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MONROE CREEK (EARLY MIOCENE) MICROFOSSILS FROM THE WOUNDED KNEE AREA, SOUTH DAKOTA

by

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ABSTRACT

The middle Arikareean Monroe Creek Formation was named by J. B. Hatcher in 1902 for exposures near Harrison, Nebraska. This thick sequence of wind- and stream-deposited silt and ash also crops out in southeastern Wyoming and southwestern South Dakota. Harvester ant mounds in the Monroe Creek Formation in the Wounded Knee area, South Dakota, are a source of abundant fossils of small fish, amphibians, reptiles, birds, and mammals. Such small specimens are not usually found by conventional surface prospecting methods. Most of the mammals from the anthills were burrowing types which could easily burrow in the soft but compact sediments. They probably lived on plains and low hills rather than along streams. The wealth of specimens from one small locality suggests that colonies of animals lived in the area over an extended period of time.

INTRODUCTION

PREVIOUS WORK

After many years of exploration and collecting by paleontologists in the Big Badlands of South Dakota, the first foray into the Wounded Knee area was made by W. D. Matthew and Albert Thomson for the American Museum of Natural History in 1906. Matthew and Thomson moved south from the White River along Wounded Knee Creek, crossed the divide east to Porcupine Creek and moved north along its course, collecting fossils from the early Miocene rocks along their route. Unfortunately, they confused the lower part of the Miocene section with Oligocene rocks they had seen farther north. This neglected section was to become part of the Sharps Formation (Harksen, Macdonald, and Sevon, 1961), a richly fossiliferous siltstone of earliest Miocene (early Arikareean) age. Matthew and Thomson did most of their collecting higher in the section in what they termed the "Rosebud beds" (Matthew, 1907), which they felt were equivalent to rocks so named by Gidley on the Little White River near Rosebud Agency, South Dakota. This sequence in the Wounded Knee area is now assigned to the uppermost part of the Sharps Formation, and to the Monroe Creek, Harrison, and Rosebud (*sensu stricto*) Formations. Most of Matthew's 1907 report on the fossils collected in 1906 described forms from the Monroe Creek and Rosebud Formations, since the Harrison Formation is largely unfossiliferous in the Wounded Knee area.

From 1906 until 1953, the Wounded Knee area was generally ignored, although occasional collecting was done by various institutions and a few new specimens were described. In the summer of 1953, J. R. Macdonald, then of the Museum of Geology, School of Mines and Technology, began field work near Manderson, South Dakota, and along Wounded Knee Creek. In that and 14 later field seasons, a fauna of more than 150 taxa was collected from the four Miocene formations by parties under Macdonald's direction and in connection with geological mapping done under the direction of J. C. Harksen of the South Dakota Geological Survey. The first report on these faunas (Macdonald, 1963) is now supplemented by a second (Macdonald, 1970).

Nearly all of the material discussed by Macdonald (1963 and 1970) was recovered by routine surface collecting; only a few specimens were collected from channel deposits or anthills because of the abundance of surface material. However, by 1964 it had become apparent that ordinary surface collecting was not going to produce small animals from the Monroe Creek Formation as it had from the Sharps Formation.

Discovery of harvester ant mounds, covered with bones and teeth, in the Monroe Creek Formation has provided a partial solution to this imbalance. The anthill collections of 1964 and subsequent seasons, collected largely by field parties from the Los Angeles County Museum of Natural History, were given to me for study; they have to date produced 37 taxa of fish, amphibians, reptiles, birds, and mammals.

ACKNOWLEDGMENTS

I am indebted to many people for their help in field and laboratory, and particularly to the following:

J. R. Macdonald gave me the opportunity to study the fauna of the Monroe Creek Formation anthills, provided the encouragement and technical assistance I needed to continue it, and criticized the manuscript. R. W. Wilson has offered endless patience and invaluable advice on rodents in particular and paleontology in general, and supervised the entire project. J. C. Harksen of the South Dakota Geological Survey contributed his understanding of the geology of the Monroe Creek Formation and made a special effort in collecting much of the original anthill material, and a great deal from outside the Wounded Knee area. Morton Green's suggestions on rodent identification made that task much easier. M. R. Dawson of the Carnegie Museum identified the troublesome lagomorph specimens and commented on their morphology and evolutionary relationships. J. H. Hutchison of the University of California Museum of Paleontology offered advice and comments on the moles and other insectivores and discovered several specimens I had overlooked.

The greater part of the research and writing of this paper was done as partial fulfillment of the requirements for the Master of Science degree at the School of Mines and Technology, Rapid City, South Dakota, 1968-1969. I am particularly grateful to the Research Committee, School of Mines and Technology, for granting the Research Assistantship which made the work possible.

The drawings were very kindly done by Miss Mary Butler of the Los Angeles County Museum (figs. 8-11, 12B, 13, and 14) and Mr. Merton Bowman of the South Dakota School of Mines Museum of Geology (figs. 3-7 and 12A).

ABBREVIATIONS

AMNH	American Museum of Natural History, New York
FM	Field Museum of Natural History, Chicago
KU	University of Kansas Museum, Lawrence
LACM	Los Angeles County Museum of Natural History
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
SDSM	South Dakota School of Mines and Technology, Museum of Geology, Rapid City
UNSM	University of Nebraska State Museum, Lincoln
YPM	Yale Peabody Museum, Yale University, New Haven, Connecticut

LOCALITIES

The fauna described in this paper was recovered from nine anthills at two localities east of Porcupine Creek in the Wounded Knee area, South Dakota. Both SDSM and LACM numbers have been given the localities because of collecting interests of both institutions; the SDSM numbers will be used exclusively throughout when referring to localities. The locality numbers are SDSM V6229 (=LACM 1871) and SDSM V6215 (=LACM 2008). Locality descriptions will not be given, in the hope of discouraging amateur collectors, but are available from either institution to any qualified investigator.

HARVESTER ANTS

The collectors of the Monroe Creek Formation anthill fauna were harvester ants (*Pogonomyrmex*), builders of elaborate tunnels in soft sediments. Debris from the tunnels is piled on the ground surface, and the ants cover the resulting mound with small pebbles which serve to hold down the finer particles. In the Monroe Creek Formation, bones and teeth of small fossil animals are often substituted for pebbles, which are scarce. Harvester ants have been found to be quite selective in the materials they use, if only because they are limited by the size and weight of particles they can carry. Wheeler and Wheeler (1963) observed that particles one to eight millimeters in diameter made up most of the surface material on hills they studied in North Dakota, and particles between two and four millimeters predominated. Clark *et al.* (1967) maintain that ants are biased in many ways, and that they may go so far as to select surface material for their hills for its specific gravity, shape, luster, or even color. The makeup of the Monroe Creek Formation anthills in the Wounded Knee area shows no such biases, although they may be apparent in other areas. The scarcity of particles larger than silt-sized probably forces the ants to use practically anything they can find, and they cannot afford to be so selective.

Ants in the Monroe Creek Formation also use the abundant tiny calcareous concretions which weather out of the finer matrix, in about the same amounts as they use the fossil material. The only other rock fragments found on the hills were a few igneous pebbles and two perfect garnet crystals, presumably transported from the Black Hills.

METHODS

Specimens from all the anthills were collected in the same way. One or two people, armed with paper bags, whisk brooms, and insecticide, simply swept the top one-fourth to one-half inch of the anthill surface into paper sacks. The tunnels and mounds were left undisturbed, and the ants quickly recover them. Some of the hills have been swept off five or six times, and yet still continue to produce fossils.

A shot of insecticide was used to kill what few ants were swept into the sacks, and the containers were sealed. In the laboratory the material was sifted to remove the silt, washed to remove seeds, grass, and ants, and the remainder sorted under a binocular microscope, where bones and teeth were separated from concretions and pebbles.

It proved impossible to measure even the large teeth with calipers. Measurements were made in millimeters with a Leitz Ortholux microscope equipped with an Ultropak illuminator and a Heine measuring stage. The measurements are accurate to 0.01 millimeters, and they have the advantage of being readily repeatable by other workers using a similar instrument.

For the most part, the smaller and less-manageable specimens were glued to deep-well slides with a transparent glue which allows the root structure to be seen. The larger specimens were put into numbered shell vials. Numbers after the catalogue number, for instance the 6 in LACM 23515-6, indicate the square occupied by a specimen on a deep-well slide.

GEOLOGY OF THE MONROE CREEK FORMATION

The Monroe Creek Formation (Hatcher, 1902) is exposed in an area about 150 miles long and 80 miles wide in eastern Wyoming, northwestern Nebraska, and southwestern South Dakota. Throughout most of this area the texture, color, and composition are extremely homogeneous. As much as 250 feet of the formation may be exposed in vertical cliffs, for the most part composed of fine-grained, pinkish- or grayish-tan soft, compact silt and ash. The uniformity is locally interrupted by beds of fresh-water limestone, thin falls of ash, stream channel deposits, and geyser cones (Harksen and Macdonald, 1969, p. 63, fig. 45). Black lichen commonly grows on outcrops near the top of the section. In the western part of the outcrop area, the Monroe Creek Formation characteristically weathers to form high vertical cliffs. East of Shannon County, South Dakota, it forms low rolling hills, probably because of a change in composition.

So far as I know, the composition of the Monroe Creek Formation has never been studied adequately. It has generally been assumed, apparently without benefit of observation, that the formation was almost entirely fine sand and silt, with some clay. It is actually as much as 90 percent volcanic ash in the Wounded Knee area and in northwestern Nebraska, although the ash content may decrease to the east.

Calcareous concretions are common in the Monroe Creek Formation, particularly in Nebraska, where they may be several inches in diameter and several feet long. Smaller ones are found in the Wounded Knee area.

Deposition of the Monroe Creek Formation was probably largely aeolian in areas where the ash content is high and bedding is not developed, and where cross-bedding may be seen. Where stream channels and bedding planes are well-developed, fluviatile deposition was dominant. Aeolian deposition resulted in slow accumulation of angular fragments and produced an extremely compact rock, not unlike loess in its physical properties.

Thickness of the Monroe Creek Formation varies greatly. In the type area which Hatcher selected at the mouth of Monroe Creek Canyon north of Harrison, Nebraska, it is about 250 feet thick. To the northeast, in Shannon County, South Dakota, the thickness is only 90 to 115 feet. A much thicker section is exposed in Bennett County, South Dakota, but thins again rapidly to the east. East of Bennett County the Monroe Creek Formation has simply been mapped as part of the Arikaree Group by the South Dakota Geological Survey.

AGE AND STRATIGRAPHIC RELATIONSHIPS

The Monroe Creek Formation conformably overlies the early Arikareean (earliest Miocene) Sharps or Gering Formation in most places. However, along the Chadron Arch, uplift during the earliest Miocene prevented deposition of either of these formations, and the Monroe Creek Formation disconformably overlies the late Oligocene rocks of the Brule Formation (Harksen and Macdonald, 1969, p. 82, fig. 60).

For the most part, the Monroe Creek Formation is conformably overlain by the late Arikareean Harrison Formation, although in eastern Bennett County, South Dakota, it may be disconformably overlain by early Pliocene Ogallala Group deposits.

Bounded as it is by undoubted early Arikareean rocks below and late Arikareean rocks above, the Monroe Creek Formation is certainly Arikareean in age, probably middle Arikareean. In addition, it is the middle formation in what is sometimes called the Arikaree Group, the standard section for the Arikareean age in North America.

FAUNAL CORRELATION

As a whole, the Wounded Knee-Monroe Creek fauna described by Macdonald (1963 and 1970) and in this paper is related most closely to the Sharps fauna of earliest Arikareean age. The Sharps Formation underlies the Monroe Creek Formation in the Wounded Knee area, and the contact between them is gradational. Seventeen genera are common to both Monroe Creek and Sharps Formations. These are *Peratherium, Proscalops* (=*Arctoryctes*), *Allomys, Grangerimus, Heliscomys, Proheteromys, Sanctimus, Palaeocastor, Capatanka, Eutypomys, Paciculus, Nothocyon, Enhydrocyon, Nimravus, Miohippus, Diceratherium*, and *Nanotragulus*. The similarity of these two faunas is indicative of the continuity of deposition and habitation in the Wounded Knee area throughout Sharps and Monroe Creek times.

A somewhat more distant relationship exists between the Wounded Knee-Monroe Creek fauna and the "Harrison" faunas of Schlaikjer (1935) from the Goshen Hole area, Wyoming. Although the lower part of the Goshen Hole Harrison is probably older than the Monroe Creek Formation, the upper part may be contemporaneous. Nine genera, *Archaeolagus, Promylagaulus, Gregorymys, Palaeocastor, Plesiosminthus, Nothocyon, Miohippus, Diceratherium*, and *Nanotragulus* are common to these two formations. This may be misleading, as some of these genera, which are known from the Sharps as well as the Monroe Creek Formation, probably only reflect the correlation of the Sharps and lower "Harrison" Formations.

An interesting and surprising relationship exists between the Wounded Knee-Monroe Creek fauna and the Martin Canyon Quarry A local fauna of northeastern Colorado. Wilson (1960) assigned that assemblage to the latest Arikareean, although others, including myself, would argue that it is as young as early Hemingfordian. Six genera are found in both the Monroe Creek and Quarry A faunas: *Trimylus* (=*Heterosorex*), *Proscalops, Scalopoides, Pseudotheridomys, Proheteromys*, and *Plesiosminthus*. Perhaps the most striking point of correlation is the occurrence of three of the four probable European immigrants in the Monroe Creek Formation which Wilson (ibid., p. 20) recorded from Quarry A. It may be that increasing understanding of Miocene microfaunas will prove these and other European forms to be far more common in North America than was previously realized.

Unfortunately, *Trimylus, Pseudotheridomys*, and *Plesiosminthus* have such long ranges in Europe that they are not particularly useful in intercontinental correlation. Probably the best guess is that one or more of these forms entered North America in an early wave of the Burdigalian migration, and that the middle Arikareean in North America is about equivalent to the beginning of the Burdigalian in Europe. Figure 1 is a regional and intercontinental correlation chart.

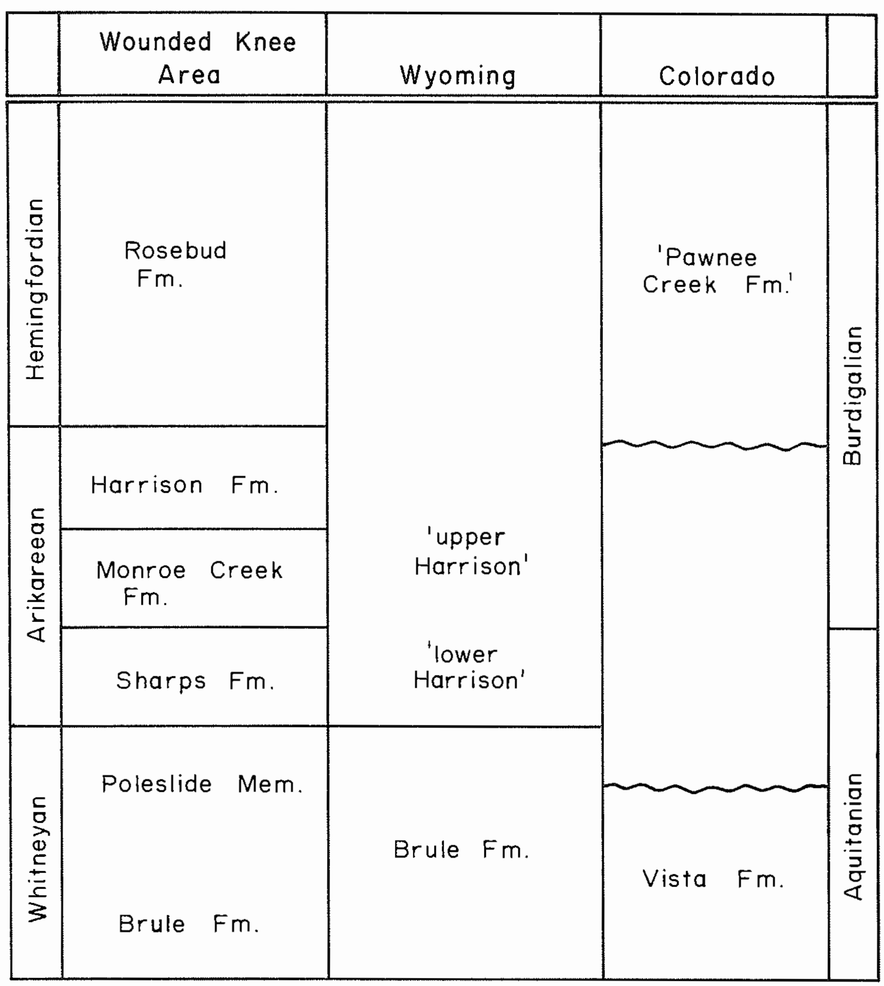

Fig. 1. Regional and intercontinental correlation chart.

ENVIRONMENT OF DEPOSITION

Something of the depositional conditions at the two anthill localities can be determined from a study of the source of the fossils at locality V6229. Relative abundance of faunal elements from locality V6229 is shown in figure 2. Fossils used on the eight anthills at this locality appear to have come from thin layers of bone breccia, at least two, and possibly three, of which are exposed in the vertical cliffs at this locality in the upper half of the formation. The fossils are of large and small animals, but the larger bones are broken into fragments a few millimeters or a centimeter or larger in diameter. These larger fragments are all much waterworn, while the small specimens show almost no wear. There may be several reasons for this including 1) they may be from a different and more distant source than the small specimens, 2) their size and weight may mean that it takes much longer for them to be washed into the ultimate site of deposition and they are thus exposed for a longer time before burial, or 3) the large bones may have been transported by traction and saltation while the smaller ones moved in virtual suspension, resulting in greater wear on the large bones.

Material which has weathered out of the cliffs at V6229 accumulates in blowouts, forming a thick bone pavement which is also a good source of fossils. The ants probably gather most of their building material from the blowouts rather than the breccia layers.

There is no evidence of stream channel or pond deposition at either of the anthill localities. Probably the remains accumulated on the plains or hills of a heavily populated

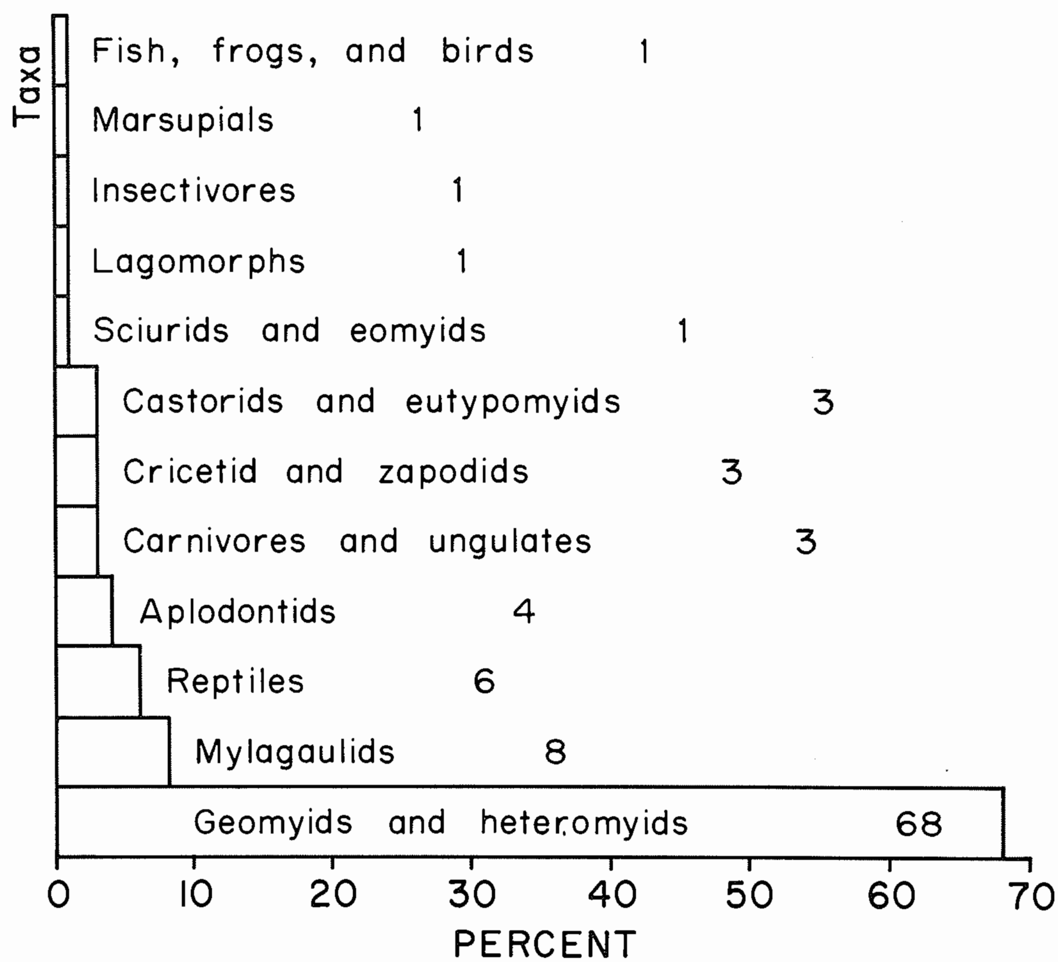

Fig. 2. Relative abundance of faunal elements in the collection from locality V6229.

area and were periodically washed into the valleys by heavy rains. The general impression is one of an extremely brief episode of subaqueous deposition, followed by the continuation of aeolian deposition characteristic of the Monroe Creek Formation in the Wounded Knee area. Cross-bedded sediments overlie the layers of bone breccia.

Most of the small taxa, both at V6229 and V6215, are burrowing or subterranean types, or are related to later burrowing types. I suggest that these areas were inhabited by colonies of burrowing animals which could dig easily in the soft, compact sediments and were attracted to the area. Dead individuals were removed from their burrows to the surface, where the bones were scattered and eventually buried. The wealth of pocket gopher and pocket mouse remains (about 68 percent of the collection) is particularly suggestive of this conclusion. At least an additional 20 percent of the remains are of lizards, snakes, rabbits, hedgehogs, moles, ground squirrels, deermice, and jumping mice, all of which have close living relatives which dig burrows. Others, the beavers and mylagaulids, had Miocene relatives known to have dug burrows. The non-burrowing types in the fauna probably roamed the surface or lived in near-by ponds and streams and were mixed with the others sometime after death.

Some 25 miles east of V6229 is the SDSM Yellow Bear locality, a stream channel deposit in the Monroe Creek Formation from which microfossils have been collected. Preliminary investigation of the Yellow Bear collection indicates that exactly the same taxa are found there as are found at the other two localities, V6229 and V6215. The difference lies in the percentages of various groups. Pocket mice and pocket gophers, for instance, appear to make up no more than 25 percent of the fauna, and there are proportionately more zapodids and cricetids than at the anthill localites. This is probably a reflection of the differences between stream-bank and open plains communities preserved in the thanatocoenosis.

Table 1. FAUNAL LIST, MONROE CREEK FORMATION ANTHILLS

PISCES

PISCES, undetermined

AMPHIBIA

ANURAN, indeterminate

REPTILIA

SQUAMATA

Sceloporus?

Scincidae, indeterminate

Anguidae, indeterminate

Gerrhonotus, species

Lacertilia, indeterminate

Serpentes

Serpentes, indeterminate

Table 1 -- continued.

AVES

NEOGNATHAE, indeterminate

MAMMALIA

MARSUPIALIA

Peratherium youngi

INSECTIVORA

Erinaceidae

Parvericius cf. *P. montanus*

Metechinus cf. *M. marslandensis* *

Geolabis, species

Soricidae

Trimylus, species

Talpidae

Proscalops secundus

Scalopoides, species

LAGOMORPHA

Ochotonidae

?*Desmatolagus*

?Ochotonid

Leporidae

Palaeolaginae cf. *Palaeolagus philoi*

RODENTIA

Aplodontidae

Allomys harkseni

Mylagaulidae

Promylagaulus riggsi

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* Synonymous with *Brachyerix macrotis*

Table 1 -- continued.

Sciuridae

Sciurid, small species

Sciurid, large species

Eomyidae

Pseudotheridomys cf. *P. hesperus*

Geomyidae

Gregorymys formosus

Heteromyidae

Proheteromys, species

Sanctimus tiptoni

Castoridae

Palaeocastor cf. *P. simplicidens*

Capatanka, species

Eutypomyidae

Eutypomys cf. *E. montanensis*

Cricetidae

Paciculus cf. *P. montanus*

Cricetid, genus undescribed

Zapodidae

Plesiosminthus, species

CARNIVORA

Canoidea, indeterminate

PERISSODACTYLA

Miohippus, species

ARTIODACTYLA

Merycoidodontidae, indeterminate

Hypertragulidae

Nanotragulus, species

SYSTEMATIC PALEONTOLOGY

PISCES Linnaeus, 1758

PISCES, undetermined

Referred specimens: SDSM 64203, three spines, a vertebra, and several fragments of skull bones, from V6215. SDSM 64157, 23 spines and other bones, from V6229.
Discussion: Although these specimens have not been studied or identified, I include them here for the record. Some large spines from V6215 are probably ictalurids, and the smaller bones are probably from centrarchids, which have been identified (T. Cavender, pers. comm. to J. R. Macdonald) from elsewhere in the Monroe Creek Formation in the Wounded Knee area. These fish probably lived in small ponds or streams, into which the bones of other animals were washed during heavy rains. Or conversely, the fish may have been carried by predators into the site of deposition. Various small carnivores which might have been fishers are found in both anthill localities.

AMPHIBIA Linnaeus, 1758

ANURAN, indeterminate

Referred specimens: SDSM 64184, two fragments of humerus and vertebra fragments, from V6229.
Discussion: These specimens represent the first known occurrence of frogs in the Monroe Creek Formation. Unfortunately, the material is too fragmentary to be identifiable. A partial skeleton of a frog, *Scaphiopus neuter* Kluge, is known from the Sharps Formation, and another skeleton was recently collected (1969) from the Poleslide Member of the Brule Formation by a School of Mines party.

REPTILIA Linnaeus, 1758

SQUAMATA Oppel, 1811

Sceloporus?

Referred specimens: SDSM 64188, eight jaw and maxillary fragments, from V6229.
Discussion: These specimens can be tentatively assigned to this iguanid genus and are the first reported from the Monroe Creek Formation. An indeterminate iguanid was reported from the Sharps Formation by Macdonald (1963). Assistance in identifying these and the other lizard specimens was given by members of the Department of Herpetology, Los Angeles County Museum of Natural History.

Scincidae, indeterminate

Referred specimens: SDSM 64187, two jaw fragments, from V6229. SDSM 64202, two jaw fragments, from V6215.
Discussion: These four fragments are the first recorded scincid specimens from the Monroe Creek Formation and from the Wounded Knee area.

Anguidae Cope, 1864

Gerrhonotus, species

Referred specimens: SDSM 64185, three jaw fragments and a maxillary fragment, from V6229.
Discussion: Anguids were apparently fairly common in Oligocene and Miocene times in the Badlands area. Specimens of alligator lizards are known from throughout the Brule and Sharps Formations. An indeterminate anguid and a species of *Peltosaurus* have been reported from the Sharps Formation, but this is the first record of the family from the Monroe Creek Formation.

Anguidae, indeterminate

Referred specimens: SDSM 64186, four jaw and maxillary fragments, from V6229.
Discussion: These small fragments are not identifiable to genus; they serve primarily to indicate the presence of an anguid other than *Gerrhonotus* in the fauna.

Lacertilia, indeterminate

Hundreds of bony scales, a few vertebrae, a premaxillary, and two humerus fragments of lizards have been found in both localities, but are not identifiable. Probably most of the bony scales belonged to anguids, which have prominent rows of them beneath the external scales both ventrally and dorsally.

Serpentes Linnaeus, 1758

Serpentes, indeterminate

Referred specimens: SDSM 64200, some 280 vertebrae, two articulars, and two ribs, from V6229.
Discussion: These are the first reported specimens of snakes from the Monroe Creek Formation and from the Wounded Knee area. Despite the large number of snake vertebrae at locality V6229, none has been found at V6215. A series of articulated vertebrae from the Sharps Formation (LACM 9208) has not been studied.

AVES Linnaeus, 1758

NEOGNATHAE, indeterminate

Referred specimens: SDSM 64190, two fragments of the distal ends of tarsometatarsi, from V6229.
Discussion: These tiny fragments are the only indication of birds in the Monroe Creek Formation. Possibly they belonged to a bird about the size of a quail, but further identification is not possible.

MAMMALIA Linnaeus, 1758

MARSUPIALIA Illiger, 1811

Peratherium youngi McGrew, 1937

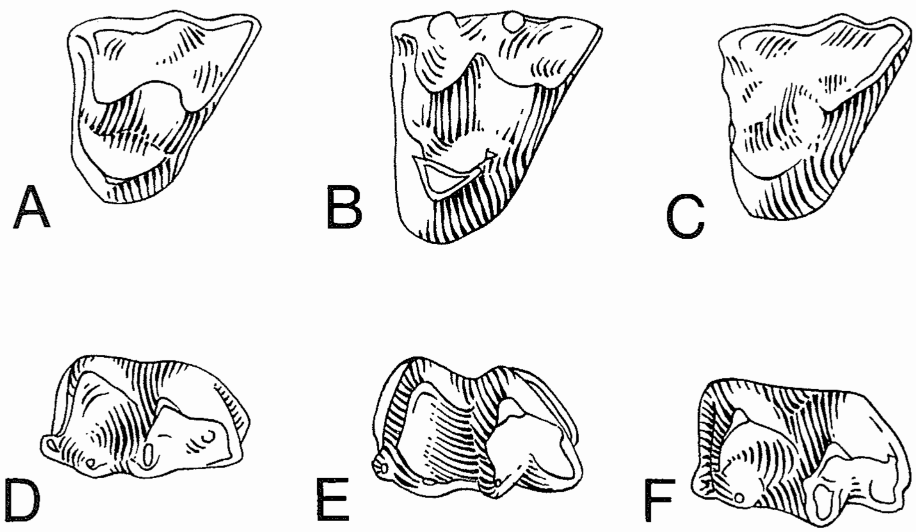


Fig. 3. *Peratherium youngi* McGrew. A. SDSM 64179-27, left M^1 or M^2, occlusal view. B. SDSM 64179-26, left M^3 occlusal view. C. SDSM 64179-25, left M^4, occlusal view. D. SDSM 64179-2, left M_1, occlusal view. E. SDSM 64179-1, left M_2, occlusal view. F. SDSM 64179-3, left M_3. All X 15.

Referred specimens: SDSM 64179, six cheek teeth; LACM 23505, 14 cheek teeth, from V6229. SDSM 64175, four cheek teeth, from V6215.

Description: M^3 wider than long, but only slightly so. Metacone largest and tallest cusp, paracone smaller. Broad, W-shaped ectoloph forms with wear. V-shaped protocone. Stylar cusp C (McGrew, 1937) well-developed; situated just posterior to labial tip of anterior arm of metacone on external cingulum. Cusps B and E well-developed. M^1 or M^2 similar to M^3 but considerably wider than long. External margin curved rather than straight. Stylar cusp C and anterior cingulum prominent. M^4 a reduced version of M^3 with slightly broader protocone and width equal to length. Cingula little developed. M_1 with narrow trigonid, strong cingula on all but lingual margin. Hypoconulid prominent. M_2 similar to M_1 but with trigonid as wide as talonid and with wider anterior cingulum. M_3 with trigonid somewhat shorter than talonid, posterior cinglum wide. Anterior cingulum as in M_1. Lower teeth all two-rooted, upper molars three-rooted. A single P_4, presumably *Peratherium*, resembles that of *P. merriami*; two-rooted with principal cusp over anterior root. Small cingular cusp on posterior margin; outline rectangular.

Discussion: I have referred these teeth to *Peratherium youngi* because of 1) the unique development of the metastyle and anterior cingulum, which forms a small "hook" on the antero-labial corner of the upper molars, 2) the straight external margin of M^3, 3) the size and position of stylar cusp C in the absence of stylar cusps A and D on M^3 and the other upper molars, and 4) the reduction of the paracone with respect to the metacone. The lower teeth of *P. youngi* have not been reported previously and are tentatively referred to this species because of their association with the upper teeth.

Macdonald (1963, p. 164) named *Peratherium spindleri* from the Sharps Formation in the Wounded Knee area and noted that upper teeth from the Godsell Ranch channel faunule did not resemble those of *P. youngi*. I have been unable to locate the teeth Macdonald was discussing (SDSM 5835), but since the lower teeth of *P. spindleri* do not particularly resemble those I have assigned to *P. youngi*, I will assume that we are dealing with two different species. *P. youngi* could conceivably be a descendant of *P. spindleri*, as the latter is found only in the Sharps Formation and the former is recorded from the Monroe Creek and Harrison Formations.

Measurement (in millimeters) of the cheek teeth of *Peratherium youngi*

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
M^1 or ^{2}	LACM 23505-25	1.87	2.28
M^1 or ^{2}	LACM 23505-28	1.81	2.25
	SDSM 64179-27	1.55	1.91
M^3	LACM 23505-38	1.79	1.89
	SDSM 64175-4	1.71	1.44
	SDSM 64179-26	1.84	2.01
M^4	SDSM 64179-25	1.67	1.74
M_1	SDSM 64179-2	1.81	1.00
M_2	LACM 23505-1	1.95	1.23
	LACM 23505-4	1.93	1.05
	LACM 23505-5	1.82	1.06
	LACM 23505-6	1.94	1.17
	LACM 23505-14	1.94	1.15
	LACM 23505-16	1.96	1.21
	SDSM 64179-1	1.85	1.22
M_3	LACM 23505-3	1.83	1.14
	SDSM 64179-3	2.00	1.19

INSECTIVORA Bowditch, 1821

Six species in six genera of insectivores have been identified from the Monroe Creek Formation anthills. In addition, a number of fragmentary and/or doubtful specimens of erinaceids (?) and other forms remain unidentifiable. Perhaps as more material becomes available from the anthills or other localities, identification of these fragments will be possible.

Erinaceidae Bonaparte, 1838

Parvericius cf. *P. montanus* Koerner, 1940

Referred specimens: SDSM 64182, four cheek teeth; LACM 23512, four M^1; LACM 23515, lower premolar, two M_2; LACM 23514, three M_1; LACM 23513, M_3, and fragments of cheek teeth, from V6229. SDSM 64173, four M_1; SDSM 64174, M^2, from V6215.

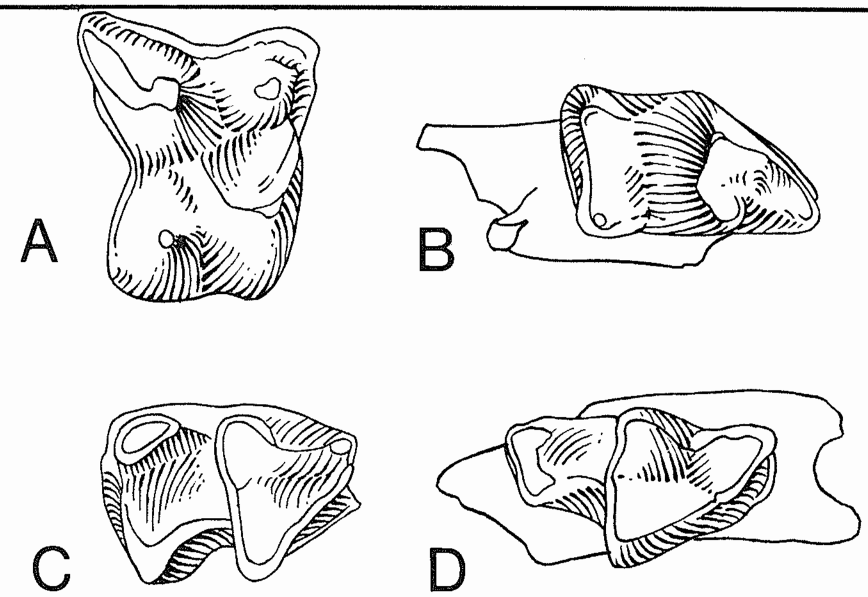


Fig. 4. *Parvericius* cf. *P. montanus* Koerner. A. SDSM 64182-2, right M^1, occlusal view. X 15. B. SDSM 64182-6, left M_1, occlusal view. X 20. C. SDSM 64182-8, right M_2, occlusal view. X 20. D. SDSM 64182-4, right M_3, occlusal view. X 20.

Description: M^1 subquadrate, with metastyle extended on the tip of a shearing blade. Prominent, isolated parastyle. Strong metaloph connects metacone and protocone; protoloph extends from protocone to between paracone and parastyle. Hypocone large and isolated. Continuous cingulum on all but anterior margin. M^2 quadrate, with protocone placed more posteriorly than in M^1; lingual half of tooth slightly "swept back." Lophs not well-developed. Hypocone not isolated from rest of tooth. Cingulum continuous. P_x (indeterminate lower premolar) two-rooted with principal cusp directly over anterior root. Complete cingulum; accessory cingular cusps front and rear. Blade of principal cusp slopes sharply down to posterior margin. P_4 with rudimentary trigonid, cusps not as trenchant as those of molars. Paraconid not on lingual margin as in molars, but forward between protoconid and metaconid. Talonid rudimentary, forming only a narrow shelf along posterior margin of tooth. M_1 with trigonid slightly shorter than talonid. Trigonid right-triangular, with paraconid and metaconid on straight line with entoconid along lingual margin. Talonid square and basined, slightly open on lingual side. Trigonid portion raised above talonid. Cingulum extends from paraconid around labial margin to center of posterior margin. M_2 similar to M_1 but generally smaller and more delicate. M_3 with trigonid as in anterior molars. Slight expansion of anterior cingulum. Talonid tapered posteriorly, with hypoconid and entoconid much reduced. Hypoconulid just behind and outside entoconid, subequal to other two cusps. Talonid basin divided by a ridge which connects hypoconid to center base of trigonid. External cingulum complete between anterior face of paraconid and hypoconulid.

Discussion: Koerner (1940) described (p. 841) and figured (fig. 1) a right maxillary fragment with P^4 to M^3 from the Deep River Formation, Montana, as *Parvericius montanus*. So far as I know, the type, YPM 13956, remains the only specimen assigned to that species. Those I have described from the Monroe Creek Formation anthills are assigned to *Parvericius* with misgivings. It has been suggested that *Parvericius* is actually synonymous with the European genus *Amphechinus* (P. Robinson, pers. comm. to R. W. Wilson), and I am persuaded that this is probably so. Judging only from published figures and descriptions, I am not in a position here to analyze or discuss the possible relationships of these two and other genera. For the purposes of this paper, the name *Parvericius* will suffice, whether or not synonymy with *Amphechinus* can be proven.

Measurements (in millimeters) of the
cheek teeth of *Parvericius* cf. *P. montanus*

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
M^1	LACM 23512-14	2.03	2.62
	LACM 23512-16	2.06	2.65
	LACM 23512-18	1.89	2.17
M^1	LACM 23512-20	1.95	2.39
	SDSM 64182-2	1.90	2.29
M^2	SDSM 64174	1.74	1.93
M_1	LACM 23515-2	2.59	1.55
	SDSM 64182-6	2.26	1.23
	SDSM 64173-1	2.25	1.39
	SDSM 64173-3	2.21	1.43
	SDSM 64173-4	2.25	1.43
M_2	LACM 23515-3	2.11	1.48
	SDSM 64182-8	1.84	1.33
M_3	SDSM 64182-4	1.85	1.05

Metechinus Matthew, 1929

Metechinus cf. *M. marslandensis* Meade, 1941

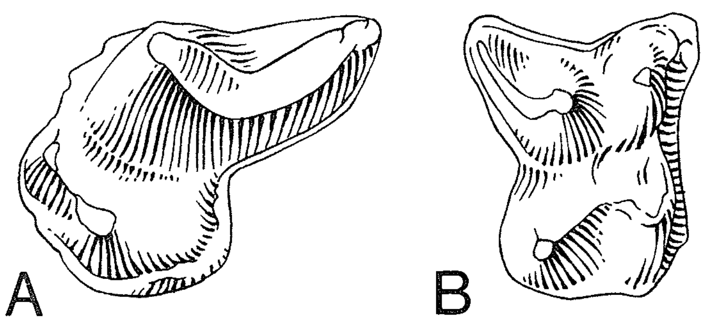


Fig. 5. *Metechinus* cf. *M. marslandensis* Meade. A. SDSM 64180, left P^4, occlusal view. B. SDSM 64172, right M^1, occlusal view. Both X 10.

Referred specimens: SDSM 64180, P^4; LACM 23510, M^1; LACM 23511; three M_1, from V6229. SDSM 64172, M^1, from V6215.

Description: P^4 consists of shearing blade (paracone and metastyle), and lingual shelf with two cusps, protocone and hypocone. Paracone and metastyle subequal. Paracone higher than metastyle, but exceeded by it in overall size. Protocone and hypocone occupy anterior half of lingual shelf; protocone larger and taller than hypocone but not well separated from it. Protocone and hypocone become united into a crest with wear. Faint cingulum around lingual margin. Slightly pinched "waist" between shelf and blade portions of tooth. Two roots present, one below shelf, the other below metastyle. Part of tooth, and possibly a root, at base of protocone are broken off. M^1 with subequal paracone and metacone, U-shaped protocone connected to base of paracone by strong protoloph; metaloph not developed. Hypocone somewhat isolated from rest of tooth but connected with a broad shelf and ridge to posterior border of protocone. Metastyle connected by strong ridge to metacone. Cingulum continuous around tooth. M_1 similar in outline to that of *Parvericius*, but with talonid and trigonid subequal in length and width. Both talonid and trigonid more open lingually than in *Parvericius*. Teeth larger and less delicate than in *Parvericius*. Trigonid right-triangular, with paraconid well forward of other cusps. Talonid square and broadly open lingually. Cusps rounded rather than trenchant. Faint cingulum on labial margin only. Small hypoconulid.

Discussion: Meade's (1941) description and figures of *Metechinus marslandensis* are supplemented by detailed treatment of some specimens from the Split Rock (Hemingfordian) fauna of Wyoming (Reed, 1960). The Monroe Creek Formation specimens resemble both the original and supplementary material quite closely. M^1 differs slightly from them in having a better-developed metastyle and parastyle, more trenchant cusps, and a more delicate structure in general. Although Reed did not figure any of the lower teeth from Split Rock, the anthill specimens agree with her descriptions and measurements.

All of the erinaceids from the Monroe Creek Formation anthills are species and genera which would not ordinarily be expected in the middle Arikareean. *Geolabis, Parvericius*, and *Metechinus* all appear to have very long ranges, and their occurrence in the Monroe Creek Formation establishes new upper or lower stratigraphic limits for each. This is the earliest known occurrence of both *Parvericius* and *Metechinus*, and the last known occurrence of *Geolabis*, which McKenna (1960) recognizes as early as the early Oligocene. 'Note: since the time of submission of this manuscript it has been suggested (T. H. V. Rich and P. V. Rich, 1971) that *Metechinus marslandensis* is a synonym of *Brachyerix macrotis* Matthew, 1933. They describe a complete skull with mandibles in association (UCMP 86137) from the Hemingfordian of Split Rock, Wyoming. I concur with their decision of synonymy; therefore the specimens described above should be referred to *Brachyerix macrotis*.'

Measurements (in millimeters) of the
cheek teeth of *Metechinus* cf. *M. marslandensis*

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
P^4	SDSM 64180-14	3.61	4.90
M^1	LACM 23510-14	3.42	3.88
	SDSM 64172-1	3.01	3.72
M_1	LACM 23511-1	2.93	1.81
	LACM 23511-2	2.72	1.70

Geolabis Cope, 1884

Geolabis, species

Referred specimens: LACM 23516-14, M^1; and SDSM 64181, M^2, from V6229.

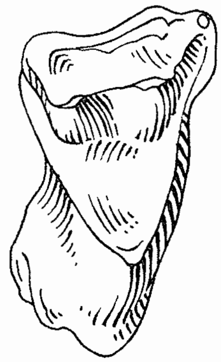


Fig. 6. *Geolabis*, species. SDSM 64181, right M^2, occlusal view. X 15.

Description: M^1 with prominent protocone, paracone, metacone, and metastyle; parastyle area broken away. Broad posterior cingular shelf with small hypocone (?) on extreme lingual margin. Protocone triangular, strongly connected by high ridges to parastylar area and metastyle. M^2 similar to M^1 but smaller and more delicate. Parastyle large and well-developed, metastyle smaller, no indication of hypocone on broken posterior cingular shelf. Labial and posterior margins of both teeth deeply concave. Both teeth much wider than long. Anterior and labial cingula well-developed on both teeth.

Discussion: These specimens, assuming that they actually do belong to that genus, represent the latest known occurrence of *Geolabis*. Their presence in the Arikareean may clarify the phylogenetic position of *G. wolffi* Macdonald (1965). Before the description of *G. wolffi*, *Geolabis* was known only from the Chadronian and Orellan of Colorado and Wyoming, and known species appeared closely related to each other. *G. wolffi*, from the Poleslide Member of the Brule Formation in the White River Badlands of South Dakota, seems far off the main line of descent in both large size and strong development of a hypocone on the upper cheek teeth. Typical *Geolabis*, if the Monroe Creek Formation specimens belong in that category, retained their small size and no more than a small cusp on the posterior shelf even through the middle Arikareean. The shape of these teeth (extremely short and wide), the closely appressed paracone and metacone, and the presence of four roots on the upper molars seems to ally them with the Geolabidinae (McKenna, 1960).

Measurements (in millimeters) of the cheek teeth of *Geolabis*, species

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
M^1	LACM 23516-14	*ca.* 1.7	*ca.* 3.4
M^2	SDSM 64181-1	1.88	3.10

Soricidae Gray, 1821

Trimylus Roger, 1885

Trimylus, species

Referred specimen: LACM 23517, antemolar tooth, from V6229.

Discussion: This single tooth recovered from the anthills is nearly identical to a specimen from the Martin Canyon Quarry A fauna, KU 10302, described by Wilson (1963). I am indebted to Mr. J. H. Hutchison of the University of California Museum of Paleontology for finding and identifying the specimen.

Talpidae Gray, 1821

Proscalops secundus Matthew, 1901

Referred specimens: LACM 23507, ten lower molars, two M^1 and two M^2; LACM 23506, M^1; SDSM 64201, two fragments of distal ends of humeri; and various broken cheek teeth, from V6229. SDSM 64176, five lower teeth and two upper teeth, from V6215.

Description: M^1 large. Ectoloph with large, labially projecting metastyle and small parastyle which give the tooth the appearance of being wider posteriorly than anteriorly. Protocone very large; placed anteriorly about opposite paracone on prominent ridge. Protoconule and metaconule distinct on unworn tooth; subequal. Parastyle relatively large and isolated; projects straight forward from anterior face of paracone. Metastyle larger than parastyle. M^2 nearly square; protocone similar to that of M^1 but placed opposite mesostyle rather than displaced anteriorly. Parastyle and metastyle subequal; protoconule and metaconule subequal. M^3 small. Protocone not as prominent as on anterior molars. Paracone similar to those of anterior molars; metacone and metastyle poorly developed, without the usual postero-labial projection. Protoconule very small, metaconule well-developed. Parastyle broken away. M_1 with reduced trigonid, paraconid displaced anteriorly and medially rather than on lingual border as in M_2; trigonid basin open lingually. Posterior cingulum prominent, fragment of lingual cingulum closes talonid valley. M_2 square, with short, closed trigonid valley. Paraconid opposite protoconid on lingual border. Entoconid round and prominent. Metastylid (absent on M_1) prominent and slightly lower than metaconid. Anterior cingulum strong, posterior cingulum forms broad shelf widening lingually. M_3 reduced and slightly tapered from front to rear. Trigonid valley narrow as in M_2, talonid reduced and open lingually. Fragments of cingulum present on anterior, posterior, and labial borders.

Discussion: Macdonald (1963, p. 168) described a new species of mole, *Domninoides evelynae*, from the Sharps Formation of the Wounded Knee area. Hutchison (1968, p. 5) suggested that *D. evelynae* is actually a proscalopine; Macdonald (1970) and I concur. Although *P. evelynae* (Macdonald) is similar to *P. secundus*, the type specimen of the former consists of lower teeth and the type of the latter consists of upper teeth; comparison is thus based on referred material.

Since the upper teeth from the Monroe Creek Formation anthills are referable to *Proscalops secundus*, I refer the lower teeth to that species as well. The lower teeth do not resemble *P. evelynae* in that they have a metastylid on M_2 – M_3. Matthew's type of *P. secundus* came from a locality some 40 miles east of the Wounded Knee area, probably from the Monroe Creek or Harrison Formation. A second cranium, now in the LACM collection, was collected from the Sharps Formation in 1968.

The two humerus fragments, SDSM 64201, both lack the lateral epicondyles, the internal one-third of the bone and the upper two-thirds of the bone. Despite their fragmentary nature, they are readily identifiable as "*Arctoryctes*" which Hutchison (1968, p. 5) assigns to the Proscalopinae. Since *Proscalops* is the proscalopine in this fauna, they seem best assigned to that genus.

Measurements (in millimeters) of the cheek teeth of *Proscalops secundus*

	Antero-posterior Diameter	Transverse Diameter	N	
M^1	2.12	3.89		maximum
	2.00	3.39		minimum
	2.06	3.64	2	average
M^2	2.80	3.60		maximum
	2.47	3.46		minimum
	2.625	3.53	2	average
M^3	1.83	1.90	1	
M_1	2.75	2.21		maximum
	2.11	1.80		minimum
	2.53	1.95	5	average
M_2	2.85	2.39		maximum
	2.73	2.12		minimum
	2.78	2.22	3	average
M_3	2.49	1.75		maximum
	2.00	1.27		minimum
	2.23	1.45	3	average

Scalopoides Wilson, 1960

Scalopoides, species

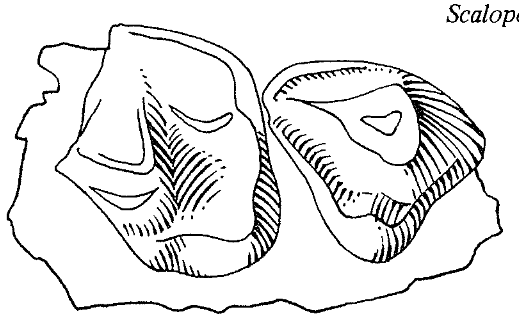


Fig. 7. *Scalopoides*, species. SDSM 64183-27, right P^4 to M^1, occlusal view. X 15.

Referred specimens: SDSM 64183, jaw fragment with M_2, palate fragments with right P^4 – M^1 and left P^4 -- M^1, from V6229.

Description: Occlusal surfaces of all teeth heavily worn; all except P^4 have some breakage. Specimens more waterworn than usual at this locality. P^4 broadly triangular; three-rooted. Protocone somewhat isolated from remainder of tooth. M^1 tritubercular; protoconule and metaconule very small. Paracone and metacone equal in size and height. Postero-labial portions of both M^1 broken away. M_2 is heavily worn and with much enamel chipped off, but retains the typical *Scalopoides* outline and strong anterior cinglum. Mental foramina between P_3 and P_4 alveoli, and between P_4 and M_1 alveoli, about halfway down side of mandible.

Discussion: These specimens have suffered more wear and breakage than any others from this locality. This perhaps indicates either 1) greater than usual fragility or 2) more transport. They provide the earliest known record of *Scalopoides* and are quite similar to the genotypic species, *S. isodens*, from the Martin Canyon Quarry A fauna in northeast Colorado. They are so battered that virtually nothing else can be said about them.

Measurements (in millimeters) of the cheek teeth of *Scalopoides*, species

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
P^4	SDSM 64183-29	2.06	1.76
	SDSM 64183-41	1.90	1.58
M^1	SDSM 64183-29	---	2.24
	SDSM 64183-41	---	1.95
M_2	SDSM 64183-18	*ca.* 1.95	1.45

LAGOMORPHA Brant, 1855

Ochotonidae Thomas, 1897

Desmatolagus Matthew and Granger, 1923

?*Desmatolagus*

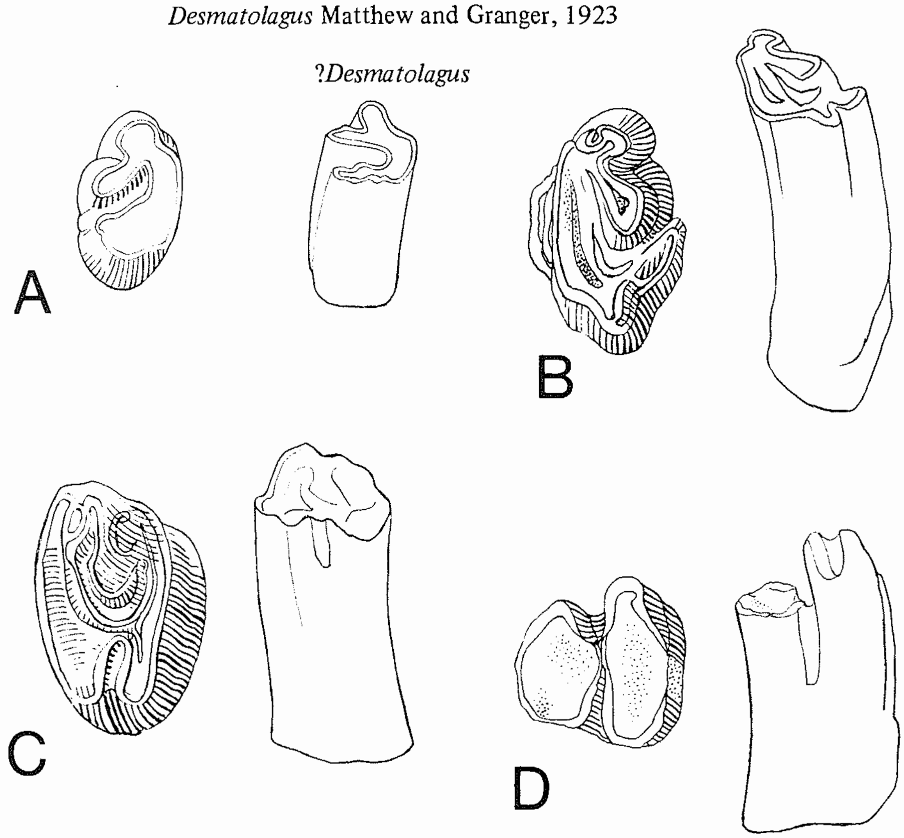


Fig. 8. ?*Desmatolagus*. A. LACM 23518-28, left P^2, occlusal and lingual views. B. LACM 23518-26, right P^3, occlusal and lingual views. C. LACM 23518-25, left upper molariform tooth, occlusal and lingual views. D. LACM 23518-4, left lower molariform tooth, occlusal and lingual views. All x 10.

Referred specimens: LACM 23518, five lower molariform teeth, two upper molariform teeth, and four upper premolars, from V6229. SDSM 64168, upper molariform tooth and two lower molariform teeth from V6215.

Description: Small. Cheek teeth mesodont and rooted. P^2 greatly reduced, with two deep anterior folds, of which the internal one is the deeper. P^3 with anterior loph extending halfway across width of tooth. Crescentic valley connected to antero-external wall of tooth. Shallow lingual hypostria. Upper molariform teeth rooted, with persistent lingual hypostria and crescents. Lower molariform teeth with short, wide trigonid and rounded talonid, not connected by lingual enamel bridge.

Discussion: Dawson (pers. comm.) suggests that this small ochotonid may be related to *Hesperolagomys* Dawson, but that it has lower-crowned cheek teeth. The upper teeth resemble *Desmatolagus*, particularly in the reduction of P^2 and the pattern of P^3. Although the Monroe Creek Formation specimens are probably referable to *Desmatolagus*, they are not referable to the later Split Rock, Wyoming, species, *D. schizopetrus* Dawson (1965). So far as I know, these few teeth represent the earliest recorded occurrence of undoubted ochotonids in North America (see Dawson, 1967, p. 291).

Measurements (in millimeters) of the cheek teeth of ?*Desmatolagus*

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
P^2	LACM 23518-28	.95	1.55
	LACM 23518-29	1.0	1.75
P^3	LACM 23518-26	1.4	3.1
	LACM 23518-27	1.5	3.3
M^x	LACM 23518-25	1.3	2.5
	SDSM 64168-1	1.5	3.0
M_x	LACM 23518-2	1.85	1.85
	LACM 23518-3	2.0	2.3
	LACM 23518-4	1.8	2.0
	LACM 23518-1	2.0	2.5
	SDSM 64168-2	1.9	2.1
	SDSM 64168-3	2.0	2.2

?Ochotonid

Referred specimens: SDSM 64177, P_3 and lower molariform tooth, and fragment of upper molariform tooth, from V6215.

Description: P_3 about the size of that of *Palaeolagus philoi*, but with posterior and external walls joining at 90 degree angle. Rounded trigonid. Lower molariform tooth large and rooted, trigonid both wider and longer than talonid; talonid oval. Trigonid and talonid show no evidence of joining lingually, even with considerable wear. Upper molariform tooth fragment with deep lingual hypostria.

Discussion: These three specimens are of extremely doubtful affinities. The preservation is poor, and the material is not particularly diagnostic. Dawson (pers. comm.) suggests a queried designation.

Measurements (in millimeters) of the
cheek teeth of ?Ochotonid

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
P_3	SDSM 64177-1	2.7	2.5
M_x	SDSM 64177-2	3.4	3.2

Leporidae Gray, 1821

Palaeolaginae cf. *Palaeolagus philoi* Dawson, 1958

Referred specimens: LACM 23558, 12 upper cheek teeth; LACM 23559, eight lower cheek teeth; SDSM 64189, ten deciduous premolars and two upper incisors, from V6229.
Description: P^3 to M^2 high-crowned, with single hypostria extending as much as halfway across occlusal surface in some specimens, obliterated by wear in others. Three specimens have crescents. P_3 very similar to that of *P. philoi*, with bulbous trigonid, single lingual reentrant, and anteroposteriorly compressed talonid wider than trigonid. P_4 to M_2 show lingual enamel bridge between talonid and trigonid only in two of seven specimens; in others, bridge may be expected to form at later stage of wear.
Discussion: These specimens represent the first record of palaeolagines younger than early Arikareean in the Wounded Knee area. The only previously known specimen of a leporid from the Wounded Knee-Monroe Creek fauna was a fragmentary lower jaw identified by Dawson (pers. comm. to J. R. Macdonald) as *Archaeolagus* cf. *ennisianus*. Although Dawson (pers. comm.) hesitates to refer these specimens to *Palaeolagus philoi* with certainty because most of the lower teeth lack the characteristic lingual connection between trigonid and talonid, she suggests that they might resemble that species more closely with further wear.

Measurements (in millimeters) of the cheek
teeth of Palaeolaginae cf. *Palaeolagus philoi*

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
M^x	LACM 23558-1	1.9	3.4
	LACM 23558-2	1.9	3.4
	LACM 23558-3	2.2	3.5
	LACM 23558-4	2.3	4.3
	LACM 23558-5	1.8	3.5
	LACM 23558-6	1.8	3.0
	LACM 23558-7	1.9	3.3
P_3	LACM 23559-1	2.6	2.1
M_x	LACM 23559-2	2.9	2.9
	LACM 23559-3	2.8	3.0
	LACM 23559-4	2.6	2.85
	LACM 23559-5	2.1	2.2
	LACM 23559-6	3.1	3.1

RODENTIA Bowditch, 1821

Aplodontidae Trouessart, 1897

Allomys harkseni Macdonald, 1963

Referred specimens: LACM 23523, 34 M^1 or M^2; LACM 23524, three P^4; LACM 23527, six P^4; LACM 23525, P_4, two M_1, M_2; LACM 23521, five M^3; LACM 23526, five M_2; LACM 23522, three M_3; and various isolated and broken cheek teeth from V6229. SDSM 64156, five M^1 or M^2; SDSM 64164, lower cheek teeth; and various isolated and broken cheek teeth from V6215.

Description: M^1 or M^2 rectangular, length to width ratio approximately 3:4. Strong development of ectoloph and stylar cusps. Larger than *Allomys cavatus* Marsh. P^4 with protocone smaller than that of *A. cavatus*, metaconule and hypoconule larger; otherwise similar. M^3 much shorter than in *A. cavatus*, but otherwise similar. P_4 with large "paraconid," deep anteroflexid, no paraflexid. Entoconid obliquely elongated and isolated. Hypoconulid triangular, joined to hypoconid; hypoconid with posterior and labial arms, joins mesoconid. Hypoflexid and protoflexid joined. M_1 with protoconid and "paraconid" connected by anterior cingulum. Three fossettids present. Deep mesoflexid, isolated entoconid. Broad metaflexid. Hypoconulid elongated and connected to metaconid and mesoconid; hypofossettid does not open into central basin. M_3 similar to M_2 but with hypoconulid reduced; metafossettid does not open through tooth wall; tooth is tapered instead of having a square posterior end. (Terminology from J. A. Shotwell, 1958, p. 452.)

Discussion: Macdonald (1963, p. 177-178) has presented a detailed description of the type specimen of *Allomys harkseni*, SDSM 59156, and since the additional specimens are virtually identical to that tooth I do not feel that repetition serves any purpose. Macdonald (1970) described two lower jaws and the dentition (SDSM 6273 and SDSM 62114), so I have simply summarized the main characteristics in the above description.

Some 45 upper anterior molars have been recovered from the anthills. When the type specimen, also from a Monroe Creek Formation anthill, was described, it was impossible to tell whether it was an M^1 or an M^2, and it was hoped that the material now available would provide a means of determining one from the other. Unfortunately, this has not been possible. All these specimens are quite similar, and measurement does not produce definite grouping. Perhaps the six teeth at the small end of the scale may be M^2's, but morphologically they are not different from the larger teeth. The ratio of length to width is always about 3:4, although measurements may vary as much as ten percent from the median.

This suite of upper molars thus adds little to our knowledge of *Allomys harkseni* beyond giving some idea of what the range of size variation might be.

Although upper and lower teeth have not been found in occlusion, the lower teeth of aplodontids doubtless represent *Allomys harkseni*, since that is the only aplodontid known from the anthills.

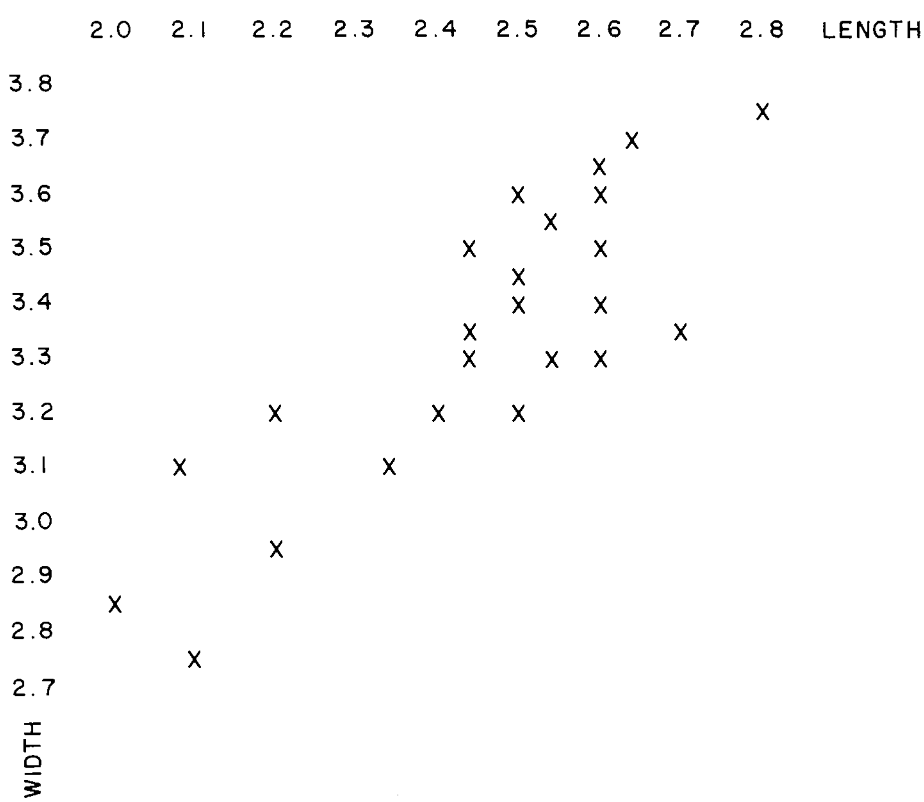
Measurements (in millimeters) of the cheek teeth of *Allomys harkseni*

	Antero-posterior Diameter	Transverse Diameter	N	
M^1 or M^2	2.8	3.75		maximum
	2.0	2.75		minimum
	2.46	3.33	35	average

Allomys harkseni – continued.

	Antero-posterior Diameter	Transverse Diameter	N	
P^4	3.77	3.91		maximum
	2.83	2.92		minimum
	3.21	3.38	7	average
M^3	2.37	2.93		maximum
	2.34	2.63		minimum
	2.36	2.75	4	average
P_4	2.54	2.03	1	
M_1	2.54	2.29	1	
M_2	3.0	2.74		maximum
	2.54	2.18		minimum
	2.84	2.47	6	average
M_3	3.35	2.43		maximum
	2.83	2.22		minimum
	3.11	2.33	3	average

Table 2. Scatter diagram of *Allomys harkseni* M^1 or M^2 from V6229.



Mylagaulidae Cope, 1881

Promylagaulus riggsi McGrew, 1941

Referred specimens: LACM 23533, nine P^4; LACM 23531, 18 upper molars; LACM 23538, nine P^4, M^1, and M^2; LACM 23529, lower molars; LACM 23534, lower molars; LACM 23535, LACM 23536, and LACM 23530, 28 P_4; LACM 23532, two P_4 and two M_1; and various isolated and broken cheek teeth, from V6229. SDSM 64204, various isolated cheek teeth from V6215.

Description: P^4 with strong mesostyle; small parastyle present in early wear stages. Five fossettes (anterofossette, protofossette, parafossette, hypofossette, metafossette) are present initially. Small central parafossette disappears with only slight wear; moderate wear obliterates protofossette. Tooth becomes progressively more triangular with wear. M^1 with faint mesostyle, no parastyle. Rounded parafossette, triangular protofossette. Very shallow mesofossette disappears with slight wear. Anteroposteriorly elongated metafossette and hypofossette. Hypofossette may join mesofossette before the latter is completely removed by wear. M^2 very similar to M^1, but smaller. M^3 similar to anterior molars, but much reduced in size. Four fossettes present in unworn tooth. Protofossette shallow, lost in early wear. Mesofossette apparently not present in M^3. In extreme wear, M^3 is reduced to a simple peg bearing a single central fossette, the ?hypofossette. P_4 elongate. Large triangular anteroflexid closing with moderate wear to form anterofossettid. Deep parafossettid retained throughout wear. Mesoflexid prominent in early wear stages; closed and confluent with parafossettid in late wear. Metafossettid closed even in unworn teeth; persists throughout wear. Hypoflexid and protoflexid never close; fuse in intermediate wear stage; separated by thin mesoconid crest in early wear. M_1 averages slightly larger than M_2, teeth otherwise similar. Both with fairly shallow anterofossettid which disappears in later wear stages. Tiny hypofossettid first lake to disappear, after only moderate wear. Large, deep metafossettid persists throughout wear; mesoflexid closes to form mesofossettid with moderate wear and persists even in extremely worn teeth. Very shallow parafossettid disappears with moderate wear. M_3 much smaller than M_2; only three fossettids present in unworn teeth. Protofossettid fairly shallow; mesofossettid persistent and deep. Mesofossettid confluent with metafossettid until the latter disappears with moderate wear.

Discussion: Although the type of *Promylagaulus riggsi*, the only known upper dentition (FM P26256), is heavily worn, I believe that the Monroe Creek Formation specimens are definitely referable to this species. McGrew (1941, p. 6) originally recorded the horizon as the top of the lower Rosebud beds, and in a recent letter indicated that the type locality was probably in a ravine south of Porcupine, South Dakota. Monroe Creek, Harrison, and Rosebud Formations are all exposed in the ravine he indicated, so the type may have come from any of these levels.

The lower cheek teeth of mylagaulids found in the anthill localities may also be referred to this species. McGrew (1941, p. 9) referred a lower jaw of a mylagaulid (AMNH 10824) from the Wounded Knee area to *Promylagaulus* cf. *riggsi*, although there was no other material to which it could be compared. Matthew (1907) had referred this same jaw to *Meniscomys* close to *hippodus*. Specimens from the Monroe Creek Formation anthills, and a specimen described by Macdonald (1970) indicate that McGrew was correct in assigning the jaw to *Promylagaulus*, as the many similar lower teeth are far too high-crowned to belong to a contemporary *Meniscomys*. Lower and upper teeth of mylagaulids are about equal in abundance in the anthills, and I can only assume that they represent the same species.

Measurements (in millimeters) of the cheek teeth of *Promylagaulus riggsi*

	Antero-posterior Diameter	Transverse Diameter	N	
P^4	3.92	3.41		maximum
	3.34	2.52		minimum
	3.53	2.93	10	average
M^1	2.35	2.32		maximum
	2.10	1.76		minimum
	2.21	2.11	11	average
M^2	1.76	2.03		maximum
	1.68	1.75		minimum
	1.71	1.86	4	average
P_4	3.80	2.45		maximum
	2.62	1.88		minimum
	3.19	2.14	11	average
M_1	2.83	2.22		maximum
	2.22	1.68		minimum
	2.49	1.93	5	average
M_2	2.07	1.86		maximum
	1.88	1.70		minimum
	1.98	1.80	4	average

Sciuridae Gray, 1821

Two sizes of squirrels are recorded from the two anthill localities. The more common is a large ground squirrel about the size of *Protosciurus* Black, and the smaller is about the size of a chipmunk. Teeth of the large form come from both localities, and the small form is found only at V6229.

It may be possible to refer these isolated teeth to definite genera, but until better material is found I will not attempt to do so. The terminology used is that of Black (1963).

Sciurid, small species

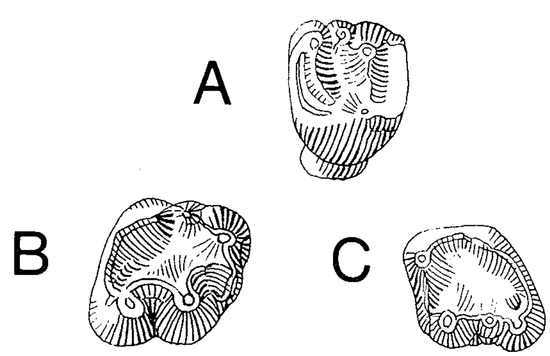


Fig. 9. Sciurid, small species. A. LACM 23519-26, right M^1 or M^2, occlusal view. B. LACM 23519-4, right M_1 or M_2, occlusal view. C. LACM 23519-5, left M_1 or M_2, occlusal view. All X 10.

Referred specimens: LACM 23519, two M^1 or M^2, two dP^4, two M_1 or M_2, and three M_3, from V6229.

Description: Roughly triangular dP^4 with large parastyle and wide anterior valley. Five distinct transverse lophs, of which the posterior two converge just behind the protocone, the anterior two converge just in front of the protocone, and the medial loph connects to longitudinal loph connecting labial ends of other four lophs. Large metacone. Deep longitudinal valley between protocone and longitudinal loph. M^1 or ^{2} nearly quadrate, with large protocone, sharply defined paracone and metacone. Distinct mesostyle on faint external cingulum. Strong metaloph and protoloph, suggestion of metaconule becoming more pronounced with wear. Deep anterior valley and strong anterior and posterior cingula. M_1 or $_2$ approximately quadrate, with subequal protoconid, metaconid, hypoconid, and entoconid. Small but distinct mesoconid. Short metalophid extends into trigonid-talonid basin only slightly, resulting in connection of basins and limitation of trigonid valley to antero-lingual corner of tooth. M_3 with high, prominent protoconid. Small mesoconid, suggestion of mesostylid, not present on M_1 or $_2$. Metalophid aborted, trigonid and talonid basins joined as in anterior molars.

Measurements (in millimeters) of the cheek teeth of Sciurid, small species

	Antero-posterior Diameter	Transverse Diameter	N	
dP^4	1.63	1.55		maximum
	1.58	1.44		minimum
	1.60	1.49	2	average
M^1 or M^2	1.75	2.15		maximum
	1.49	1.83		minimum
	1.62	1.99	2	average
M_1 or M_2	1.85	1.75		maximum
	1.52	1.44		minimum
	1.68	1.59	2	average
M_3	1.85	1.51		maximum
	1.50	1.40		minimum
	1.72	1.46	3	average

Discussion: Black (1963) referred several sciurid teeth from the Sharps Formation of the Wounded Knee area to *Tamias* sp. He noted the difficulties involved in nomenclature of the *Tamias-Eutamias* group and admitted that his assignment of several early Miocene specimens to *Tamias* was at best arbitrary. Since it is impossible to distinguish *Tamias* from *Eutamias* without the baculum and P^3, I feel that using either of these names for isolated teeth would only be confusing. Black also noted that his use of the name *Tamias* did not constitute belief that the early Miocene form actually represented a species of the Recent genus; this is probably another good reason for not using *Tamias* for the Monroe Creek Formation specimens. Wilson (1960) makes the point that sciurids from chipmunk to marmot size are known from several stratigraphic levels, although they are probably not representatives of Recent genera.

Sciurid, large species

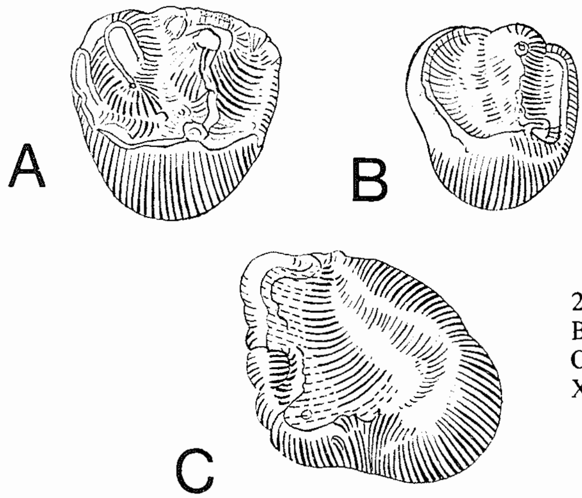


Fig. 10. Sciurid, large species. A. LACM 23520-6, right M^1 or M^2, occlusal view. B. LACM 23520-11, right M^1 occlusal view. C. LACM 23520-1, left M_3, occlusal view. All X 10.

Referred specimens: LACM 23520, P^4, seven M^1 or M^2, two M^3, four M_3, from V6229. SDSM 64160, three M_1 or M_2, one M_3, from V6215.

Description: P^4 approximately quadrate with projecting parastyle. Metaconule and mesostyle present. M^1 or ^{2} somewhat more triangular than square. Deep anterior valley; protoloph complete; metaloph usually incomplete and curved toward protoloph, bearing distinct metaconule. Mesostyle present. M^3 roughly triangular, with expanded metacone; high, sharp protoloph; metaloph reduced to variable series of cusps (two or three) in the central basin, one of which is probably the metaconule. Distinct mesostyle. M_1 or $_2$ nearly quadrate; anteroposteriorly compressed. Large entoconid; high protoconid. Mesoconid and mesostylid distinct. Metalophid nearly complete, extending from metaconid almost to base of protoconid and definitely separating trigonid and talonid basins. Very strong anterior cingulum and posterolophid; distinct anteroconid. M_3 right triangular in outline, with hypoconid much reduced. Very large entoconid. Metalophid extending about halfway from metaconid to protoconid. Distinct anteroconid and mesostylid; faint mesoconid.

Discussion: Macdonald (1970) reports a maxillary fragment from the Monroe Creek Formation which he refers to *Protosciurus* species indeterminate. His specimen (SDSM 632) has the very low-crowned teeth and lack of conules typical of *Protosciurus* and other tree squirrels (Black, 1963). On the other hand, the anthill specimens are certainly not referable to *Protosciurus* although they are close to it in size. They are quite high-crowned and have distinct conules on the upper teeth, as is typical of ground squirrels.

Measurements (in millimeters) of the cheek teeth of Sciurid, large species

	Antero-posterior Diameter	Transverse Diameter	N	
P^4	2.33	2.29	1	
M^1 or M^2	2.57	3.00		maximum
	2.44	2.84		minimum
	2.51	2.91	7	average
M^3	2.39	2.48		maximum

Sciurid, large species -- continued.

	Antero-posterior Diameter	Transverse Diameter	N	
M^3	2.22	2.19		minimum
	2.30	2.33	2	average
M_1 or M_2	2.43	2.74		maximum
	2.38	2.29		minimum
	2.41	2.51	3	average
M_3	2.92	2.92		maximum
	2.84	2.76	5	average

Eomyidae Deperet and Douxami, 1902

Pseudotheridomys cf. *P. hesperus* Wilson, 1960

Referred specimens: LACM 23548, P^4 and M^2, from V6229.
Description: P^4 lacking anterior valley; posterior valley closed posteriorly only by fragments of cingulum not connected to hypocone; mesoloph greatly reduced and present only as a minor extension from the hypocone. Deep embayment between protocone and hypocone, deepening toward labial margin. Tooth nearly square. M^2 with long, narrow anterior valley; disjunct endoloph (mure); deep valley between hypocone and protocone becoming shallower toward labial margin of tooth. Mesoloph well-developed and extending into transverse valley, occupying approximate center of tooth. Posterior valley is closed.
Discussion: These two teeth can be compared to KU 10200, a P^4, and KU 10201, an M^2, as figured by Wilson (1960, figs. 96 and 97). They differ from the KU specimens somewhat in the position of the mesoloph on M^2 and in the shape, the absence of the anterior valley, and the incompleteness of the posterior cingulum on P^4. These teeth represent the earliest known occurrence of the genus in North America.

The presence of *Pseudotheridomys* in the middle Arikareean presents some problems in the correlation of European and North American faunal stages. The occurrence of *P. hesperus* in the Martin Canyon Quarry A caused Wilson to observe (1960, p. 72) that *Pseudotheridomys* "seems to have been an element in the general faunal interchange between Eurasia and North America at the beginning of Burdigalian time." If this is so, then perhaps the Burdigalian stage began as early as the middle Arikareean in North America. The other alternative is to suggest that the middle Arikareean is equivalent to the late Aquitanian and that a few European forms managed to enter North America just prior to the main wave of Burdigalian migration, without migration in the opposite direction. I favor the former suggestion, as one-way movement across a land bridge is not known to occur.

Measurements (in millimeters) of the teeth of *Pseudotheridomys* cf. *P. hesperus*

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
P^4	LACM 23548-14	1.65	1.73
M^2	LACM 23548-15	1.52	1.80

Geomyidae Gill, 1872

Gregorymys formosus (Matthew), 1907

Referred specimens: LACM 23539, 16 dP^4; LACM 23544, 22 dP_4; SDSM 64169, maxillary fragment with P^4 to M^3; and approximately 300 unworn upper and lower cheek teeth, from V6229. SDSM 64165, four dP^4; SDSM 64171, five dP_4; SDSM 64170, jaw fragment with P_4 to M_3; and approximately 75 unworn upper and lower cheek teeth from V6215.
Description: P^4 with three-cusped protoloph forming single-cusped loph after only little wear. Metaloph likewise three-cusped, with entostyle curved forward. Protoloph and metaloph joining after moderate wear, forming a broad U, the anterior leg of which lengthens with increasing wear until a stage like that seen in the type specimen (AMNH 12887) is reached. Upper molars progressively reduced in size from M^1 to M^3. All have straight, narrow protolophs in early wear; tips sharply pointed. Lophs widen and tips become rounded in later wear; lophs join lingually with moderate wear. P_4 with three-cusped protolophid; long central protolophid cusp directed forward, labial and lingual protolophid cusps directed outward at 45 degrees from midline. Anterior cingulum variable, usually with three separate cusps. Metalophid three-cusped, forming straight loph with little wear. Protolophid and metalophid join labially in late wear stages. Lower molars nearly mirror images of uppers; lophs join labially in late wear and lingually in extreme wear stages. Lingual enamel interrupted in extreme wear. Fragment of cingulum present on anterolabial corner of each molar, disappears with little wear. The dP^4 is variable in size and shape, from long and triangular to short and nearly square. Three transverse lophs each bear three cusps; lophs separated from each other by deep transverse valleys and connected by a high lingual ridge. Accessory cusps may be developed in the transverse valleys. The dP_4 is longer than wide, with two longitudinal rows of cusps along the margins, each row having three cusps. Semicircular anterior cingulum with variable number of cusps. Fragment of posterior cingulum between two posterior cusps. Posterior cusps connected by a V-shaped ridge in the valley between them; apex points forward. Median labial cusp connected to anterior lingual cusp by a high, strong ridge.
Discussion: *Gregorymys formosus* is the only geomyid known from the Monroe Creek Formation anthills, and is the most abundant form found in them. Hundreds of unworn upper and lower cheek teeth are readily identifiable, and literally thousands of worn cheek teeth and incisors are very likely referable to this species, although I have not dealt with any but the unworn ones. Macdonald (1970) has reported a skull, 13 crania and maxillary fragments, and 14 jaws from the Monroe Creek Formation in the Wounded Knee area. Most of these came from a small area within a few yards of the anthill at V6215. These specimens are in all stages of wear; three crania even retain the deciduous upper premolar, previously unknown.

The 20 deciduous upper premolars from the anthill collection compare favorably with those in the three crania (SDSM 6222, 6276, and 6297). They are also very similar to a tooth (MCZ 7353) described by Black (1960) from the early Miocene rocks of Goshen Hole, Wyoming, as *Palustrimus* sp. *Palustrimus* Wood (1935) was originally described as a murid. While Wood's type specimen (YPM 10572) is not referable to *Gregorymys*, it is certainly a geomyid, probably *Entoptychus*, as Rensberger (1966) has suggested. Black (1969) reaches the same conclusion.

The lower deciduous premolars are of a size and shape that would occlude with the dP^4's of *Gregorymys formosus*, and are present in about the same numbers at both anthill localities. Since they are not known in association with other teeth, I shall tentatively refer them to this species. The teeth are quite similar to one (AMNH 12981) which Wood (1936, fig. 13) referred to *Gregorymys curtus*, but the pattern is more complicated.

Measurements (in millimeters) of the cheek teeth of *Gregorymys formosus*

	Antero-posterior Diameter	Transverse Diameter	N	
dP^4	2.83	2.31		maximum
	2.04	1.63		minimum
	2.43	1.88	20	average
dP_4	2.77	1.82		maximum
	1.97	1.30		minimum
	2.26	1.48	19	average

Specimen Number SDSM 64169		Antero-posterior Diameter	Transverse Diameter
	P^4	2.18	2.29
	M^1	1.58	2.18
	M^2	1.52	2.16
	M^3	1.47	1.58
Specimen Number SDSM 64170			
	P_4	1.65	1.76
	M_1	1.38	1.92
	M_2	1.30	1.90
	M_3	1.20	1.56

Heteromyidae Allen and Chapman, 1893

Proheteromys Wood, 1932

Proheteromys, species

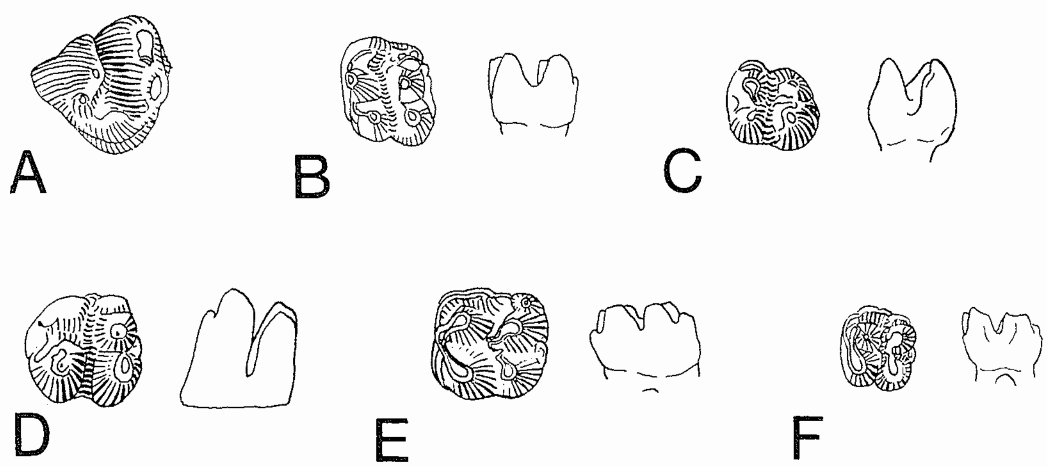


Fig. 11. *Proheteromys*, species. A. LACM 23545-4, left P^4, occlusal view. B LACM 23545-11, left M^2 occlusal and lingual views. C. SDSM 64166-41, left P_4, occlusal and lingual views. D. SDSM 64166-40, right P_4, occlusal and labial views. E. LACM 23545-15, right M_1, occlusal and lingual views. F. LACM 23545-20, right M_3, occlusal and lingual views. All X 10.

Referred specimens: LACM 23545, 15 cheek teeth and a maxillary fragment with P^4 to M^1, from V6229. SDSM 64166, 12 cheek teeth, maxillary fragment with P^4, and maxillary fragment with P^4 to M^1, from V6215.

Description: P^4 triangular, with single anterior cusp (protocone) and three-cusped metaloph. Posterolingual cusp (entostyle) turned forward. Posterior cingulum absent. Small accessory cusp may be present lingual to protocone, but is reduced or absent in some specimens. Upper molars generally wider than long, three-rooted, six-cusped. Lingual cingulum notched when unworn but unbroken when moderately worn. Anterior cingulum well-developed. Metaloph somewhat crescentic, with ends forward. P_4 with three-cusped protolophid; anteroconid well forward of other cusps in one specimen, central and elongated in another. Metalophid three-cusped; hypostylid small and lower than other cusps. Cingula absent. Lower molars square with well-developed Y-pattern formed by migration of protoconid toward protostylid. H-pattern never developed, even in heavily worn specimens. Labial cingulum cut by medial valley; anterior cingulum well-developed; posterior cingulum reduced to a small cusp between hypoconid and entoconid. Hypostylid small, round, and well-developed, but not as high as other cusps of hypolophid. Median valleys not straight. M_3 similar to anterior molars, but smaller and with hypolophid reduced to two cusps. Roots slant sharply backward.

Discussion: I have assigned these teeth to *Proheteromys* on the basis of the prominent Y-pattern of the lower molars. The X-pattern of the P_4 and the H-pattern of the upper molars are not developed, although one P_4 shows what might develop into an X-pattern with more wear.

The P^4's resemble that of *Heliscomys schlaikjeri* Black (1961), but since the other teeth are certainly *Proheteromys*, it seems unreasonable to refer only the P^4's to another genus. Furthermore, two skulls of *Proheteromys*, one from the Wounded Knee area and another from a few miles east, are now known. Both have the upper and lower dentitions in occlusion. These two skulls (LACM 15011 and 15219) represent the first known occurrence of such association. Both skulls have the four-cusped lower premolar, and a primitive triangular upper premolar like that of *Heliscomys schlaikjeri*. The molars are, unfortunately, worn nearly flat, but traces of the Y-pattern can be seen in the lower molars. The upper molars have not developed the H-pattern, even in late wear.

Although Wood (1935, p. 166) noted that "upper teeth of *Heliscomys* have posterior, and the lower teeth have anterior, cingula, . . . the cingula are on the other ends in *Prohetoromys* . . . ", this does not seem to hold true. In fact, the type of the genotypic species of *Proheteromys*, *P. floridanus*, does not have a posterior cingulum of M_1. Both *Heliscomys tenuiceps* Galbreath and *H. schlaikjeri* have strong anterior cingula on the upper molars. The *Proheteromys* sp. teeth from the Monroe Formation anthills do, however, follow the pattern proposed by Wood.

The similarity of P^4 in *Proheteromys* and *Heliscomys* makes Wood's (1935, p. 166) postulate of the close relationship of these genera highly plausible. They differ largely in that *Proheteromys* lacks the fragment of posterior cingulum seen in some species of *Heliscomys*.

The *Proheteromys* teeth from the anthills are not definitely referable to any described species. They are relatively large, and the variation seen in the two P_4's indicates that the species was highly variable, or that there were two species of the same genus present. The lower molars may be compared favorably with any of the three species described by Macdonald (1963) from the Sharps Formation in the Wounded Knee area.

Measurements (in millimeters) of the
cheek teeth of *Proheteromys*, species

	Antero-posterior Diameter	Transverse Diameter	N	
P^4	1.68	1.80		maximum
	1.17	1.33		minimum
	1.42	1.60	8	average
M^2	1.27	1.60	1	
P_4	1.26	1.25		maximum
	1.24	1.23		minimum
	1.25	1.24	2	average
M_1	1.48	1.49		maximum
	1.30	1.30		minimum
	1.37	1.41	10	average
M_2	1.38	1.51		maximum
	1.04	1.32		minimum
	1.22	1.44	6	average
M_3	1.18	1.28		maximum
	1.13	1.15		minimum
	1.16	1.22	2	average

Sanctimus tiptoni Macdonald, 1970

Referred specimens: LACM 23546, four P^4, six M^1, one M^3, and 12 lower molars, from V6229. SDSM 64167, M^2, M^3, and five lower molars, from V6215.

Description: Very large heteromyid. P^4 with large, round protocone; smaller paracone closely appressed. Protoloph well separated from protostyle and metaloph. Metaloph with well-developed J-pattern formed by forward-curving protostyle and entostyle. Posterior cingulum much reduced, represented only by a small cuspule between hypocone and metacone. Transverse valley deep and straight. Upper molars four-cusped with high, strong cingulum complete across internal margin. Cingulum not broken into cusps even when unworn. Transverse valleys deep and straight. Protocone, paracone, metacone, and hypocone subequal in size and height. M^3 smaller than anterior molars; protocone displaced posteriorly. Protoloph and metaloph crescentic, with ends of lophs curved toward each other, giving tooth a rounded outline. Internal cingulum complete; paracone and metacone join externally with moderate wear. Strong anterior cingulum as on all upper molars, extending to center of anterior face of paracone. M_1 and M_2 similar to each other; M_1 more nearly square, M_2 somewhat wider than long. Both four-cusped, with two cusped antero-labial cingulum forming strong Y-pattern. Small hypostylid. Anterior cingulum very weak and low; in some cases nearly absent. Posterior cingulum completely absent, except in one tooth, which retains a minute cuspule between hypoconid and entoconid. M_3 similar to anterior molars, but with hypolophid much reduced in height and width; hypostylid very small. No anterior or posterior cingula; antero-labial cingulum relatively reduced.

Discussion: These teeth are referable to a new genus and species described by Macdonald (1970). The Monroe Creek Formation anthill specimens represent the first known lower teeth of the species (the type and only other specimen, SDSM 623, was collected at V6215 and consists of a left maxillary with unworn P^4 to M^3). P. Robinson (pers. comm.) has suggested that *Sanctimus* is actually *Florentiamys*, but I think this is not the case. Certainly the two genera are closely related, but the Monroe Creek Formation specimens (and a complete skull of another species, *Sanctimus stuartae*, from the Sharps Formation) lack the prominent anterior cingula on P^4 and all traces of posterior cingula on the upper molars.

Measurements (in millimeters) of the cheek teeth of *Sanctimus tiptoni*

	Antero-posterior Diameter	Transverse Diameter	N	
P^4	2.50	2.53		maximum
	2.18	2.29		minimum
	2.33	2.38	4	average
M^x	2.06	2.54		maximum
	1.81	2.19		minimum
	1.93	2.37	6	average
M^3	1.72	2.01	1	
M_x	2.32	2.35		maximum
	1.78	2.02		minimum
	2.07	2.19	15	average
M_3	1.90	2.19		maximum
	1.80	1.98		minimum
	1.84	2.06	3	average

Castoridae Gray, 1821

About 150 cheek teeth and incisors of castorids have come from the two anthill localities. Most of these are heavily worn or broken, as complete, unworn teeth are too large for a single harvester ant to move. Apparently, some complete teeth did reach the anthills. Unfortunately, even these are not particularly useful in castorid taxonomy, as the diagnostic characters of many species are based largely on cranial anatomy. However, some general statements can be made as to generic assignment on the basis of size and tooth pattern.

Palaeocastor cf. *P. simplicidens* (Matthew), 1907

Forty-five complete teeth from V6229 and 16 from V6215 compare well in size, pattern, and crown height with teeth in skulls which Macdonald (1963) referred to *P. simplicidens*. Since there is no discernible difference between teeth of *P. simplicidens* and *P. nebrascensis* (from the Sharps Formation in the Wounded Knee area) I have not assigned these teeth to either species. Since *P. simplicidens* is reported only from the Monroe Creek Formation in the Wounded Knee area, it seems reasonable to expect that it would occur in the anthill collections.

Capatanka Macdonald, 1963

Capatanka, species

Five cheek teeth from V6229 and one cheek tooth and an incisor from V6215 are of a beaver larger than *Palaeocastor*. *Capatanka brachyceps* (Matthew) is known from the Wounded Knee-Monroe Creek fauna (Macdonald, 1963, p. 195), and these teeth compare with it in size, crown height, and pattern. Here also, however, the various species of the genus are not separable on the basis of the dentition. Furthermore, *C. brachyceps* may, as Macdonald (1963, p. 197) has suggested, be referable to *Euhapsis*.

Eutypomyidae Miller and Gidley, 1918

Eutypomys cf. *E. montanensis* Wood and Konizeski, 1965

Referred specimen: LACM 23547, an M_3, from V6229.
Discussion: This single tooth from the Monroe Creek Formation represents the highest known stratigraphic occurrence of *Eutypomys*. Species of *Eutypomys* are known from the early Oligocene of Montana and the Cypress Hills, Alberta, from the middle Oligocene of the Big Badlands of South Dakota, and from the Arikareean of Montana (Wood and Konizeski, 1965). Macdonald has collected a nearly complete skull from the Sharps Formation which is referable to *E. montanensis* (Macdonald, 1970). The M_3 of that skull (SDSM 6227) compares well with the Monroe Creek Formation tooth, although the latter is somewhat larger and in an earlier stage of wear.

Measurements (in millimeters) of the
M_3 of *Eutypomys* cf. *E. montanensis*

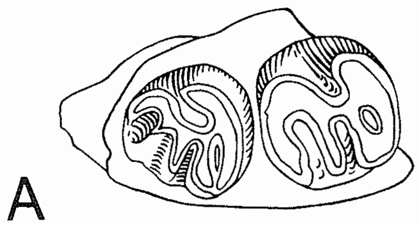
Specimen Number	Antero-posterior Diameter	Transverse Diameter
LACM 23547	4.8	4.2

Cricetidae Rochebrune, 1883

Paciculus cf. *P. montanus* Black, 1961

Referred specimens: LACM 23552, upper cheek teeth, maxillary fragment with M^{1}-^{2}; LACM 23550, 11 M_1; LACM 23549, four M_2, one M_3; SDSM 64205, maxillary fragment with M^{2}-^{3} and two M^3; and various isolated cheek teeth from V6229. SDSM 64154 and 65155, upper cheek teeth; SDSM 64161, four M_1; SDSM 64162, two M_2; SDSM 64163, two M_3, from V6215.
Description: Teeth relatively high-crowned. M^1 elongated, with large anterocone. Five transverse crests of subequal length and width, all extending to labial margin of tooth. Lingual reentrants deepening toward center of tooth. Anterocone strongly connected to protocone. Strong anterior and posterior cingula become confluent with protoloph and metaloph, respectively, with wear. M^2 similar to M^1, but lacking the large anterocone. Generally rectangular outline. M^3 with small, distinct hypocone; five crests directed postero-labially, rounded outline. M_1 with well-developed anteroconid which connects to metaconid with only slight wear. Metaconid somewhat anterior to protoconid, becomes connected to it by metalophid after slight wear. Mesolophid strong and of variable length;

may be quite short or extend to lingual margin of tooth. Large hypoconid and entoconid. No hypoconulid on any of the lower teeth. M_2 with very straight, short anterior cingulum which connects to base of protoconid. Strong metaconid. Short mesolophid; never reaches lingual border of tooth. Hypoconid and entoconid subequal. Posterior cingulum does not reach lingual margin of tooth. M_3 with talonid portion compressed transversely; triangular. Suggestion of anterior cingulum, joined to metalophid along most of its length. Large metaconid. Mesolophulid and hypolophulid weak, uniting early in wear. Strong posterior cingulum.



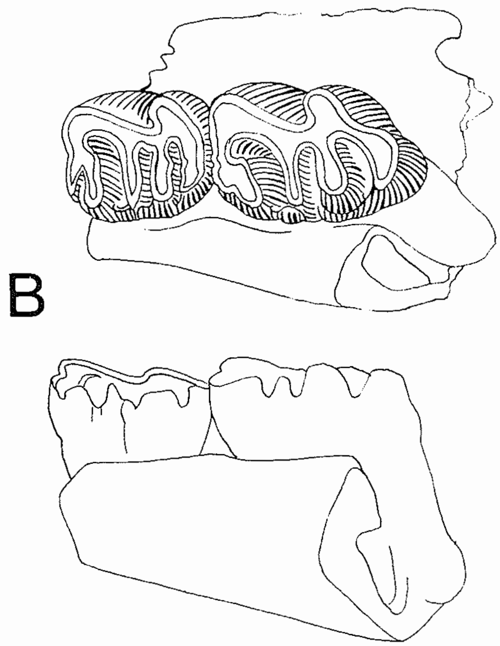


Fig. 12. *Paciculus* cf. *P. montanus* Black. A. SDSM 64205-17, left maxillary fragment with M^2 - ^{3}, occlusal view. B. LACM 23552-1, left maxillary fragment with M^1 - ^{2}, occlusal and labial views. Both X 10.

Discussion: Thirty-seven upper molars of a medium-sized cricetid have come from the two anthill localities. They cannot definitely be assigned to either of the described species of *Paciculus*, although they certainly belong to that genus. *P. montanus*, from the Barstovian or Hemingfordian Deep River beds of Montana is separated from the anthill specimens by considerable time (in terms of the usual speed of rodent evolution), during which some change would normally be expected. *P. insolitus* Cope from the John Day beds of Oregon is closer in time, but is widely separated geographically from the anthill specimens. The type, and only described, specimen of *P. insolitus* is so worn as to make comparison with other specimens rather pointless.

The Monroe Creek Formation specimens can be compared to Black's type and paratype (YPM 10427 and 10426), which they closely resemble. However, none of the characteristics which allies these teeth with *P. montanus* serves to differentiate them from *P. insolitus*. The proportional differences noted by Black (1961, p. 12) disappear when the described specimens and the anthill specimens are seen together. Known specimens of *P. montanus* and *P. insolitus* fall well within the size and proportion ranges of the Monroe Creek Formation specimens. More cricetid material from Montana and the John Day region will have to be examined before the status of these two species can be determined.

Lower cheek teeth from the anthills are no doubt *Paciculus*. They are about equal in number to specimens of upper teeth, they are of a size which would occlude with the upper teeth, and they have about the same height of crown. In addition to the anthill specimens, two lower jaws, LACM 9259 and 9262, with similar teeth to those found in the anthills, recently came to light and will be described in a separate paper.

Alker (1969) reports *Paciculus insolitus* from the Gering Formation of Nebraska. While this species may well be found in Nebraska, the specimens he illustrates are certainly not referable to it. The M^1 of UNSM 66163 has virtually no anterocone; the anterior and posterior cingula and the mesoloph do not reach the labial border of the tooth. An enlarged anterocone and five long transverse lophs characterize *P. insolitus*. In addition, the lower dentitions as Alker illustrates them bear no resemblance to the Monroe Creek Formation *Paciculus*, but this may not necessarily preclude their belonging to that genus.

Alker suggests that, based on similarities between the lower teeth from Nebraska and a specimen of the Recent zapodid *Zapus hudsonius campestris*, *Paciculus* might be more properly assigned to the Zapodidae. However, since *Paciculus* has a large anterocone on M^1 and lacks a P^4, as is typical of cricetids, I think this is not the case. It may well be that Alker's specimens are zapodids, however, since they are not *Paciculus*.

Measurements (in millimeters) of the
cheek teeth of *Paciculus* cf. *P. montanus*

	Antero-posterior Diameter	Transverse Diameter	N	
M^1	2.60	2.10		maximum
	2.20	1.40		minimum
	2.55	1.78	18	average
	2.35	1.80		Type, *P. montanus*
	2.30	1.60		Paratype, *P. montanus*
M^2	1.95	2.00		maximum
	1.60	1.60		minimum
	1.78	1.87	12	average
	1.80	1.80		Type, *P. montanus*
	1.75	1.80		Paratype, *P. montanus*
M^3	1.50	1.80		maximum
	1.30	1.50		minimum
	1.40	1.60	4	average
	1.50	1.60		Paratype, *P. montanus*
M_1	2.40	1.82		maximum
	2.16	1.44		minimum
	2.31	1.58	10	average
M_2	2.10	1.80		maximum
	2.04	1.70		minimum
	2.07	1.75	2	average
M_3	1.99	1.60		maximum
	1.94	1.56		minimum
	1.97	1.58	2	average

Cricetid, genus undescribed

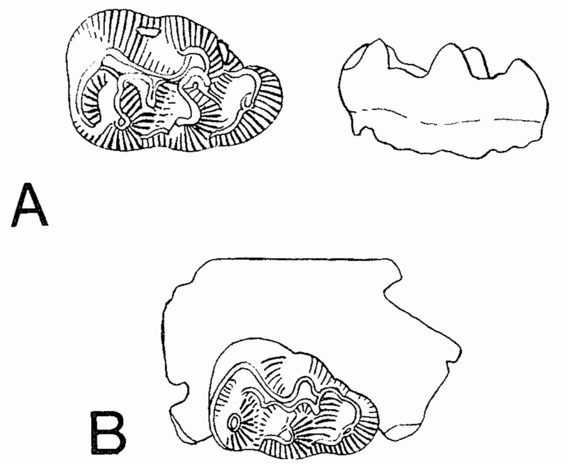


Fig. 13. Cricetid, genus undescribed. A. LACM 23554-1, left M^1, occlusal and labial views. B. SDSM 64159-1, left M^1 in maxillary fragment, occlusal view. Both X 10.

Referred specimens: LACM 23554, three M^1, one M_2, from V6229. SDSM 64159, M^1 in maxillary fragment, from V6215.

Description: M^1 with large anterocone connected to protocone, well-developed anteroloph and anterior cingulum forming nearly closed basin at front of tooth. Isolated parastyle. Small loph from protocone extends into the closed basin. Tapering mesoloph extends nearly to labial margin of tooth. Small mesocone. Large hypocone strongly connected to metacone. Well-developed posterior cingulum. M_2 with strong anterolophid connected to metalophulid; not connected to protoconid. Metaconid anterior to protoconid. Mesoconid little developed. Mesolophid short, without labial spur. Hypoconid and entoconid connected by hypolophulid. Strong posterior cingulum and posterolophid. Teeth very low-crowned.

Discussion: These five teeth represent the only low-crowned cricetids in the anthill collections. No other teeth have been found, and it is possible that the M_2 is not of the same species as the M^1's. The M^1's fall into two size groups, large and small. Possibly this is a reflection of sexual dimorphism rather than specific difference.

Although they somewhat resemble a primitive type of *Democricetodon*, these teeth are not referable to any described cricetid or zapodid. *Leidymys* and *Copemys* differ from them in having the metacone united with the posteroloph rather than the hypocone. When more complete material is found perhaps it can be described as a new genus; I hesitate to base such a description on the specimens now at hand.

Measurements (in millimeters) of the cheek teeth of Cricetid, genus undescribed

	Specimen Number	Antero-posterior Diameter	Transverse Diameter
M^1	LACM 23554-1	2.56	1.67
M^1	LACM 23554-2	2.05	1.38
M^1	LACM 23554-3	2.72	1.92
M^1	SDSM 64159-1	1.90	1.30
M_2	LACM 23554-4	2.17	1.81

Zapodidae Coues, 1875

Plesiosminthus Viret, 1926

Plesiosminthus, species

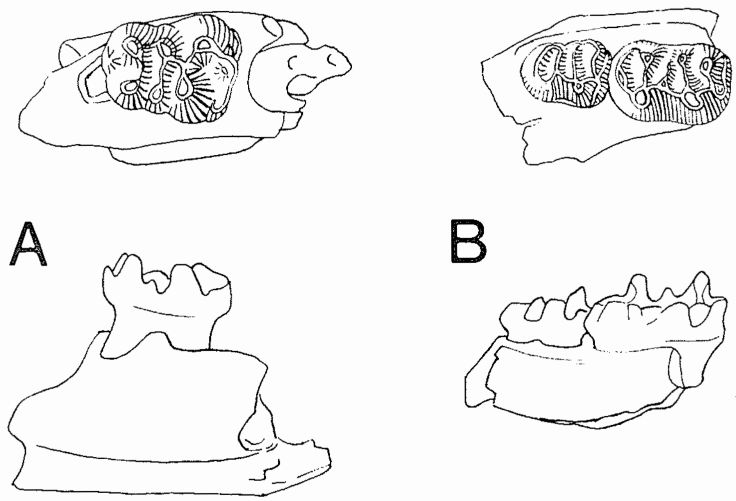


Fig. 14. *Plesiosminthus*, species. A. SDSM 64158-3, right M_1, occlusal and lingual views. B. LACM 23557-1, right $M_2 - _3$, occlusal and labial views. Both X 10.

Referred specimens: LACM 23555, jaw fragment with M_1 to M_2; LACM 23556, M_2; LACM 23557, jaw fragment with M_2 to M_3, from V6229. SDSM 64158, two M_1, from V6215.

Description: M_1 with well-developed anteroconid situated closer to protoconid than to metaconid. Metaconid and protoconid subequal. Small mesoconid, weak mesolophid extending internally to a line between metaconid and entoconid. No mesostylid. Hypoconid and entoconid subequal. Hypoconulid forming bulge on posterolophid. Posterior cingulum extends lingually to a line between entoconid and metaconid. M_2 with strong anteroconid; protoconid and hypoconid of equal size; metaconid and entoconid subequal and smaller. Protoconid connected to metaconid and anteroconid. Accessory loph of variable length connects ectolophid to mesolophid's lingual tip. Mesolophid weak. Small hypoconulid. Posterior cingulum recurved, almost reaching base of entoconid and forming a nearly closed basin. M_3 with small anteroconid connected to protoconid; mesolophid well-developed and extended to lingual border of tooth. Mesoconid with labial spur; massive extension of hypoconid forming posterior cingulum and posterolophid. Teeth generally elongate; cusped rather than lophed. Two small foramina, one just external to posterior end of M_3, the other just anterior to M_1 near top of jaw on external face.

Comparison with described species: *Plesiosminthus* sp. from the Monroe Creek Formation anthills compares favorably in size with *P. galbreathi* Wilson from the Martin Canyon Quarry A fauna of northeastern Colorado, and with *P. grangeri* (Wood) from the Potato Creek area, South Dakota. *P. galbreathi* is of latest Arikareean or early Hemingfordian age, and geologic reconnaissance in the Potato Creek area indicates that *P. grangeri* is probably early Arikareean in age. Despite size similarities, the *Plesiosminthus* specimens from the Monroe Creek Formation cannot be referred to either of these species. It differs from *P. grangeri* in having a weak mesolophid on M_1, and a distinct connection between trigonid and talonid. In M_2 there is a similar connection between trigonid and talonid which does not exist in *P. grangeri*. *Plesiosminthus* sp. differs from *P. galbreathi* in having a larger anteroconid and weaker mesolophid on M_1, and in having an extra loph on M_2 between ectolophid and mesolophid. M_3 has a much more elongate mesolophid than *P. galbreathi*.

Plesiosminthus sabrae (Black) lacks the anteroconid on M_1. The transverse lophs are poorly developed on M_1 and M_2, and the M_3 is much smaller than that in *Plesiosminthus* sp.
Discussion: The use of *Plesiosminthus* in intercontinental correlation is not a simple matter, due to the confusion surrounding the affinities and place of origin of the genus. The European record of the genus extends from late Stampian through the Aquitanian; in North America it occurs in the Arikareean and Clarendonian. *Simimys* Wilson from the Uintan of southern California may be ancestral to European species of *Plesiosminthus*, some of which were reintroduced into North America in the early Miocene. Or, *Simimys* may be directly ancestral to the North American species, although none is known between late Eocene and early Miocene. Or *Plesiosminthus* may be a strictly European genus which first entered North America in the Burdigalian migration. Unfortunately, the fossil record of *Plesiosminthus* in North America is limited to five occurrences, all but one of which is in the Arikareean. So far, no earlier representatives of the Zapodidae which might serve to ally *Plesiosminthus* and *Simimys* are known. It seems unlikely, however, if the genus originated in Europe, that representatives could have reached North America by the early Arikareean, as there is (as yet) no good evidence for migration of other forms at that time.

Measurements (in millimeters) of the
cheek teeth of *Plesiosminthus*, species

	Antero-posterior Diameter	Transverse Diameter	N	
M_1	1.55	1.07		maximum
	1.41	1.06		minimum
	1.48	1.065	2	average
M_2	1.42	1.17		maximum
	1.27	0.97		minimum
	1.35	1.09	4	average
M_3	1.10	0.88	1	

CARNIVORA Bowditch, 1821

Canoidea Simpson, 1941

Canoidea, indeterminate

Referred specimens: SDSM 64195, 70 isolated teeth, from V6229. SDSM 64196, 20 isolated teeth, from V6215.
Discussion: Only the most general identification of these teeth can be made. All are small and most are broken; certainly they are all either canids or mustelids, but because of the great variation between individual carnivores, I cannot place any specimen in one genus to the exclusion of another.

PERISSODACTYLA Owen, 1894

Miohippus Marsh, 1874

Miohippus, species

Referred specimens: SDSM 64197, lower molariform tooth, incisor, and a fragment of an upper molariform tooth, from V6229.

Discussion: These three teeth constitute the entire record of perissodactyls from the anthill collections. Clearly, these large and heavy objects were not carried onto the hills by ants; probably they rolled or were washed into the area and were picked up along with the surface material from the hills. A complete skull of *Miohippus equinanus* was collected *in situ* from the Monroe Creek Formation at V6229 in 1964 by the Los Angeles County Museum; perhaps the anthill specimens are referable to that species, although specific identification of such fragmentary material is unjustified.

ARTIODACTYLA Owen, 1848

Merycoidodontidae Thorpe, 1923

Merycoidodontidae, indeterminate

Referred specimens: SDSM 64198, 20 fragments of upper and lower teeth, from V6229.
Discussion: The only apparent value of these specimens is in establishing the presence of oredonts in the anthill fauna, as they are generically indeterminate. Several genera and species of oreodonts are common in the Monroe Creek Formation in the Wounded Knee area.

Hypertragulidae Cope, 1879

Nanotragulus Lull, 1922

Nanotragulus, species

Referred specimens: SDSM 64199, three fragments of cheek teeth, from V6229.
Discussion: These specimens are referred to *Nanotragulus* largely by inference, since *Nanotragulus ordinatus* (Matthew) is the only member of this family reported from the Monroe Creek Formation in the Wounded Knee area.

CONCLUSIONS

1. The Monroe Creek Formation in South Dakota is middle Arikareean (middle early Miocene) in age, as indicated by the mammalian fossil assemblage.

2. Harvester ant mounds in the Monroe Creek Formation have produced 37 taxa of fish, amphibians, reptiles, birds, and mammals to date.

3. Fossils recovered from the anthills are largely those of burrowing animals which could dig easily in the soft, compact sediments.

4. The numbers of specimens recovered from two small areas indicate that large colonies of animals occupied both surface and burrows over considerable periods of time.

5. Specimens of *Pseudotheridomys* in the Monroe Creek Formation represent the earliest North American occurrence of this European genus.

6. Specimens of *Geolabis* and *Eutypomys*, formerly known only from older rocks, are now known from the middle Arikareean in the Monroe Creek Formation.

7. *Metechinus, Parvericius, Scalopoides, Desmatolagus*, and *Pseudotheridomys*, all formerly known only from younger rocks, are now known from the middle Arikareean in the Monroe Creek Formation.

8. Fossil evidence of the Burdigalian migration indicates that the Burdigalian stage began in Europe about the same time as the beginning of the middle Arikareean in North America.

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