with the buccal cingulum, but ending at the anterolingual corner of the tooth lingually. The hypocone is circular in outline and only slightly smaller than the protocone. The only connection of the hypocone is a very low ridge that connects it to the protocone at the buccal edge of both cusps. The hypocone is slightly more lingual than the protocone. A smaller, circular metaconule is isolated

between the metacone and hypocone. The posterior cingulum runs lingually from the posterobuccal corner of the tooth to the posterobuccal side of the hypocone.

The M2, CM 83707, is similar to M1 in morphology. M2 is slightly smaller than M1 and the major cusps are not as large. Because of this, the stylar shelf is slightly wider than on M1. Unlike M1, M2 is wider anteriorly rather than posteriorly. The protoconule is smaller than on M1 and anteroposteriorly compressed rather than triangular. A low ridge runs from the protocone to the metacone (postprotocrista) which is not present on M1. The metaconule is also smaller than on M1. The ridge from the hypocone does not connect with the protocone as in M1, but extends anterobuccally, joining the postprotocrista just lingual to the metaconule. The postmetacrista is much shorter than on M1, and runs almost directly buccal from the metacone.

The trigonid and talonid of m1 are subequal in width and length. The trigonid is widely open lingually. The paraconid is just a minor swelling at the lingual end of the preprotocristid and much lower than the other trigonid cusps. The protoconid and metaconid form the posterior wall of the trigonid. The protoconid is only slightly higher than the metaconid. Between the latter cusps is a minute basin bounded by the anterior and posterior slopes of the cusps. A small cingulum originates along the base of the tooth on the buccal side below the paraconid and extends along the buccal side of the tooth to the base of the hypoconid. The talonid is lower than the trigonid. The cristid obliqua joins the trigonid posterior to the apex of the protoconid. The entoconid is higher than the hypoconid, and appears obliquely compressed. The entoconid and hypoconid are connected along a ridge that runs the width of the posterior margin of the tooth. Near the center of the ridge is a minute hypoconulid. It appears that the hypoconulid will be eliminated after only minimal wear.

Discussion—The specimens referred to *Proterix minimus* fit the diagnosis of the genus presented by Gawne (1968), but are much smaller than any previously reported species. The major difference other than size, that separates *P. minimus* from other species of the genus in the upper molar, is the presence of a distinct protoconule. In the other known species of *Proterix*, *P. bicuspis* and *P. loomisi*, there is no protoconule (Matthew, 1903; Gawne, 1968; Bjork, 1975). In proportions, the upper molars of *P. bicuspis* are relatively longer, being nearly as long as they are wide, whereas those of *P. loomisi* which are much shorter than wide (Bjork, 1975), as in the upper molar of *P. minimus*. The only difference between the m1 of *P. minimus* and other species of *Proterix* is the presence of a minute hypoconulid at the center of the posterior margin of the talonid. On other species this cusp is lacking (Gawne, 1968).

Proterix is known elsewhere from the Whitneyan and only possibly from the Orellan (Gunnell, et al., 2008b). Specimens cited by Gunnell et al. (2008b) as Arikareean are from the Blue Ash fauna, which may not be Arikareean.

Ocajila Macdonald, 1963
Ocajila sp., cf. *O. makpiyahe* Macdonald, 1963
(Figure 2E-G)

Referred Specimens—CM 83708, right m2; CM 83709, talonid of left m1.

Measurements—CM 83708 (m2): length = 1.65 mm; width = 1.22 mm. CM 83709 (m1): width = 1.35 mm.

Description—The m2, CM 83708, is longer than wide. The trigonid is anteroposteriorly compressed; the lingual opening between the metaconid and paraconid is narrow. The paraconid is reduced to a low loph along the anterior margin of the tooth, much lower than the protoconid and metaconid. There is a small valley separating the anterior margin of the protoconid and the paraconid crest. The protoconid and metaconid are equal in size and arranged in a transverse row along the back of the trigonid. The trigonid is slightly wider than the talonid. The talonid is nearly has high as the trigonid. The hypoconid is V-shaped. The cristid obliqua meets the posterior wall of the trigonid at a point just lingual to the apex of the protoconid. The entoconid is round and subequal in size to the metaconid. The hypoconid and entoconid are connected by a crest along the posterior margin of the tooth that is convex posteriorly with a distinct hypoconulid at its center. A posterior cingulum runs from the hypoconulid on the occlusal surface of the tooth to the posterior base of the hypoconid. The anterior cingulum runs along the base of the tooth from below the paraconid and wraps around the anterobuccal corner of the tooth, continuing posteriorly ending at the anterior base of the hypoconid.

CM 83709 is a partial m1 that consists of the posterior wall of the trigonid and the complete talonid. This specimen was referred to *Ocajila* because of its nearly identical morphology to the m2 described above and its slightly larger size. Except for this size difference, the morphology of the talonid of CM 83709 is nearly identical to that of m2. The only difference is that the entoconid is slightly transversely compressed, making the anterior slope of the entoconid a descending loph that partially blocks the lingual opening of the talonid.

Discussion—Previously, Macdonald (1963, 1970) described only the m2 and m3 of the type species, *Ocajila makpiyahe*, from the early Arikareean

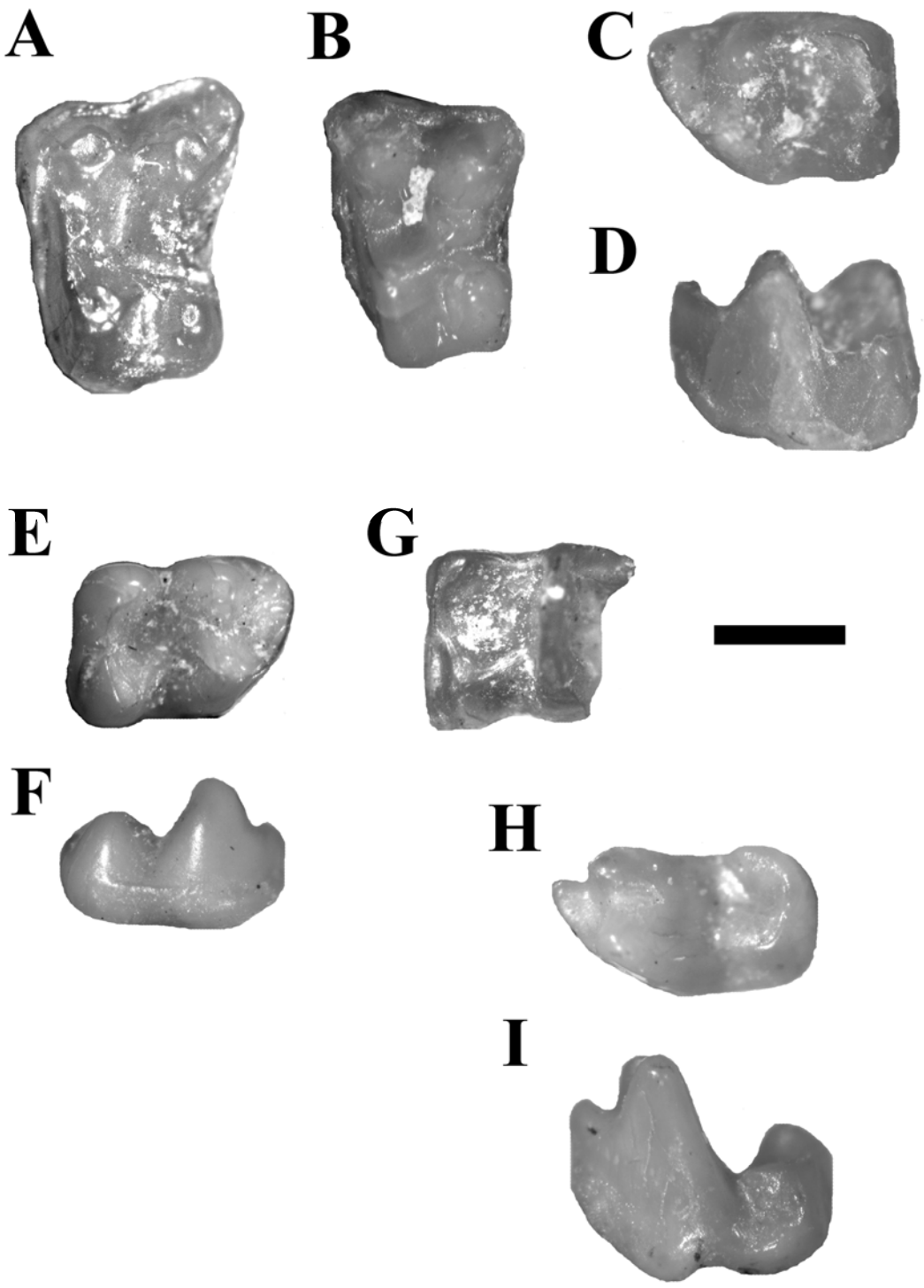

FIGURE 2. Erinaceidae and Geolabididae from the Blue Ash fauna. A-D, *Proterix minimus*. A, CM 83710, left M1 (type). B. CM 83707 right M2 (reversed). C. CM 83711, left m1. D, lateral view of C. E-G, *Ocajila* sp. cf. *O. makpiyahe*. E, CM 86708, right m2. F, lateral view of E. G, CM 83709, left m1 (reversed). H-I, *Centetodon magnus*. H, CM 76324, left m1. I, lateral view of H. Bar scale = 1 mm.

Sharps Formation of South Dakota (also see Hutchison, 1972). Korth (1992) referred an isolated m1 to *Ocajila* sp. from the later Arikareean of Nebraska, but noted it was much too large to belong to the type species *O. makpiyahe*.

The m2 from Blue Ash, CM 83708, is virtually identical to the m2 of the type specimen (Macdonald, 1963:fig. 4). The only difference between the Blue Ash m2 and that of the type and referred topotypic specimen (Macdonald, 1970:table 4) is that the Blue Ash specimen is slightly narrower transversely.

The molars referred here to *Ocajila* differ from that of *Proterix minimus* from Blue Ash mainly in the morphology of the hypoconulid. On m1 of the latter, it is a minute cusp that will likely disappear after only minimal wear, whereas in the molars referred to *Ocajila*, the hypoconulid is a larger cusp with a distinct cingulum running from it to the base of the hypoconid. There is no evidence of this posterior cingulum on the *P. minimus* specimen. The trigonid of the *P. minimus* specimen is also open more widely lingually than in the *Ocajila* specimen, and the former has a higher paraconid. Even though the *Ocajila* specimen is an m2 and that of *P. minimus* is an m1, in other species of *Proterix* the trigonid of m2 is not as anteroposteriorly compressed as in *Ocajila* (Gawne, 1968:fig. 3).

Family Geolabididae McKenna, 1960
Centetodon Marsh, 1872
Centetodon magnus (Clark, 1936)
(Figure 2H-I)

Referred Specimens—CM 76324, m1; CM 76325, m3.

Measurements—CM 76324 (m1): length = 1.92 mm; width = 1.08 mm. CM 76325 (m3): length = 1.71 mm; width = 1.10 mm.

Discussion—In a review of the species of *Centetodon*, Lillegraven et al. (1981) cited only a single species of the genus from the Whitneyan, *C. wolffi*. However, they cited the presence of *C. magnus* from both the Orellan and the Arikareean. The specimens from the Blue Ash fauna are smaller than specimens of *C. wolffi*, but well within the range of *C. magnus* (Lillegraven et al., 1981:tables 7 and 8). The only other Arikareean species of the genus is *C. divaricatus* from the later Arikareean of Nebraska that is also distinctly larger than the Blue Ash specimens (Korth, 1992:79). Since there are no morphologies of the lower molars, other than size, to separate *C. magnus* from other species of the genus (Lillegraven et al., 1981:56), these specimens are identified on this basis.

Family Soricidae Fischer de Waldheim, 1817
Domnina Cope, 1873
Domnina sp.
(Figure 3)

Referred Specimens—CM 83712, left mandible with m1 and alveoli for anterior dentition; CM 76316, right m3.

Measurements—CM 83712 (m1): length = 2.08 mm; width = 1.34 mm. CM 76316 (m3): length = 1.64 mm; width = 1.02 mm.

Description—The mandible of CM 83712 is complete from the anterior alveolus for the incisor to the posterior alveolus for m2. There is a large mental foramen opening anterolaterally below the posterior half of m1. The root of the incisor is present and it is oval in outline and large (1.14 mm, length of long axis). Posterior to the incisor are four small alveoli for the antemolar teeth. They are all crowded together and wider than long. The last alveolus is the largest, but only slightly so.

The m1 is highly lophate. The trigonid forms a V-shape and is widely open lingually. The paraconid is the lowest of the cusps and the protoconid is only slightly higher than the metaconid. The talonid is slightly wider than the trigonid and much shorter. The talonid is also much lower than the trigonid. The hypoconid is also strongly V-shaped, with the cristid obliqua meeting the base of the posterior wall of the trigonid near its center. The posterior cristid of the hypoconid forms the posterior occlusal margin of the tooth. The entoconid is transversely compressed, and the entocristid extends anteriorly to meet the posterior wall of the trigonid along the lingual margin of the tooth. There is a narrow but deep valley that separates the entoconid from the lingual end of the posterior cristid of the hypoconid. There is a low cingulum around the base of the tooth that extends the entire buccal length of the tooth and wraps around both the anterior and posterior sides. On the lingual side, the cingulum is limited to the base of the tooth at the lingually opening valley between the paraconid and metaconid.

The m3, CM 83716, is much smaller than m1. The trigonid is not as open lingually, but the trigonid cusps and cristids are similar in relative height to those of the trigonid of m1. The talonid is narrower than the trigonid and much lower. The cristids of the talonid are much lower than those of the trigonid or the talonid of m1. The hypoconid is just a small swelling at the posterobuccal corner of the tooth. The cristid obliqua is very low and joins the posterior wall of the trigonid just lingual to the apex of the protoconid. The entoconid is a small but distinct cusp. A very low ridge is continuous from the hypoconid to the

entoconid along the posterior margin of the tooth. Similarly, a very low ridge extends anteriorly from the entconid to the trigonid (entocristid), enclosing the talonid basin. A cingulum is only present along the base of the anterior and posterior sides of the tooth.

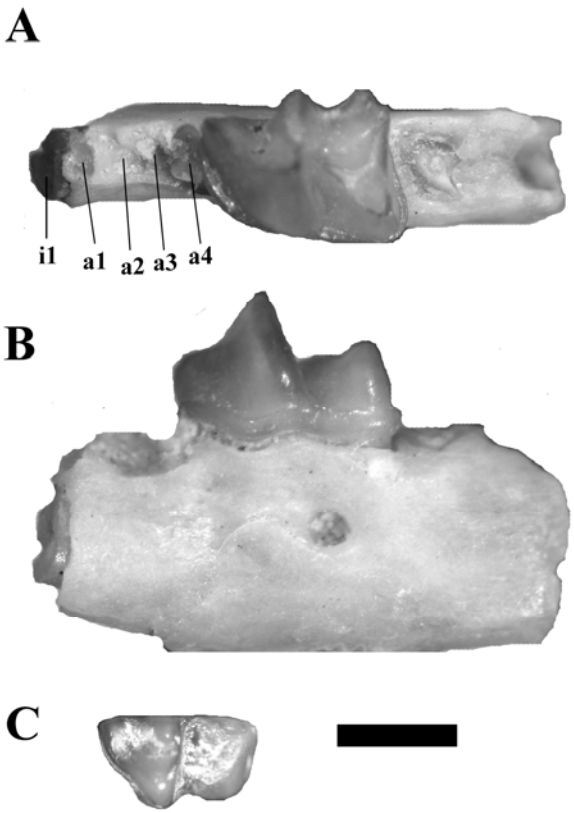

FIGURE 3. *Domnina* sp. from the Blue Ash fauna. A-B, CM 83712. A, dorsal view with m1 and alveoli for incisor (i), antemolars (a) and m2. B, lateral view of A. C, CM 76316, right m3 (reversed). Bar scale = 1 mm.

Discussion—The morphology of the mandible and lower dentition of *Domnina* sp. from Blue Ash is very similar to that of the Orellan *D. gradata* and the Arikareean *D. greeni* (Patterson and McGrew, 1937; Repenning, 1967; Macdonald, 1963, 1970). In size, the m1 from Blue Ash, CM 83712, is intermediate; larger than the Chadronian *D. thompsoni* (Simpson, 1941:2) and slightly smaller than *D. gratata* (Patterson and McGrew, 1937:256), the Chadronian *D. sagittariensis* (Kihm and Schumaker, 2008), and the Arikareean species *D. greeni* and *D. dakotensis* (Macdonald, 1970:tables 7 and 8). The Blue Ash specimen is distinguished from *D. dakotensis* by the presence of a lingually opening valley posterior to the entoconid on m1. The closure of this valley is considered a diagnostic feature of *D. dakotensis* (Macdonald, 1970; Hutchison, 1972). The number, relative size, and shape of the antemolar teeth behind the incisor of the Blue Ash specimen is most like that of *D. gradata*, but there is no indication of "incipiently doubled" roots (Repenning, 1967:8) as in the latter. Unfortunately, the antemolar teeth, or their alveoli, have not been reported for the Arikareean species. The position of the mental foramen on the mandible of the Blue Ash *Domnina* is the same as in all other species of the genus except *D. thompsoni* where it is slightly more anterior.

It is impossible to refer the Blue Ash specimens to a definite species of *Domnina* at this time. With a better record of the Arikareean species (currently only known from three specimens; Hutchison, 1972) the range of size can be established and the morphology of the antemolar teeth can be compared to that of *D. gradata*.

Family Proscalopidae Reed, 1961
Proscalops Matthew, 1901
Proscalops sp., cf. *P. tertius* Reed, 1961
(Figure 4A-D; Table 2)

Referred Specimens—CM 76762, 76763, M3; CM 76765, 83702, m1; CM 83701, 83703, 83704, 83705, 83706; m2.

Description—M3 is triangular in occlusal outline. The anterior width of the tooth is much greater than the posterior width because the parastylar area is greatly expanded buccally. The tooth is shorter than wide. The W-shape of the buccal cusps is not complete. The paracone forms a V-shape with an acute angle. However, the metacone has a single anterior crest (premetacrista), and no posterior crest (postmetacrista). On CM 76762, the metastyle is twinned with a small gap between the two cusps, whereas on the other specimen of M3, CM 76763, the postparacrista and premetacrista are joined forming an inverted U-shape and there is no distinct stylar cusp. The protocone is triangular in shape. The metaconule is a minute swelling along the postprotocrista, just lingual to the metacone.

The m1 has a well-developed W-shape of the cristids. The tooth is high-crowned. On an unworn m1, CM 86703, the height of the paraconid is 2.89 mm, greater than the total length of the tooth (Table 2). The trigonid is narrower than the talonid, but higher. The paraconid is the lowest cusp and the protoconid is just slightly higher than the metaconid. There is a minute metastylid on the unworn m1, CM 83703, but not on the worn specimen, CM 76765, where it may have been eliminated by wear or breakage. The talonid basin is blocked lingually by a low ridge between the entoconid and metaconid. There is also an entocristid extending anteriorly and ventrally from the apex of the entoconid. There is a small anterior cingulum along

the base of the anterior side of the tooth, and a posterior cingulum that extends the posterior width of the tooth. A small hypoconulid projects posteriorly from the lingual end of the posterior cingulum, posterior to the entoconid, on CM 83703, but not on CM 76765.

The m2 is as high-crowned as m1, and has the well-developed W-shape of the cristids. On the least worn specimen of m2, CM 87305, the height of the protoconid is 3.0 mm, much greater than the length of the tooth (Table 2). The m2 differs from m1 in having both the trigonid and talonid more anteroposteriorly compressed. The trigonid is equal to, or even slightly wider than the talonid. On m2, the metastylid is nearly as large and is at the same level as the metaconid, whereas on m1 it is much smaller and lower than the metaconid. The entocristid is similar to that found on m1, but there is no anteroposteriorly directed ridge along the lingual side of the talonid completely blocking it as in m1. The anterior cingulum is much better developed on m2 and wraps around the anterolingual corner of the base of the tooth. Similarly, the posterior cingulum is also bigger on m2. The only evidence of a hypoconulid is a minute swelling at the lingual end of the posterior cingulum on the least worn specimen, CM 83705.

TABLE 2. Dental measurements of *Proscalops* sp., cf. *P. tertius* from Blue Ash. Abbreviations: L, anteroposterior length; W, transverse width. Measurements in mm.

CM #	M3L	M3W	m1L	m1W	m2L	m2W
76762	1.86	2.44				
76763	1.8	2.1				
76765			2.34	2.05		
83702			2.34	1.99		
83701					2.73	2.15
83703					2.76	1.95
83705					2.73	2.32

Discussion—The Blue Ash specimens referred to *Proscalops* are similar in size to *P. tertius, P. evelynae*, and *P. intermedius* (Reed, 1961:476, 477; Macdonald, 1963:169, Barnosky, 1982:table 2). The Blue Ash specimens differ from *P. intermedius* in the presence of an entocristid on the lower molars. The cheek tooth morphology of *P. tertius* and *P. evelynae* are very similar with a compressed trigonid on the lower molars. Hutchison (1972) noted the great similarity of the species and questioned whether they were synonyms. One difference between the Whitneyan *P. tertius* and the Arikareean *P. evelynae* is the slightly greater crown-height of the molars of the latter. However, no quantitative values have ever been assigned to the crown-height of these species, so this difference cannot be definitely judged. Barnosky (1981) distinguished *P. tertius* by having a larger, more distinct metastylid on m2, as do the Blue Ash specimens. However, he also defined *P. evelynae* as having the precristid wrap around the anterolingual corner of the m2, as is the case in the Blue Ash specimens as well.

M3 has not been previously reported for *P. evelynae*. The Blue Ash M3s are similar to the same tooth in *P. tertius* and *P. miocenicus* because of the minute metaconule (Barnsky, 1981). However, the Blue Ash specimens of M3 differ from all other species of the genus in being shorter than wide. In most other species, M3 is longer than wide. In *P. tertius* the tooth is equal in width and length (Reed, 1961:476).

Because of the larger sized metstylid on m2 and the minute metaconule on M3 of the Blue Ash specimens, they are questionably assigned to the otherwise Whitneyan *P. tertius*.

Oligoscalops Reed, 1961
Oligoscalops sp.
(Figure 4E-G)

Referred Specimens—CM 76761, right P4; CM 83700, left m1.

Measurements—CM 76761 (P4): length = 2.11 mm; width = 1.90 mm. CM 83700 (m1): length = 2.15 mm; width = 1.64 mm.

Description—P4 is T-shaped in occlusal outline. The large central buccal cusp (paracone) is very high and conical. Anterior to it is a smaller but distinct parastyle at the anterobuccal corner of the tooth. A deep valley separates the paracone from the parastyle. A high, curved crest extends posteriorly from the paracone (postparacrista), ending at the posterobuccal corner of the tooth in a small cuspule (?metastyle). A buccal cingulum is present for the entire length of the tooth. It forms a small, low lip along the buccal margin. The anterior margin of the tooth lacks a cingulum and has a deep emargination just lingual to the parastyle. The single lingual cusp (?protocone) is intermediate in size between the paracone and parastyle. It is positioned at the anterolingual corner of the tooth, even with the valley between the parastyle and paraconid. There is a lingual shelf posterior to the protocone and lingual to the paracone and metastyle. The surface slopes posterodorsally. The lingual shelf is much longer buccally than lingually, making the posterior margin curve anteriorly lingual to the metastyle. There is a thin posterior cingulum that surrounds the area.

The m1 referred to *Oligoscalops* is very similar in morphology to the m1 of *Proscalops* but is much

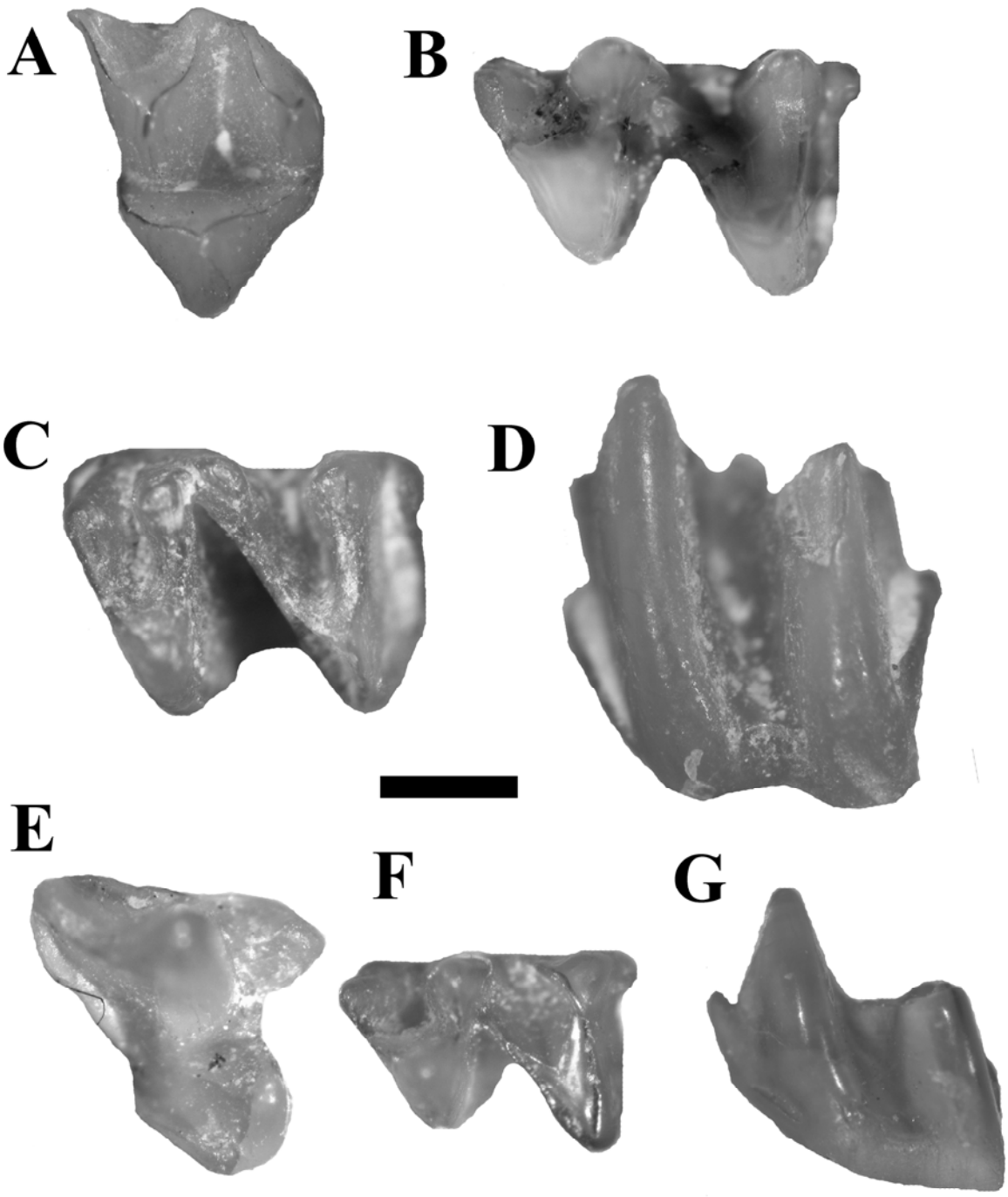

FIGURE 4. Proscalopidae from the Blue Ash fauna. A-D, *Proscalops evelynae*. A, CM 76762. left M3. B, CM 83703, left m1. C, CM 83705, left m2. D, lateral view of C. E-G, *Oligoscalops* sp. E, CM 76761, right P4. F. CM83700, left m1. G, lateral view of F. Bar scale = 1 mm.

smaller and the crown-height is not as great. On the m1 of *Oligoscalops*, the height of the protoconid is equal to the length of the tooth, not greater as in the specimens of *Proscalops*. In overall shape, the m1 is similar to that of *Proscalops* but there is no metastylid present, and the cristid obliqua joins the posterior wall of the trigonid buccal to the metaconid, not at the metaconid as in *Proscalops*. The entocristid slopes downward from the apex of the entoconid, enclosing the talonid valley lingually. The cingula of the *Oligoscalops* m1 are similar to those of *Proscalops*, but are not as well defined.

Discussion—The morphology of P4 of *Oligoscalops* is distinct from *Proscalops* in being T-shaped and having a distinct parastyle (Reed, 1961; Barnosky, 1981). The m1 referred here, CM 83700, is separable from the m1s of *Proscalops* by its smaller size and lower crown-height.

This is the latest occurrence of the genus which is elsewhere only known from the Orellan (Reed, 1956; Reed, 1961; Barnsoky, 1981; Gunnell et al., 2008b). Setoguchi (1978) referred several specimens questionably to *Oligoscalops* from what he believed to be the Whitneyan Cedar Ridge fauna of Wyoming. However, it was later demonstrated that this fauna was Orellan in age (Korth, 1989).

The only difference in the P4 from Blue Ash and previously described *Oligoscalops galbreathi* is the position of the lingual cusp. Reed (1961) noted that in *O. galbreathi* (=*O. whitmanensis*), this cusp was near the center of the lingual margin of the tooth, whereas in *Proscalops*, this cusp was anterior to the paracone. The P4 from Blue Ash, CM 76761, has a lingual cusp that is anterior to the paracone as in *Proscalops* while retaining the remainder of the morphologies of *Oligoscalops*. Due to this difference in morphology, the Blue Ash specimens cannot be referred definitely to the known species of the genus, *O. galbreathi*.

CONCLUSIONS

As has been demonstrated by other parts of the mammalian fauna from Blue Ash, the marsupial and insectivore fauna is a combination of earlier and later occurring taxa that appears to straddle the Whitneyan-Arikareean boundary (Korth, 2007a, 2007b, 2008). On the generic level, *Oligoscalops* is elsewhere restricted to the Orellan and *Proterix* is exclusive to the Whitneyan. On the species level, *Proscalops tertius* is exclusively Whitenyan and *Nanodelphys* sp., and *Ocajila makpiyahe* are only known from the Arikareean. Simpson (1985) argued that the deposit. from which the fossils were found, especially those from anthills, might involve mixed or reworked specimens from lower level. Based on the condition and type of preservation of the fossils, there appears to be no indication that taxa otherwise known from earlier horizons are preserved differently or are more weathered than those known from later horizons. The degree of weathering or etching of specimens or number of weathered specimens in any one taxon is not different from that of any other.

Some insectivorans previously cited as occurring in the Blue Ash fauna are not present in the anthill fauna described here. In their preliminary faunal lists of the Blue Ash fauna, both Martin (1974) and Simpson (1985) listed the occurrence of the leptictid *Leptictis* (=*Ictops*) which has the Whitenyan as its latest occurrence (Table 1). Gunnell et al. (2008a:fig. 6-3) extended this range into the base of the Arikareean, however, this was based on the occurrence in the Blue Ash fauna. The occurrence of *Leptictis* would support a Whitneyan age for the fauna. Similarly, the apatemyid *Sinclairella* was cited in the preliminary faunal lists as occurring in the Blue Ash fauna (Table 1) but no specimens are present in the anthill collections. The fossil record of *Sinclairella* is similar to that of *Leptictis*, with its latest occurrence being in the Whitneyan and the Blue Ash fauna. If *Sinclairella* were present in the fauna, it too would suggest a Whitneyan occurrence.

If the co-occurrence of earlier and later taxa is not an artifact of reworking or mixing, then the Blue Ash fauna either represents the latest Whitneyan or earliest Arikareean. Sadly, very few of the taxa used to define the boundary of these land mammal ages are micromammals (Prothero and Emry, 2004; Tedford et al., 2004). The reference of the Blue Ash fauna to either of these provincial ages is still uncertain.

ACKNOWLEDGMENTS

Specimens described in the study were graciously loaned by Dr. M. R. Dawson of the Carnegie Museum of Natural History. Assistance in curation of the specimens was provided by A. Henrici, also of CM. Camera equipment for figures was provided by Dr. W. Hallahan of Nazareth College, Rochester, NY. Earlier versions of this paper were critically read by Drs. G. Gunnell and K. Schumaker.

LITERATURE CITED

Barnosky, A. D. 1981. A skeleton of *Mesoscalops* (Mammalia, Insectivora) from the Miocene Deep River Formation, Montana, and a review of the proscalopid moles: evolutionary, functional and stratigraphic relationships. Journal of Vertebrate Paleontology 1:285-339.

Barnosky, A. D. 1982. A new species of *Proscalops* (Mammalia, Insectivora) from the Arikareean Deep River Formation, Meagher County, Montana. Journal of Paleontology 56:1103-1111.

Bjork, P. R. 1975. Observations on the morphology of the hedgehog genus *Proterix* (Insectiovora: Erinaceidae). University of Michigan Papers on Paleontology 12:81-88.

Crochet, J.-Y. 1980. Les marrsupiaux du Tertiarie d'Europe. Editons de la Fondtion Singer-Polignac, Paris, 279 p.

Gawne, C. E. 1968. The genus *Proterix* (Insectivora, Erinaceidae) of the Upper Oligocene of North America. American Museum Novitates 2315:1-26.

Gunnell, G. F., T. M. Bown, and J. I. Bloch. 2008a. Leptictida. Pp. 82-88, in C. M. Janis, G. F. Gunnell, and M. D. Uhen (eds.), Evolution of Tertiary Mammals of North America. Volume 2: Small Mammals, Xenarthrans, and Marine Mammals. Cambridge University Press, New York.

Gunnell, G. F., T. M. Bown, J. H. Hutchison, and J. I. Bloch. 2008b. Lipotyphla. Pp. 89-126, in C. M. Janis, G. F. Gunnell, and M. D. Uhen (eds.), Evolution of Tertiary Mammals of North America. Volume 2: Small Mammals, Xenarthrans, and Marine Mammals. Cambridge University Press, New York.

Hutchison, J. H. 1972. Review of the Insectivora from the early Miocene Sharps Formation of South Dakota. Contributions in Science, Natural History Museum, Los Angeles County 235:1-16.

Kihm, A. J. and K. K. Schumaker. 2008. *Domnina* (Mammalia, Soricomorpha) form the latest Eocene (Chadronian) Medicine Pole Hills local fauna of North Dakota. Paludicola 7:26-36.

Korth, W. W. 1989. Stratigraphic occurrence of rodents and lagomorphs in the Orella Member, Brule Formation, Sioux County, Nebraska. University of Wyoming Contributions to Geology 28:15-20.

Korth, W. W. 1992. Small mammals from the Harrison Formation (late Arikareean, early Miocene), Cherry County, Nebraska. Annals of Carnegie Museum 61:69-131.

Korth, W. W. 1994. Middle Tertiary marsupials (Mammalia) from North America. Journal of Paleontology 68:376-397.

Korth, W. W. 2007a. Mammals from the Blue Ash local fauna (late Oligocene), South Dakota. Rodentia, Part 1: Families Eutypomyidae, Eomyidae, Heliscomyidae, and *Zetamys*. Paludicola 6:31-40.

Korth, W. W. 2007b. Mammals from the Blue Ash local fauna (late Oligocene), South Dakota, Marsupialia and Lagomorpha. Paludicola 6:111-117.

Korth, W. W. 2008. Mammals from the Blue Ash local fauna (late Oligocene), South Dakota. Rodentia, Part 2: Families Florentiamyidae and Geomyidae. Paludicola 7:14-25.

Lillegraven, J. A., M. C. McKenna, and L. Krishtalka. 1981. Evolutionary relationships of middle Eocene and younger species of *Centetodon* (Mammalia, Insectivora, Geolabididae) with a description of the dentition of *Ankylodon* (Adapisoricidae). University of Wyoming Publications 45:1-115.

Macdonald, J. R. 1963. The Miocene faunas from the Wounded Knee area of western South Dakota. Bulletin of the American Museum of Natural History 125:139-238.

Macdonald, J. R. 1970. Review of the Miocene Wounded Knee faunas of southwestern South Dakota. Bulletin of the Los Angeles County Museum of Natural History, Science 8:1-82.

Martin, L. D. 1973. The mammalian fauna of the Lower Miocene Gering Formation of western Nebraska and the early evolution of the North American Cricetidae. Unpublished PhD dissertation, University of Kansas, 264 p.

Martin, L. D. 1974. New rodents from the Lower Miocene Gering Formation of western Nebraska. Occasional Papers of the Museum of Natural history, University of Kansas 32:1-12.

Matthew, W. D. 1903. A fossil hedgehog from the American Oligocene. Bulletin of the American Museum of Natural History 19:227-229.

Patterson, B. and P. O. McGrew. 1937. A soricid and two erinaceids from the White River Oligocene. Geological Series of the Field Museum of Natural History 6:245-272.

Prothero, D. R. and R. J. Emry. 2004. The Chadronian, Orellan, and Whitneyan North American land mammal ages. Pp. 156-168, in M. O. Woodburne (ed.), Late Cretaceous and Cenozoic Mammals of North America, Biostratigraphy and Geochronology. Columbia University Press, New York.

Reed, C. A. 1956. A new species of the fossorial mammal *Arctoryctes* from the Oligocene of Colorado. Fieldiana: Geology 10:305-311.

Reed, K. M. 1961. The Proscalopinae, a new subfamily of talpid insectivores. Bulletin of the Museum of Comparative Zoology 125:473-494.

Repenning, C. A. 1967. Subfamilies and genera of the Soricidae. Geological Survey Professional Paper 565:1-74.

Setoguchi, T. 1978. Paleontology and geology of the Badwater Creek area, central Wyoming. Part 16. The Cedar Ridge local fauna (late Oligocene). Bulletin of the Carnegie Museum of Natural History 9:1-61.

Simpson, G. G. 1941. A new Oligocene insectivore. American Museum Novitates 1150:1-3.

Simpson, W. F. 1985. Geology and paleontology of the Oligocene Harris Ranch Badlands, southwestern South Dakota. Dakoterra 2:303-333.

Tedford, R. H., L. B. Albright, III, A. D. Barnosky, I. Ferrusquia-Villafranca, R. M. Hunt, Jr., J. E. Storer, C. C. Swisher, III, M. R. Voorhies, S. D. Webb, and D. P. Whistler. 2004. Mammalian biochronology of the Arikareean through Hemphillian interval (late Oligocene through early Pliocene epochs). Pp. 169-231, in M. O. Woodburne (ed.), Late Cretaceous and Cenozoic Mammals of North America, Biostratigraphy and Geochronology. Columbia University Press, New York.

Van Valen, L. 1966. Deltatheridia, a new order of mammals. Bulletin of the American Museum of Natural History 132:1-126.