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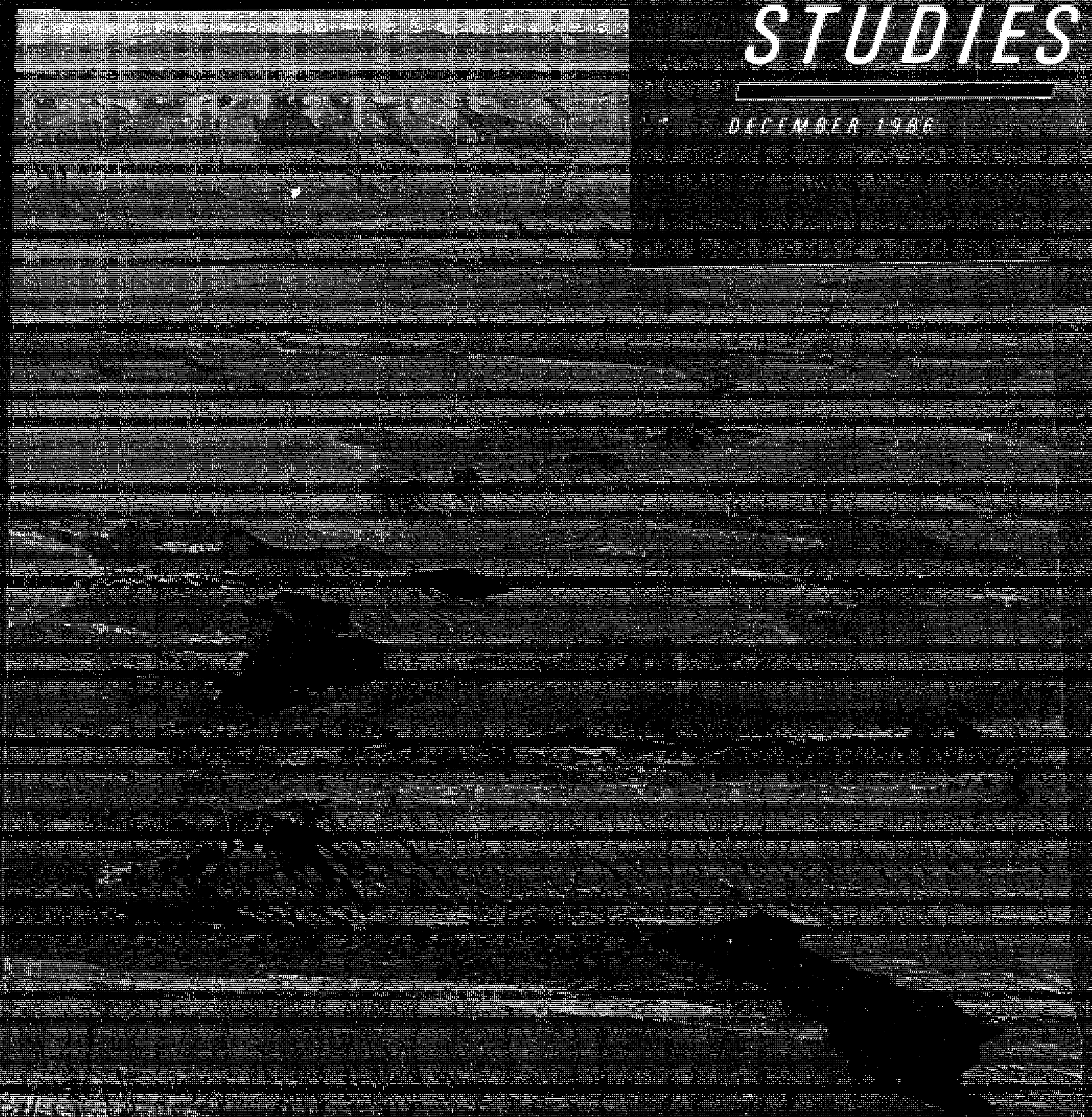

VOLUME 33, PART 1

BRIGHAM YOUNG UNIVERSITY GEOLOGY STUDIES

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Cover: Moenkopi Formation, Southern Utah

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Paleocene (Puercan-Torrejonian) Mammalian Faunas of the North Horn Formation, Central Utah*

STEVEN F. ROBISON
USDA Forest Service, Ogden, Utah 84401

Thesis chairman: WADE E. MILLER

ABSTRACT

Five new localities for Paleocene mammals have recently been found in the North Horn Formation of central Utah. Specimens collected from these new localities, plus additional specimens collected from previously known localities, have enlarged the known faunas and have enabled a more accurate biostratigraphic correlation of the North Horn Formation. A better stratigraphic framework has also been established to help correlate localities within the North Horn Formation.

Three distinct Paleocene local faunas are recognized in the North Horn Formation and are, in ascending order, the Gas Tank, Wagonroad, and Dragon. The Gas Tank local fauna was previously poorly known (Van Valen 1978), but the discovery of four new localities helps to further substantiate it. The Gas Tank local fauna is definitely Puercan (probably middle) in age based on the presence of the following condylarths: *Ectoconus ditrigonus, Periptychus coarctatus, Oxyacodon ferronensis, Oxyacodon apiculatus, Loxolophus pentacus, Conacodon,* cf. *Taeniolabis taoensis,* and *Oxyclaenus pugnax.*

The Wagonroad local fauna is also believed to be Puercan but somewhat later in age than the Gas Tank local fauna. Previously unreported taxa from the Wagonroad local fauna include: *Onychodectes* sp., *Conacodon, Ptilodus,* stylinodont gen. and sp. indet., *Loxolophus* sp., and *Protoselene.*

The Dragon local fauna is believed to be Torrejonian, probably early Torrejonian, as evidenced by these previously unreported taxa: *Myrmecoboides, Paromomys* cf. *P. depressidens,* ? *Palaechthon* sp., *Bryanictis, Chriacus truncatus, Chriacus* sp. near *C. pelvidens, Mimotricentes subtrigonus, Ellipsodon grangeri, Promioclaenus lemuroides,* and *Litaletes disjunctus.* These taxa, plus those previously reported from the Dragon local fauna (Tomida and Butler 1980), show a very strong similarity to the Torrejonian of the San Juan Basin, New Mexico. The Dragonian Land Mammal "Age," based on the Dragon local fauna, is invalid because the fauna is of early Torrejonian age.

The previously unreported reptilian (mostly chelonian and crocodilian) and molluscan faunas are also listed.

Synonyms include the following: *Anisonchus eowynae* = *Anisonchus athelas,* and *Thangorodrim thalion* = *Oxyclaenus pugnax. Chriacus truncatus, Desmatoclaenus paracreodus, Litaletes mantiensis, Oxyclaenus pugnax,* and *Oxytomodon perissum,* taxa of previously questioned validity, are all believed to be valid. *Desmatoclaenus* is retained in the Phenacodontidae.

Oxyacodon, and *Myrmecoboides* are believed to have new species from the present collections, and *Litaletes gazinensis* n. sp. and *Conacodon utahensis* n. sp. are formally named and described.

INTRODUCTION

The non-marine Cenozoic rocks of North America, especially western North America, have been largely correlated on the basis of the fossil mammals they contain. North American Provincial Land Mammal "Ages" established by the Wood Committee (Wood and others 1941) have been a very useful chronologic framework for corre-

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lating these Cenozoic rocks. The Wood Committee divided the Paleocene epoch into five "ages": the Puercan, Dragonian, Torrejonian, Tiffinian, and Clarkforkian. The Dragonian Land Mammal "Age" is based on the fauna from the North Horn Formation in Dragon Canyon, central Utah.

The validity of the Dragonian Land Mammal "Age" has been questioned by many workers (i.e., Evernden and others 1964; Rigby 1980; Sloan 1970; Tedford 1970) as few mammalian taxa are distinctly restricted to or characteristic of the Dragon, and because both Puercan and Torrejonian forms are present. Also, the Dragon local fauna is the only known one of this age.

Three distinct local faunas are present in the North Horn Formation: the Gas Tank, Wagonroad, and Dragon. The purpose of this paper is to describe the taxa, especially new forms found in the Dragon, Wagonroad, and five previously unreported localities, and their biostratigraphic correlations.

LOCATION AND ACCESSIBILITY

The study area is entirely on the Wasatch Plateau in Emery and Sanpete Counties, Utah. The town of Castledale, Utah, lies approximately 16 km from the east edge of the northern portion of the study area and Ferron, Utah, lies about seven km east of the central part of the study area (fig. 1). Access to the northern part of the area is best obtained on Utah 29 through Straight Canyon to Joe's Valley Reservoir and then south up the North Dragon Canyon forest development road. Access to the southern and central parts of the study area can best be obtained through Ferron Canyon. The study area is accessible only during the summer and early fall, and then only if the roads are relatively dry.

Each of the known and newly discovered Paleocene mammal-bearing localities from the North Horn Formation are listed in table 1.

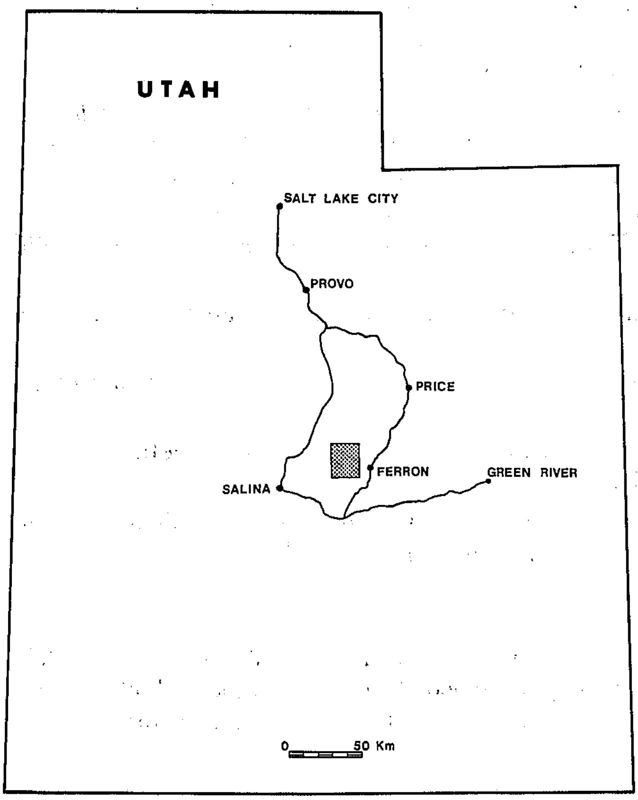


FIGURE 1.—*Index map showing the study area (stippled).*

PREVIOUS WORK

The North Horn Formation was originally described by Spieker and Reeside (1925) as the North Horn Member of the Eocene Wasatch Formation. However, in 1934 Spieker discovered dinosaur bones in the lower part of the North Horn beds, and in 1935 he discovered Paleocene mammalian remains in the upper portion at Wagon Road Ridge. Spieker (1946) raised the North Horn Member to formational rank after it had been shown, faunally, to be much older than the Wasatch Formation. The reptilian faunas of the North Horn Formation were studied by C. W. Gilmore of the Smithsonian Institution between 1937 and 1940 (Gilmore 1946). C. L. Gazin, also of the Smithsonian Institution, studied the Paleocene mammals from the upper portion of the formation at the Dragon Canyon and Wagonroad localities between 1937 and 1941 (Gazin 1941). Spieker (1960) described a new locality (Gas Tank Hill) for Paleocene mammals that produced only three identifiable specimens. Clemens (1961) described a Cretaceous mammal from the lower part of the formation and Van Valen (1978) described four new species of Paleocene mammals from the upper portion. Tomida and Butler (1980) conducted paleomagnetic investigations of Gazin's fossil mammal localities in the North Horn Formation and made some additions to the fauna. The American Museum of Natural History made limited collections of fossil mammal materials from the known localities (and at Jason Spring) in 1967 and 1970.

Numerous other workers have discussed faunal relationships and/or various taxa known from the North Horn Formation including Evernden and others (1964), MacIntyre (1966), Rigby (1980), Rose (1977), Sloan (1970), Szalay (1969), Tedford (1970), Tomida (1981), Van Houten (1948), Van Valen (1966, 1967), West (1976), Wilson (1956), and Wood and others (1941).

METHODS

Field work was started in the fall of 1977 and continued during the summer and early fall of 1978 and 1979. Additional specimens were collected in 1981–1984. Air photos

Table 1. Paleocene Mammal Localities in the North Horn Formation.

Locality Name	Location	Stratigraphic Position of the Fossil Locality (in meters) Below the North Horn–Flagstaff Contact
Dragon Canyon	Sec. 8, T. 19 S, R. 6 E	unknown
Wagonroad	Sec. 7, T. 19 S, R. 6 E	Upper Horizon 87 Lower Horizon 129
Wagon Road Ridge	Sec. 36, T. 18 S, R. 5 E	179
Gas Tank Hill	Sec. 30, T. 20 S, R. 6 E	179
*Dairy Creek	Sec. 35, T. 19½ S, R. 5 E	183
*Jason Spring	Sec. 4, T. 20 S, R. 5 E	179
*Ferron Mountain	Sec. 9, T. 20 S, R. 5 E	180
*Blue Lake	Sec. 10, T. 20 S, R. 5 E	182
*Sage Flat	Sec. 33, T. 20 S, R. 6 E	uncertain

*Previously unreported localities
The new localities are in slumped areas; consequently, the stratigraphic position is only accurate to ± 10 m.

of the area were used in an attempt to locate outcrops which might yield fossils. Success with this method was poor because the photos were not color and because they were taken in the late fall when there was no green vegetation left on the ground. Thus it was very difficult to differentiate between outcrops and fields or meadows.

The greatest success for locating outcrops was obtained by driving along all the possible roads of the area and looking for outcrops. When outcrops were discovered they were carefully inspected for fossil mammalian remains. If abundant fossils were found on the surface, sediment was taken back to the lab for screen washing (McKenna 1962). Only two identifiable specimens were found by the screen-washing method. Several areas outside the study area that expose the North Horn Formation were investigated for fossil mammals. These areas include Salina Canyon near Gooseberry Creek, Upper Joe's Valley area, Acord Lakes–Salina Creek area, Twelve Mile Canyon area, all of the Wasatch Plateau, Diamond Fork Canyon area, Price Canyon area, Spanish Fork Canyon area, and in the San Pitch Mountains west of Wales, Utah. The only mammalian specimen found in these areas was an unidentified isolated incisor from Diamond Fork Canyon.

The only mammalian specimens identified were isolated teeth or jaw fragments with teeth. The postcranial elements of early Paleocene mammals are very poorly known anywhere and very few were found in the North Horn Formation. Measurements of specimens are in millimeters and were made using a vernier caliper with 0.05 ± 0.025 mm accuracy. All measurements were made by the author using the same caliper and a binocular dissecting microscope.

The stratigraphic position of each locality (table 1) was determined by measuring the stratigraphic separation between the fossil-bearing strata and the North Horn–Flagstaff contact (described in the General Geology section). Measurements were made with a Jacob's staff and Abney hand level; altimeter readings were used as a support method for the measurements.

GEOLOGIC SETTING

The study area lies near the central portion of the Wasatch Plateau. Spieker (1946) described the general stratigraphy of the Late Cretaceous and early Tertiary sequence of mainly fluvial and lacustrine sediments deposited in central Utah. The North Horn Formation, comformably overlying the Price River Formation in the study area, consists primarily of red and variegated claystones and siltstones, buff to white channel sandstones, and minor gray limestones. Spieker divided the North Horn Formation into four units in his type section, at the southwest point of North Horn Mountain where the thickness is ≈ 500 m. This thickness is very constant throughout the study area. The Cretaceous dinosaurian remains are from the two lowermost units, Spieker's units 3 and 4 (Spieker 1946, 1960). The Paleocene mammalian remains described by Gazin (1938, 1939, 1941) are from Spieker's unit 2. Spieker's unit 1 has not produced mammalian remains. The North Horn Formation is conformably overlain by the Flagstaff Limestone, except in the western margin of the Wasatch Plateau, where the contact is unconformable (Spieker 1946). Spieker (1946, p. 136) considered the age of the Flagstaff Limestone as probably Paleocene, but Rich and Collinson (1973) described the early Eocene carnivore *Vulpavus australis* from the uppermost part of the formation, thereby indicating that part of the Flagstaff Limestone is early Eocene (Wasatchian) in age.

The Wagonroad, Dragon, and Sage Flat localities all lie on downdropped blocks of the Joe's Valley Graben. The other localities are all west of this graben.

Rocks of the North Horn Formation in the study area, unless directly disturbed by local slumping or fault drag, dip west-southwest at 2–4 degrees. The North Horn–Flagstaff contact was used as a marker horizon to determine the stratigraphic position and physical correlation of the fossil mammal localities within the North Horn Formation.

The North Horn–Flagstaff contact in the study area is gradational, changing from a sandstone-shale sequence below to a limestone-shale sequence. Accompanying this change is a key marker horizon, here used as the North Horn–Flagstaff contact. A color change occurs at this horizon; the rocks below have a reddish color, those above are gray. A change in slope and vegetation also occurs at this level; slopes are more gentle and have distinctly more vegetation below this horizon than above. A close inspection of this horizon on the south side of Ferron Mountain shows a 0.7 m thick sandstone unit at the top of the lower red unit overlain by a 1.0 m thick gray shale unit which is overlain by a 0.9 m thick gray limestone unit. Sandstones are rare above this horizon while limestones are rare below it. It was at this transition of sandstone-shale to limestone-shale that Spieker (1946) placed the contact. This distinct color-change horizon merely refines the contact in the study area. This color-change horizon is present in the type section and throughout the entire study area.

Gazin (1941) used a massive sandstone unit (10 m thick) present in the type section as roughly the Cretaceous-Tertiary boundary. This unit is quite close to the boundary in the northern part of the tract and would have been used as a reference horizon throughout the tract, but it thins out to the south and is not present in the Ferron Mountain area (southern portion of the study area).

The fossil mammal-bearing localities, characterized by variegated red, purple, light and dark gray clay shales with minor tan sandstones and siltstones, are lithologically similar. These colored shale units are generally 0.5–3.0 m thick and somewhat discontinuous. The sandstone units are lenticular, fine to medium grained, tan, cross-bedded, bioturbated, and generally 1–3 m thick, indicating channel sandstones. The most fossiliferous units are commonly dark gray carbonaceous shales.

The beds, especially the sandstones, thin and thicken and are generally quite discontinuous. Lithologic correlation of the fossil-bearing strata could not be recognized from one locality to another.

The paleoenvironment of the fossil mammal-bearing strata is somewhat difficult to determine. The fossil mammals present in the North Horn Formation are poor paleoenvironmental indicators because they are all extinct. Their habitats and living conditions can only be hypothesized. The absence of identifiable plant megafossils greatly hinders the accurate determination of the probable paleoenvironment. The best environmental indicators present are the crocodilians, chelonians, and fish. Paleocene gar pike, crocodiles, and turtles probably needed similar environmental conditions and habitats as their living counterparts. Modern forms live in warm temperate to subtropical environments. The presence of small coal seams in the North Horn Formation tends to support the idea that the early Paleocene climate in central Utah was warm temperate to subtropical.

BIOSTRATIGRAPHY AND CORRELATION

GENERAL STATEMENT

There are three distinct Paleocene mammalian local faunas present in the North Horn Formation. It was previously reported that only two were present (Robison and Lucas 1980), but this was based on a misunderstanding regarding the locality from which several of the American Museum of Natural History specimens were collected, and on preliminary data. The belief that three horizons or local faunas are present agrees with the opinions expressed by D. E. Russell (1967), Van Valen and Sloan (1966), and Van Valen (1978).

Precise stratigraphic position of the new localities was sometimes difficult to obtain because continuous exposures of the North Horn–Flagstaff contact were covered and because some minor local slumping was observed in these localities. The stratigraphic position of the Dairy Creek, Jason Spring, Ferron Mountain, and Blue Lake localities is therefore only accurate to within about 10 meters. The stratigraphic position of the Sage Flat locality is unknown.

As can be seen from table 1, except for the Dragon Canyon locality, three stratigraphic units are present at about 180, 130, and 85 meters below the North Horn–Flagstaff contact. These three units or local faunas, in ascending order, have been reported as Gas Tank (Van Valen and Sloan 1966 and Van Valen 1978), Wagonroad (Gazin 1941; D. E. Russell 1967; Sloan 1970; Tomida and Butler 1980; Van Valen 1978; and others) and Dragon or Dragonian (Gazin 1941; D. E. Russell 1967; Van Valen and Sloan 1966; Wood and others 1941; and many others). D. E. Russell (1967) and Spieker (1960) referred to the Gas Tank Hill locality as the Flagstaff Peak locality. It will here be referred to as Gas Tank because it has been more widely and more recently used that way, plus the fact that the locality is at Gas Tank Hill.

A problem exists concerning the stratigraphic position of the Dragon Canyon locality, the type section for the "Dragonian" Land Mammal Age. Faults have apparently separated the beds containing the fossil mammals from their original stratigraphic position. The North Horn-Flagstaff contact has been eroded away all around the locality except to the north. Here the contact is 149 m above the locality (across a fault). Were this section in place, it would be stratigraphically lower, thus older, than the Wagonroad local fauna located less than one mile to the west. However, faunal relationships indicate that the Wagonroad local fauna is the older of the two (Gazin 1941; D. E. Russell 1967; Sloan 1970; Tomida and Butler 1980; etc.). This stratigraphic attenuation is further pointed out by data from other localities. The upper fossil level at the Wagonroad locality, correlated faunally with the Dragon Canyon locality by Gazin (1941), is only 87 m below the North Horn–Flagstaff contact. The stratigraphic position of the Dragon Canyon locality can only be inferred by comparison with the limited taxa and stratigraphic position of the Wagonroad (upper level) locality. Taxa described in this report from the Gas Tank, Wagonroad, and Dragon local faunas are shown in tables 2 to 4, respectively.

The invertebrates listed in this paper, especially when identified only to the generic level, do not have the biostratigraphic precision or usefulness that the fossil mammals collected have. They will not be discussed in a biostratigraphic framework, but are included to make the faunal lists more complete.

The fossil reptiles listed in this report do not have the biostratigraphic precision that the fossil mammals have but are, however, useful paleoecological indicators. The crocodilian and chelonian faunas are essentially identical to those of the San Juan Basin Paleocene (Hutchison personal communication 1980) and further support the tentative correlation of the San Juan Basin and North Horn faunas. The genus *Hoplochelys*, common in the Nacimiento Formation of New Mexico and the North Horn Formation of Utah, is unknown in Paleocene localities north of the Uinta Mountains of northern Utah.

Table 2. Mammalian taxa described in this report from the Gas Tank local fauna. An asterisk (*) before a taxon indicates a new record. DC = Dairy Creek locality, B = Blue Lake locality, G = Gas Tank Hill locality, J = Jason Spring locality, F = Ferron Mountain locality.

Taxa GAS TANK FAUNA	Locality
Mammalia	
Multituberculata	
Taeniolabidae	
*cf. *Taeniolabis taoensis*	F
Ptilodontidae	
**Ptilodus* cf. *P. tsosiensis*	DC
*?Insectivora Gen. et sp. indet.	J
Condylarthra	
Periptychidae	
Ectoconus ditrigonus	DC, F
**Ectoconus symbolus*	B, DC, F, J
Ectoconus sp.	J
**Periptychus coarctatus*	B, DC
**Periptychus hamaxitus*	B, DC, F, J
Anisonchus athelas	DC, F
**Anisonchus onostus*	DC
Anisonchus cf. *A. oligistus*	F
Haploconus elachistus	DC
**Conacodon utahensis*, n. sp.	G
Haploconus sp.	DC
**Oxyacodon ferronensis*	B, F
**Oxyacodon apiculatus*	B, DC
**Oxyacodon O.* n. sp.	B
Phenacodontidae	
**Desmatoclaenus paracreodus*	B, F
Arctocyonidae	
**Loxolophus pentacus*	F, B
**Loxolophus* cf. *L. spiekeri*	DC
**Oxyclaenus pugnax*	B, DC
Hyopsodontidae	
**Promioclaenus acolytus*	F
**Promioclaenus wilsoni*	F
Promioclaenus sp.	B
**Litaletes gazinensis* n. sp.	DC

GAS TANK LOCAL FAUNA

The previouly reported Gas Tank local fauna is small and includes the following condylarths: *Desmatoclaenus* sp., *Ectoconus* cf. *E.* "*majusculus*" (now *Ectoconus ditrigonus*, Van Valen 1978), *Loxolophus* sp., and *Anisonchus athelas* (D. E. Russell 1967; Spieker 1960; Van Valen 1978). Van Valen and Sloan (1966) considered the Gas Tank local fauna to be early middle Puercan, presumably because of the presence of *Ectoconus ditrigonus*. The fauna from the Wagon Road Ridge locality, stratigraphically equivalent to the Gas Tank Hill locality, is poorly known. However, Gazin (1941) reported the presence of an oxyclaenid near *Oxyclaenus simplex* and a form near *Eoconodon* from this locality. The discovery of four new mammalian localities that are Gas Tank equivalents, based on stratigraphic position and faunal similarity, has greatly increased the number of known taxa from this local fauna. The taxa new to the local fauna reported in this paper strongly support the assignment of the Gas Tank local fauna to the Puercan. Taxa known only from the Puercan Age found in the new localities include the following condylarths: *Periptychus coarctatus*, *Oxya-*

Table 3. Mammalian Taxa described in this report from the Wagonroad local fauna. An asterisk (*) before a taxon indicates a new record. All specimens are from Gazin's Wagonroad locality (Gazin 1941).

Taxa	WAGONROAD FAUNA
Mammalia	
Taeniodonta	
Stylinodontidae	
**Onychodectes* cf. *O. tisonensis*	
*Gen. and sp. indet.	
Condylarthra	
Periptychidae	
Periptychus hamaxitus	
**Conacodon utahensis*, n. sp.	
**Anisonchus athelas*	
Haploconus sp.	
Phenacodontidae	
Desmatoclaenus paracreodus	
**Desmatoclaenus hermaeus*	
Arctocyonidae	
**Loxolophus* sp.	

Table 4. Mammalian taxa described in this report from the Dragon local fauna. An asterisk (*) before a taxon indicates a new record. D = Dragon Canyon locality, S = Sage Flat locality (probably does not represent the Dragon local fauna—unknown).

Taxa	DRAGON FAUNA	Locality
Mammalia		
Multituberculata		
Taeniolabidae		
Catopsalis utahensis		D
Ptilodontidae		
?*Ptilodus* sp.		D
Gen. and sp. indet.		D
Neoplagiaulacidae		
**Neoplagiaulax macintyrei*		D
Insectivora		
Pentacodontidae		
Aphronorus sp.		D
Leptictidae		
**Myrmecoboides* n. sp.		D
Taeniodonta		
Stylinodontidae		
Gen. and sp. indet		D
Primates		
Paromomyidae		
**Paromomys* cf. *P. depressidens*		D
?*Palaechthon* sp.		D
Carnivora		
Miacidae		
Protictis haydenianus		D
**Bryanictis* sp.		D
Condylarthra		
Periptychidae		
**Periptychus* cf. *P. hamaxitus*		S
Periptychus cf. *P. gilmorei*		D
Anisonchus dracus		D
Anisonchus cf. *A. oligistus*		D, S
Anisonchus sp.		S
Phenacodontidae		
Desmatoclaenus sp.		S, ?D
Arctocyonidae		
**Loxolophus pentacus*		S
**Chriacus truncatus*		D
Chriacus sp.		D, S
**Mimotricentes subtrigonus*		D, S
Mimotricentes sp.		D, S
Hyopsodontidae		
Oxytomodon perissum		D
**Promioclaenus lemuroides*		D
Promioclaenus shepherdi		D
Promioclaenus sp.		D
**Ellipsodon grangeri*		D
Protoselene griphus		D
**Litaletes disjunctus*		D

codon ferronensis, *Oxyacodon apiculatus*, *Loxolophus pentacus*, cf. *Taeniolabis taoensis*, *Conacodon*, and *Oxyclaenus pugnax* (Matthew 1937; Sloan 1970; and Van Valen 1978). All these taxa, with the possible exception of *Oxyclaenus pugnax*, are well known from the Puercan portion of the Nacimiento Formation in the San Juan Basin. Van Valen (1978) reported *Oxyacodon apiculatus* and *Loxolophus pentacus* as being restricted to the Taeniolabis "zone" (upper faunal "zone" of the Puercan) and *Oxyacodon agapetillus* (including *Oxyacodon priscilla*) to the *Hemithlaeus* (*Ectoconus*) or lower faunal "zone" of the Puercan. *Loxolophus pentacus* and *Oxyacodon ferronensis* have been found together at the Ferron Mountain locality of the North Horn Formation.

Several of the taxa found in the new localities represent an early occurrence for that taxon. Included in this group are *Ptilodus*, *Ectoconus symbolus*, *Periptychus hamaxitus*, *Anisonchus onostus*, *Haploconus elachistus*, *Desmatoclaenus paracreodus*, *Loxolophus* cf. *L. spiekeri*, *Promioclaenus* cf. *acolytus* (typically Torrejonian), and *Litaletes* sp.. Most of these forms are known, however, from the Late Puercan Wagonroad local fauna (see below).

The presence of taxa restricted to early Puercan strongly suggests correlation of the Gas Tank local fauna with the Puerco fauna of the San Juan Basin. Tomida and Butler (1980) did not make paleomagnetic investigations of the strata containing the Gas Tank fauna; they apparently incorrectly assumed it was equivalent with the Wagonroad local fauna.

Other formations which have yielded Puercan mammalian faunas include the lower part of the Nacimiento Formation of New Mexico, the upper part of the Denver Formation of Colorado, the Polecat Bench Formation of Wyoming, the Tullock Formation of Montana, and the Ravenscrag Formation of Saskatchewan (Russell 1975).

WAGONROAD LOCAL FAUNA

Although I visited Gazin's (1941) Wagonroad locality on four different occasions, I was able to find only a few identifiable mammalian specimen. Nearly all the additions to the Wagonroad local fauna in this report are from specimens loaned to Brigham Young University by the American Museum of Natural History. These specimens were collected from the Wagonroad locality by Dr. M. C. McKenna and others in 1967 and 1970.

The Wagonroad locality, situated stratigraphically between the Gas Tank and Dragon levels, has been shown by many workers to represent a late Puercan fauna (e.g., Gazin 1941; D. E. Russell 1967; Sloan 1970; Tomida 1981; Tomida and Butler 1980; Van Valen 1978; Van Valen and Sloan 1966; and others). Information acquired in the present study strengthens their conclusions. The Puercan age for this fauna comes from the previously reported presence of such taxa as *Taeniolabis, Oxyclaenus, Periptychus* (*Carsioptychus*), *Ectoconus* (Gazin 1941), *Loxolophus* (D. E. Russell 1967), and *Oxyacodon* (Van Valen 1978). The presence of *Loxolophus*, *Anisonchus athelas, Conacodon utahensis* (n. sp.), and especially *Onychodectes* (restricted to the Puercan, Matthew 1937) from the Wagonroad local fauna reported in this paper, greatly strengthens the age assignment of this local fauna to the Puercan. The presence of *Desmatoclaenus paracreodus* and *Conacodon utahensis* (n. sp.), in both the Gas Tank and Wagonroad local faunas further tends to support the view that the latter is Puercan.

The stylinodont described in this paper from the Wagonroad local fauna is intermediate in development between the Puercan *Wortmania* and the Torrejonian *Psittacotherium*, indicating a late Puercan or early Torrejonian age. The presence of *Goniacodon, Haplaletes* (Van Valen 1978), and *Haploconus* (Gazin 1941), all typically Torrejonian forms, further indicates the late Puercan nature of the fauna. I agree with the opinion of the above-named authors concerning the late Puercan age of the Wagonroad local fauna, a view that is strengthened by the additions to the fauna described in this paper. The Wagonroad local fauna probably best correlates with the late Puercan Purgatory Hill local fauna of Montana, as indicated by the presence in both faunas of *Oxyacodon marshater, Haplaletes andakupensis*, and *Anisonchus oligistus* reported by Van Valen and Sloan (1965) and Van Valen (1978).

DRAGON LOCAL FAUNA

The age and correlation of the Dragon local fauna or Dragonian Land Mammal "Age" have been discussed extensively by many workers including Evernden and others (1964), Gazin (1941), Rigby (1980), Rose (1977), Schoch and Lucas (1981a and 1981b), Sloan (1970), Szalay (1969), Tedford (1970), Tomida (1981), Tomida (1982), Tomida and Butler (1980), Van Houten (1948), Van Valen and Sloan (1966), Wilson (1956), Wood and others (1941), etc. It is the general consensus of these authors that the Dragon local fauna is actually early Torrejonian. Most also consider the Dragonian Land Mammal "Age" to be invalid.

Taxa that are new to the Dragon local fauna (this report) include *Neoplagianlax macintyrei* (multituberculate), *Myrmecoboides* (insectivore); *Paromomys* cf. *P. depressidens* and ? *Palaechthon* sp. (primates); the carnivore, *Bryanictis*; and the condylarths, *Chriacus truncatus, Chriacus* sp. (near *C. pelvidens*), *Mimotricentes subtrigonus, Promioclaenus lemuroides, Ellipsodon grangeri*, and *Litaletes disjunctus*. All these taxa are typically Torrejonian with *Promioclaenus lemuroides, Chriacus truncatus, Paromomys depressidens, Palaechthon*, and *Litaletes disjunctus* being restricted to the Torrejonian (Conroy 1981; Krause 1978; Novacek 1977; Rigby 1980; Simpson 1959; Taylor 1981; Tsentas 1981; and Wilson 1951).

Recent paleontological investigations in the Dragon Canyon locality of the North Horn Formation have produced more and more Torrejonian forms (Tomida and Butler 1980, Tomida, 1982). Although *Loxolophus* and *Oxyclaenus*, typically Puercan forms, are present in the Dragon local fauna (Tomida 1981), the vast majority of the forms present are Torrejonian. The fauna is, in my opinion, definitely Torrejonian, probably early Torrejonian as indicated by the presence of typically Puercan forms and by the often more primitive character of some of the Torrejonian forms (Gazin 1941).

SYSTEMATIC PALEONTOLOGY

GENERAL STATEMENT

Only poorly preserved plant remains were found during this study. Among those found were some partly carbonized, partly petrified pieces of woody material that probably represent some type of conifer (Tidwell personal communication 1979). Small twiglike structures were plentiful in some of the localities, but the ones sectioned had been completely replaced, thus destroying the internal woody structure. Charophytes, most similar to illustrations of *Chara* or *Aclistochara* (Cross 1976), were encountered at the Dairy Creek locality. Several different types of pollen grains and fungal spores were collected

Table 5. Identified invertebrate, fish, and reptilian remains from the Tertiary portion of the North Horn Formation of central Utah. Locality abbreviations used are: B = Blue Lake, D = Dragon Canyon, DC = Dairy Creek, F = Ferron Mountain, G = Gas Tank Hill, J = Jason Spring, S = Sage Flat, W = Wagonroad.

Taxa	Locality
Phylum Mollusca	
Class Gastropoda	
Order Ctenobranchiata	
Family Viviparidae	
Viviparus sp.	J
cf. *Lioplacoides*	DC, J
Family Amnicolidae	
cf. *Hydrobia*	G
Order Pulmonata	
Family Physidae	
Physa sp.	J, S
Class Bivalvia	
Order Eulamellibranchia	
Family Uniodidae	
Plesielliptio sp.	G, J
Phylum Chordata	
Subphylum Vertebrata	
Class Osteichthyes	
Order Semionotiformes	
Family Lepisosteidae	
cf. *Lepisosteus* (scales)	B, D, DC, F, G, J, S, W
(teeth)	DC, J
Class Reptilia	
Order Chelonia	
Family Trionychidae	
Trionyx sp.	B, D, DC, F, J, S
?*Plastomenus*	J
Family Baenidae	
Compsemys victa	B, D, DC, F, G, J, S, W
Family Dermatemyidae	
Hoplochelys sp.	D, DC, F, J, W
Order Squamata	
Family Anguidae	
cf. *Proxestops jepsensi*	B, D
gen. and sp. indet	D
Order Eosuchia	
Family Champsosauridae	
Champsosaurus sp.	DC, W
Order Crocodilia	
cf. *Allognathosuchus*	B, D, DC, F, G, J, W
cf. *Leidyosuchus*	B, D, DC, F, G, S, W

from a small coal seam at the Gas Tank Hill locality; tentative identifications (Robison, unpublished report, 1979) indicate an age very near the Cretaceous-Tertiary boundary. The coal seam is about seven meters stratigraphically lower than the horizon where the fossil mammals were found.

Invertebrate, fish, and reptilian fossils were present in all localities from which fossil mammal remains were found, but were not extensively collected. The specimens collected were generally identified only to the generic level (table 5) and were included in this report to make the faunal lists more complete.

J. H. Hutchison (personal communication 1979) identified the turtle materials included in this report, and R. M. Sullivan (personal communication 1984) provided advice and identifications for the lizard material.

When the term length or a form of the word is used in describing a mammalian tooth, trigonid or talonid, the anteroposterior dimension is being implied. If the term width or a form of width is used, it should be understood to represent the transverse dimension.

Size comparisons are made with casts of comparative material listed for each taxa or from published information.

Tooth morphological nomenclature follows that of Szalay (1969).

Locality designations are those discussed in the Location and Accessibility section of this paper.

ABBREVIATIONS USED

AMNH = American Museum of Natural History, New York, N.Y.

BYU = Brigham Young University, Provo, Ut.

KU = University of Kansas Museum of Natural History

PU = Princeton University, Princeton, N.J.

UALP = University of Arizona Laboratory of Paleontology, Tucson, Ariz.

UCM = University of Colorado Museum, Boulder, Colo.

UCMP = University of California Museum of Paleontology, Berkeley, Calif.

UM = University of Minnesota, Minneapolis, Minn.

UNM = University of New Mexico, Albuquerque, N. Mex.

USNM = U.S. National Museum (Smithsonian), Washington, D.C.

UW = University of Wyoming, Laramie, Wyo.

L = greatest tooth diameter parallel to the tooth row (anteroposterior)

W = greatest tooth diameter perpendicular to the tooth row (transverse)

AW = greatest anterior or trigonid width

PW = greatest posterior or talonid width

H = greatest height

D = diameter at base of enamel

Measurements in parenthesis are approximate.

Class Mammalia
Order Multituberculata
Family Taeniolabidae
Genus *Taeniolabis* Cope, 1882
cf. *Taeniolabis taoensis* (Cope, 1882)

Locality and Material. Ferron Mountain: BYU 3823, incisor fragment.

Description. BYU 3823 is a damaged, very large incisor with the enamel restricted to the labial surface.

Discussion. BYU 3823 is much larger than the incisors in the BYU collection referred to *Catopsalis* and material referred to *C. utahensis* by Sloan (1981, p. 155), but is slightly smaller than the incisor of *Taeniolabis taoensis* (AMNH 16307 and AMNH 3080) from New Mexico. The present specimen lacks the vertical grooves seen on compared specimens of *T. taoensis*, but that may be a product of weathering. BYU 3823 is questionably referred to *T. taoensis* based mainly on size.

Size. BYU 3823: incisor fragment (measurements taken at the base of the enamel) H = 9.80, W = 7.3.

Genus *Catopsalis* Cope, 1882
Catopsalis utahensis Gazin, 1939
plate 1, figs. 1–2

Locality and Material. Dragon Canyon: BYU 3740, complete right M^2; AMNH 36020, anterior half, left M_1; BYU 4471, right M^2; BYU 4470, right lower incisor; BYU 9988, ?upper left incisor; BYU 9989, ?lower incisor.

Description. BYU 3740 and BYU 4470 are wedge shaped in occlusal view, being widest anteriorly and rounded posteriorly. Two main cusp rows are present with four subequal transversely elongate lingual cusps and a labial row with three cusps (two large and one small). At the anterior edge of the teeth a small labial cusp is present (labial to the labial cusp row). The major cusp rows are separated by a deep medial groove while individual cusps are separated by shallower but distinct grooves. The two large posterior labial cusps both possess "buds," possibly representing a "third" cusp row. Wear is minor on these specimens. AMNH 36020 (M_1) has two cusp rows, one lingual and one labial. Three subequal cusps are present in each row; the anterior cusp of each row is broken. The cusps are slightly posteriorly directed. AMNH 36020 shows very little wear. The incisors, all worn, have enamel only on the labial and somewhat on the medial surfaces. BYU 9988 displays the base of the enamel, which had erupted from the tooth alveolus, indicating an older individual. All of the incisors have slightly rugose enamel with growth lines present.

Discussion. The holotypes of *Catopsalis utahensis*, *C. foliatus*, *C. calgariensis*, *C. alexanderi*, and *C. fissidens* are all lower molars. However, Middleton (1982) describes and illustrates the upper dentition of several species of *Catopsalis*. UCM 34568, *Catopsalis alexanderi* from the Denver Formation of Colorado, is a maxillary fragment containing $M^{1\text{-}2}$. The M^2 of UCM 34568 is morphologically identical to BYU 3740 and BYU 4471 (except size) in having the same cusp rows, cusp counts, structure, and shape.

Taeniolabis taoensis (casts of AMNH 16321 and UCMP 74979) of the New Mexico Puercan is morphically very similar to BYU 3740 in construction of M^2, except it possesses an anterior row of small cuspules not seen in the BYU material. *Taeniolabis taoensis* is also about 50% larger than BYU 3740, too large to be the same species.

BYU 3740 and BYU 4471 are referred to *C. utahensis* because of their similarity to UCM 34568 in structure and because their size is in the expected size range for *C. utahensis* as described by Middleton (1982).

AMNH 36020 is much too small to represent *Taeniolabis*. It is about 10% narrower than the type of *C. utahensis*, 25%–30% wider than *C. foliatus* (figured type specimen), is about the same size as the type of *C. fissidens*, and is much larger than *Catopsalis alexanderi* of Colorado (UCM 34979). The broken nature of AMNH 36020 and its similarity in size and characters to more than one species of *Catopsalis* makes specific identification tentative. BYU 9989 is essentially identical to USNM 23273 (a lower incisor referred to *C. utahensis* from New Mexico described by Sloan [1981]). BYU 9988 is a little smaller than the other incisors, but this is at least partially due to weathering. BYU 4470, a lower right incisor is the size expected for *C. utahensis*, *C. fissidens*, or *C. foliatus* (Middleton personal communication, Dec. 1983). These incisors are tentatively referred to *C. utahensis* because except for USNM 23273, incisors have not been described for *C. utahensis*, *C. fissidens*, or *C. foliatus*.

Size. BYU 3740: M^2, L = 8.60, W = 7.90. BYU 4471: M^2, L = (8.9), W = (8.5). BYU 9988: ?upper incisor, H = 6.7, W = 4.6. BYU 9989: ?lower incisor, H = 7.85, W = 5.25. AMNH 36020: M_1, W = 5.90 (anterior half).

Family Ptilodontidae
Genus *Ptilodus* Cope, 1881
Ptilodus cf. *P. tsosiensis* Sloan, 1981
plate 1, fig. 3

Locality and Material. Dairy Creek: BYU 3772, weathered and slightly damaged left M_b.

Description. BYU 3772 is an isolated lower blade with the lingual enamel mostly broken and weathered off. Twelve serrations are discernible on the tooth with the posterior four being small. When viewed in occlusal view, the tooth has a slight sinusoidal appearance. The crest and roots of the tooth are damaged.

Discussion. In arch of the tooth crest, basal notch, size, and the kind of serrations present, BYU 3772 is very similar to *Ptilodus tsosiensis* of New Mexico. AMNH 58464 (*P. tsosiensis*) is the same size as BYU 3772 and has the same serration count, but may have a slightly lower profile. Sloan (1981, p. 150) states that *P. tsosiensis* is the oldest known species, and is probably ancestral to *P. ferronensis* from Utah. BYU 3722 most likely represents *P. tsosiensis*, but its damaged character makes specific determination uncertain. Serration counts on the lower blades of *Ptilodus* are not absolutely valid specific characteristics (Rigby 1980). BYU 3772 is much larger than M_b in *P. fractus* of Wyoming, about the size of *P. trovessartinnus* (cast of holotype) from New Mexico, and is narrower and shorter than the smallest of a 54 specimen sample of *P. mediaevus* with M_b from the Swain Quarry of Wyoming (Rigby 1980). *P. ferronensis* is believed by Rigby (1980) to be a junior synonym of *P. mediavus*. *Xanclomys*, *Ectypodus*, and *Neoplagiaulax* are differently shaped and much smaller than the present specimen. *Eucosmoden molestus* (type specimen) is much larger than BYU 3772.

Size. BYU 3772: M_b, L = 6.75, W = 2.10. Height of the first serration cannot be determined from this specimen.

Ptilodus sp.

Locality and Material. Dragon Canyon: AMNH 36021, anterior portion of right M^1.

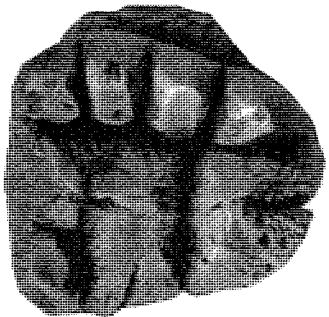
Description. AMNH 36021 is an unworn molar fragment with two cusp rows. The lingual row consists of four sharp cusps joined nearly to their apices. The sides of the tooth are vertical, the cusps are small, labially directed, and increase in height posteriorly. The labial cusp row is only half as tall as corresponding cusps of the lingual row. The cusp rows are well separated by a deep median groove.

Discussion. AMNH 36021 is very close in size to *P. mediaevus* (cast of AMNH 3033 from New Mexico) but the cusps are more differentiated. This tooth is much too small for taeniolabids and too large for most other ptilodontids. AMNH 36021, though broken, has a morphology similar to *Ptilodus*, and is about the same size. It is, therefore, referred to *Ptilodus*.

Size. AMNH 36021: M^1, W = 1.95 (measured at widest part present).

EXPLANATION OF PLATE 1

Figs. 1–2—*Catopsalis utahensis:* 1, occlusal view of right M^2, Dragon Canyon, X5 (BYU 3740); 2, same in lateral view. Fig. 3—*Ptilodus* cf. *P. tsosiensis*, lateral view of left P_4, Dairy Creek, X7 (BYU 3772). Figs. 4–5—*Myrmecoboides* n. sp. (unnamed): 4, occlusal view of left M_1, Dragon Canyon, X10 (AMNH 36042); 5, same, lateral view. Figs. 6–7—? Insectivora: 6, occlusal view of right jaw fragment with ?$M_{1\text{-}3}$ or ?$P_{2\text{-}4}$, Jason Spring, X5 (BYU 3815); 7, same in lateral view. Figs. 8–11—*Onychodectes* cf. *O. tisonensis*: 8, occlusal view of left P^4, Wagonroad, X5 (AMNH 36071); 9, same in lateral view; 10, occlusal view of right M^1, Wagonroad, X4 (AMNH 36070); 11, same in lateral view.



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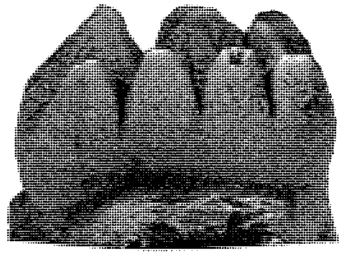

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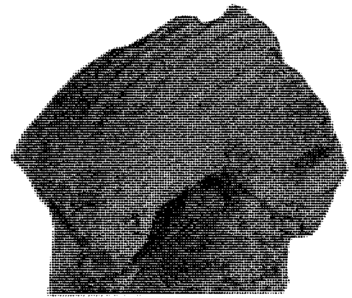

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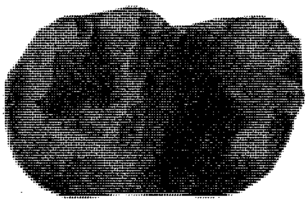

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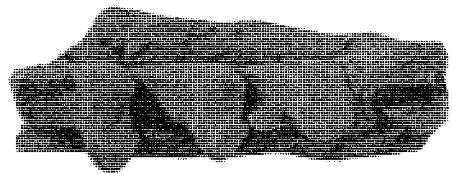

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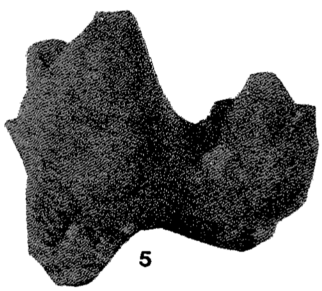

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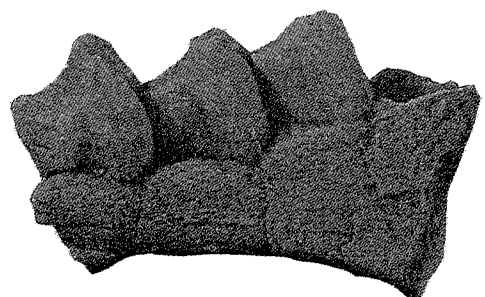

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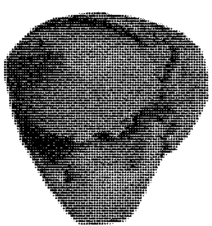

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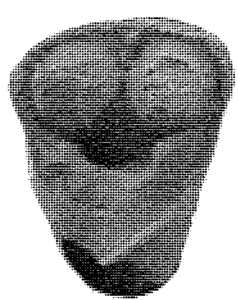

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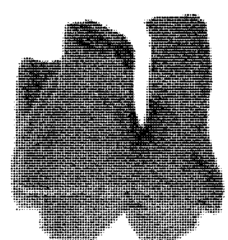


11

Family Neoplagiaulacidae
Genus *Neoplagiaulax* Lemoine, 1882
Neoplagiaulax macintyrei Sloan, 1981

Locality and Material. Dragon Canyon: BYU 9991, left M_b.

Description. This unworn, unweathered specimen has 11 serrations and is not highly arched. The posterior crest of the tooth is nearly flat. The last serration is connected to the postero-external "swelling" by a ridge, forming a small shelf.

Discussion. BYU 9991 is inseparable from AMNH 100963, the holotype of *N. macintyrei* from New Mexico. The relative height of the first serration (height of first serration divided by the tooth length) of BYU 9991 is .40; that of *N. macintyrei* is .39, while *Mesodma* has a relative height of .33. BYU 9991 is similar to *N.* cf *N. hunteri* (AMNH 100963) from Wyoming, but is not so highly arched and has fewer serrations. *Zanclomys mcgrewi* (AMNH 87860) from Wyoming is differently shaped, and not congeneric with BYU 9991.

Size. BYU 9991: left M_b, L = 3.75, H (of first serration) = 1.50, relative height of first serration = .40.

Suborder Ptilodontoidea (Simpson, 1927)
gen. and sp. indet.

Locality and Material. Dragon Canyon: AMNH 36027, M_b anterior portion.

Description. Parts of three serrations are present. AMNH 36027 is the anterior half of a very small ptilodontoid blade with parts of eight serrations visible.

Discussion. AMNH 36027 is much too small for *Ptilodus* and represents some small ptilodontoid. It does compare favorably in size to *Parectypodus* (Tomida and Butler 1981) from the North Horn Formation. The present specimen is too fragmentary to allow useful measurements.

Order Insectivora
Family Pentacodontidae
Genus *Aphronorus* Simpson, 1935
Aphronorus sp.

Locality and Material. Dragon Canyon: AMNH 36053, left M^1, with a broken parastyle.

Description. Same as described for the genus by Simpson (1935, p. 230).

Discussion. Simpson (1937) proposed Pentacodontinae as a subfamily of the family Pantolestidae. Van Valen (1967) raised Pentacodontinae to family level. *Coriphagus* and *Pentacodon* are the only early–middle Paleocene pentacodonts known.

The trigon, hypocone, precingulum, and general shape of AMNH 36053 is nearly identical to that seen in *Aphronorus fraudator* from Wyoming. *Pentacodon*, a closely related genus, is two to three times larger than AMNH 36053. *Coriphagus* has M^1 much longer anteroposteriorly yet narrower transversely than *Aphronorus.* The teeth are quite different looking in the two genera.

The only real differences between AMNH 36053 and *A. fraudator* are that in AMNH 36053 the metacone and paracone are relatively wider spaced, the metacone is posteriorly directed, and AMNH 36053 is slightly larger. *A. simpsoni*, from the North Horn Formation, is very similar to *A. fraudator* but is known only from lower teeth and upper premolars (Gazin 1941). Direct comparison with *A. simpsoni* is therefore not possible with the present specimen. The similarity between *A. fraudator* and *A. simpsoni* makes specific referral of AMNH 36053 unwise.

Size. AMNH 36053: M^1, L = 3.05, W = 4.10.

Family Leptictidae
Genus *Myrmecoboides* Gidley, 1915
Myrmecoboides n. sp. (unnamed)
plate 1, figs. 4–5

Locality and Material. Dragon Canyon: AMNH 36042, left M_1.

Description. The same as for *Myrmecoboides montanensis* except that AMNH 36042 is larger, has a small precingulid and the talonid is much lower on the lingual side.

Discussion. AMNH 36042 is almost identical to the description and illustrations of the type specimen of *Myrmecoboides montanensis* (USNM 8037 from Montana) given by Simpson (1937) and redescribed by Novacek (1977), except in size. The Dragon Canyon specimen is 67% longer anteroposteriorly and 60% wider transversely. AMNH 36042 is also 45% longer and 50%–60% wider than the largest of four M_1s of *M. montanesis* reported by Rigby (1980). *M. montanensis* is the only known species of the genus. The type specimen and four M_1s reported by Rigby (1980) are the only specimens of lower molars reported for the species, illustrating its rarity.

Matthew (1937) stated that *Myrmecoboides* shows close affinities with the other closely related leptictid genera; to this I agree because of the morphological similarity with the other compared leptictids.

Prodiacodon, the other closely related early Paleocene genus, is much smaller than the present specimen. *Diacodon*, another related genus, is also much smaller and has a greatly reduced paraconid, thus differing from AMNH 36042.

The great size difference between the present specimen and known specimens of *Myrmecoboides montanensis* with lower molars makes assignment to *M. montanensis* very unlikely; however, the great morphologic similarity of AMNH 36042 to *M. montanensis* warrants assignment to that genus. A formal designation for a new species is not made because of the extremely small sample size.

Size. AMNH 36042: M_1, L = 4.00, AW = 2.40, PW = 2.30.

Order Insectivora Gray, 1827
Inserta sedis
plate 1, figs. 6–7

Locality and Material. Jason Spring: BYU 3815, lower jaw fragment with right $?M_{1-3}$ or P_{2-4}.

Description. BYU 3815 has three teeth preserved with the alveolus for a fourth anterior tooth. Morphologically the teeth are nearly identical but increase in size posteriorly. The teeth are molariform. The posterior tooth (M_3 or P_4) is least worn and best shows tooth morphology in the series. The following description will be based on M_3 (P_4) unless otherwise noted. The tooth has a transverse blade-like trigonid. The paraconid is completely lacking. The protoconid is elongate transversely, labially projecting, posteriorly directed, shorter than the metaconid, and connected to the metaconid by a high ridge or lophid. The protoconid-metaconid ridge is as high as the protoconid but lower than the triangular-shaped metaconid. As shown by the anterior teeth, the metaconid is readily worn down and soon becomes lower than the protoconid. A small precingulid is present on the metaconid base. The trigonid is 50% wider transversely than the talonid but less than 50% of the total tooth length. A high ridge connects the metaconid with the "entoconid," forming a straight wall on the lingual side of the tooth. The "entoconid" is small and when worn forms a posterior extension of the talonid. A distinct large, rounded, and low hypoconid is present on the two anterior teeth but broken on M_3 (P_4). The talonid of the two anterior teeth is a simple platform; that of the posterior tooth is a labially sloping shelf. The talonid is open and is lowest between the protoconid and hypoconid. The teeth have a "lophodont" appearance with two "lophs": the protoconid-metaconid and the metaconid-entoconid. The two lophs meet at the metaconid at about 90°.

An alveolus (anterior to the teeth) is ovoid in outline (as in the other teeth alveoli) and about the size of the alveolus of the anterior tooth. The jaw is broken directly behind the posterior tooth.

Discussion. It is uncertain whether the teeth represent molars, premolars, or deciduous premolars. If BYU 3815 represents molars, they are unusual in that they increase in size posteriorly. If the teeth are premolars, the anterior two (P_2 and P_3) and even the third (P_4) are unusually molariform, having both trigonids and talonids. Deciduous premolars are often more molariform than the permanent premolars, but not to the extent seen in BYU 3815. The teeth appear, to the writer, to be molars.

The presence of lophodont teeth is highly unusual for an early Paleocene mammal and has not, to my knowledge, been previously reported.

The relatively high, wide trigonids and the teeth becoming larger posteriorly are more indicative of the insectivores or deltatheridians than other groups present in the early Paleocene. The affinities of BYU 3815 are presently unknown.

Size. BYU 3815: $?M_1$, L = 3.00, AW = 2.40, PW = 2.05; $?M_2$, L = 3.35, AW = 2.95, PW = 2.25; $?M_3$, L = 3.65, AW = 3.20, PW = (2.6).

Order Taeniodonta
Family Stylinodontidae
Genus *Onychodectes* Cope, 1888
Onychodectes cf. *O. tisonensis* Cope, 1888
plate 1, figs. 8–11

Locality and Material. Wagonroad: AMNH 36070, complete right M^1; AMNH 36071, slightly damaged left P^4 (these two specimens may represent the same individual).

Description. AMNH 36071 (P^4) has been slightly damaged; the protocone has been broken and moved somewhat posteriorly. The tooth is triangular shaped in occlusal view with a large oval-shaped paracone, the major cusp of the tooth. The paracone is elongate anteroposteriorly. The well-developed protocone is much smaller than the paracone. Small conules are present, one each on the preprotocrista and postprotocrista.

AMNH 36070 is triangular shaped in occlusal view. The paracone and metacone are subequal in size and well separated. A poorly developed ectocingulum and mesostyle are present, as is a distinct metaconule and paraconule. The protocone is relatively large and low.

Discussion. The preprotocrista (which becomes the preparaconule crista) of AMNH 36071 extends down to the anterior base of the paracone and persists for a short distance as a small precingulum as in P^4 of *O. tisonensis* (AMNH 785) of the San Juan Basin, New Mexico. This extension of the preprotocrista is not seen in specimens of *Conoryctes comma*, AMNH 3396, and AMNH 15939 (Matthew 1937). A slight extension of the preprotocrista is seen in the type specimen of *Conoryctella dragonensis*. The metacone of AMNH 36071 is slightly better developed than in *O. tisonensis* but not as large as in *Conoryctella dragonensis* or *Conoryctes comma*. The protocone of AMNH 36071 is relatively small as in *O. tisonensis*, but much smaller than in *Conoryctella dragonensis*. In size, AMNH is identical to *O. tisonensis*, 37% smaller than the type of *Conoryctella dragonensis*, and 85% smaller than *Conoryctes comma* (AMNH 3396 and UNM B-890).

AMNH 36070 has a very small mesostyle which *O. tisonensis* lacks, but which is pronounced in *Conoryctella dragonensis* and *Conoryctes comma*. The present M^1 ectocingulum is as small as that seen in *Onychodectes*, and distinctly smaller than those seen in the other compared species. A distinct metaconule and paraconule are present in *O. tisonensis* and AMNH 36070 but are lacking in *Conoryctes comma*. M^1, in the type specimen of *Conoryctella dragonensis*, is damaged and the presence of the conules cannot be determined. A poorly developed metastylar crest is present in AMNH 36070 and *O. tisonensis*, but is lacking in *Conoryctes comma* and apparently lacking in *Conoryctella dragonensis*. *O. tisonensis* (AMNH 785) is 6% smaller than AMNH 36070; *Conoryctella dragonensis* (type specimen) is 17%–20% larger than the present M^1 while *Conoryctes comma* (AMNH 15939) is over 40% larger. *Wortmania* and *Psittacotherium*, the other described early-middle Paleocene genera of the Stylinodontidae, have upper molars completely different in size, shape, and morphology than the present specimens.

AMNH 36070 and AMNH 36071 may represent the same species and may be from the same individual. They appear a little more advanced in some characters (mesostyle development on M^1, metaconule development on P^4, etc.) than *O. tisonensis*, but are not nearly so derived in these characters as *Conoryctes*. Taeniodonts of the early Paleocene are poorly known, thus making certain specific identification of such a small sample questionable.

Size. AMNH 36070: M^1, L = 7.00, W = 8.60. AMNH 36071: P^4, L = 5.60, W = (5.7).

Stylinodontidae Marsh, 1875
gen. and sp. indet.

Locality and Material. Wagonroad: Unnumbered AMNH specimen, incomplete ?upper premolar. Dragon Canyon: BYU 9993, ?anterior premolar.

Description. The AMNH specimen is large, apparently single-rooted, and has enamel extending down onto the root of the tooth further labially than lingually. The enamel base arches up medially between its labial and lingual downward extension. A major cusp is present and a minor crescentic ridge. BYU 9993 is much smaller than the American Museum specimen, is single rooted, has an extension of the enamel down the labial surface of the tooth, and is antero-posteriorly greatly compressed. A major labial, rounded cusp (worn) is present. A lingual cusp is lacking but a platform or shelf is present.

Discussion. The massiveness of the AMNH specimen, its large size, apparent single root, and basal enamel patern look very much like those seen in the Torrejonian form *Psittacotherium multifragum* (AMNH 16731 and AMNH 15938) from the San Juan Basin. It is, however, much smaller than *Psittacotherium* but considerably larger than *Wortmania* from the Puercan of New Mexico. It is intermediate in size between the Puercan and Torrejonian forms. The incompleteness and stage of wear of this specimen make generic assignment extremely difficult. BYU 9993 is very near *Wortmania* in size and morphology. However, the deciduous dentition of *Psittacotherium* is unknown, and generic or specific identification of BYU 9993 is unwarranted.

Size. Unnumbered AMNH: ?upper premolar, L = 8.00, W = 12.35. BYU 9993: ?anterior premolar, L = 5.0, W = 8.35.

Order Primates
Family Paromomyidae
Genus *Paromomys* Gidley, 1923
Paromomys cf. *P. depressidens* Gidley, 1923
plate 2, figs. 1–2

Locality and Material. Dragon Canyon: AMNH 36038, complete right M_2.

Description. AMNH 36038 has a relatively small, high trigonid. The metaconid and paraconid are relatively close together, subequal in height, and separated by a small groove. The metaconid and protoconid are of equal height and connected by a well-developed preprotocristid. The tooth has a distinct ectocingulid from the base of the protoconid to the hypoconulid. The hypoconulid is very small while the hypoconid is large. The entoconid is low. The talonid basin is completely closed.

Discussion. Comparative material used in the identification of AMNH 36038 include the following casts: *Paromomys maturus:* AMNH 35578 from Wyoming; *Paromomys depressidens:* AMNH 80970 from Wyoming; *Pronothodectes matthewi:* AMNH 35468, AMNH 35467, and AMNH 35469, all from Montana; *Pronothodectes simpsoni:* UW 1057 from Wyoming; *Phenacolemur pagei:* PU 13286, holotype, PU 14030, and PU 13316, all from Wyoming; *Palaechthon problematicus:* PU 14270 from Wyoming; and an unidentified paromomyid: UALP 10392 from Utah. Illustrations of *Purgatorius unio* from Montana (Van Valen and Sloan 1965) and illustrations of some of the above-mentioned specimens were also used.

The paraconid of AMNH 36038 is separated from the metaconid similar to that seen in *Paromomys maturus* and *Paramomys depressidens*. This paraconid-metaconid separation is considerably less in *Pronothodectes matthew, P. simpsoni*, and *Phenacolemur pagei* but greater in *Palaechthon problematicus*. The metaconid and protoconid of AMNH 36038 are equal in height and connected by a high ridge as in *Paromomys depressidens;* in *Palaechthon problematicus* the metaconid is lower while in *Paromomys maturus* the protoconid is slightly higher. The high ridge connecting the metaconid and protoconid is lacking (there being a groove instead) in *Pronothodectes matthew*, *P. simpsoni*, and *Phenacolemur pagei*. The continuous ectocingulid seen in AMNH 36038, *Paromomys maturus*, and *P. depressidens* is lacking in the other species discussed above. The talonid basin is more open in *Plesiolestes*, *Pronothodectes*, and *Penacolemur* than in AMNH 36038. Essentially all features of the talonid (i.e., virtually lacking hypoconulid, large hypoconid, low entoconid, and a continuous rim around the talonid basin) are the same in AMNH 36038, *Paromomys maturus*, and *P. depressidens*. *Palaechthon problematicus* has a more distinct hypoconulid and more posterior entoconid while *Pronothodectes* has a much lower trigonid than seen in the present M_2. The entoconid of *Phenacolemur* is much too large and high with the posterior of the talonid too open to be congeneric with AMNH 36038.

AMNH 36038 is 10% narrower and 17% shorter than *Palaechthon problematicus;* 10% narrower and 7% longer than *Pronothodectes matthewi* and as narrow but 12% longer than *Phenacolemur pagei*. Rigby (1980) had M_2 present in 73 specimens of *Paromomys maturus* with the following size ranges: L = 2.90–3.55, AW = 2.10–2.60, and PW = 2.45–2.90. Simpson (1937) reported 20 *Paromomys maturus* specimens with M_2 having these ranges: L = 2.9–3.2, W (maximum) = 2.2–2.5. AMNH 36038 has these measurements: L = 2.50, AW = 2.20, and PW = 2.20. As can be seen, AMNH 36038 is 16% shorter than the smallest specimen of *Paromomys maturus* of either sample and 10% (PW) narrower than Rigby's smallest specimen. Rigby (1980) also reported 42 specimens of *Paromomys depressidens* having M_2 with these ranges: L = 1.90–2.20, AW = 1.75–2.00, and PW = 1.65–2.10. The largest of these specimens is 12% shorter and 5%–10% narrower than AMNH 36038. Simpson's (1937) observed range for three specimens of *Paromomys depressidens* was: L = 2.0–2.3 and W = 1.8– 1.9. This differs from the present M_2 in being 8% shorter and 12% narrower (Simpson was using greatest width).

Purgatorius unio, another paromomyid, is considerably smaller than AMNH 36038 with a much smaller paraconid, larger hypoconulid, and generally different trigonid.

AMNH 36038 is morphologically nearly identical to M_2 in *Paromomys depressidens* and very similar to that of *Paromomys maturus*. It is nearly intermediate in size between these species. The lack of a large sample size makes assignment to either species somewhat uncertain. Manning (personal communication 1977) identified AMNH 36038 as cf. *Paromomys maturus*. The intermediate position of AMNH 36038 between *Paromomys maturus* and *P. depressidens* may indicate a new species. However, erection of a new taxon based on a single isolated tooth is felt unwise. The paromomyid M_2 described by Tomida and Butler (1980) is quite similar to AMNH 36038 but is relatively narrower. It may also be referable to *Paromomys*.

Size. AMNH 36038: M_2, L = 2.50, AW = 2.00, PW = 2.20.

Genus *Palaechthon* Gidley, 1923
? *Palaechthon* sp.
plate 2, figs. 3–4

Locality and Material: Dragon Canyon: AMNH 36054, right M_3 with a damaged protoconid.

Description. The trigonid of AMNH 36054 is short anteroposteriorly with the paraconid relatively small, well separated from, and much shorter than the metaconid. The protoconid is as tall as the metaconid. A small mesoconid is present, as is the ectocingulid and a weakly developed precingulid. The hypoconid is relatively large and labially placed while the entoconid is a little smaller and more posterior in position. The hypoconulid is very small, undivided, and posteriorly placed. The entoconid and hypoconulid are lingually placed and close together. The talonid is wider and two times longer than the trigonid.

Discussion. The same comparative specimens used for *Paromomys* cf. *depressidens* and casts of *Palenochtha minor*, AMNH 35449, and AMNH 35451 from Montana were used to identify AMNH 36054.

Gingerich (1974) stated that M_3 is one of the most interspecifically variable teeth in the mammalian jaw. Pronounced variation is seen in the talonids of paromomyid M_3s, and great care needs to be taken when identifying an isolated M_3.

The trigonid structure of AMNH 36054 (i.e., small, isolated paraconid, etc.) is very similar to some species of *Palaecthon* and also to *Palenochtha minor*. *Phenacolemur pagei*, *Pronothodectes matthewi*, and *Paromomys maturus* all have the paraconid higher and closer to the metaconid than the present specimen. The protoconid and metaconid are of equal height in AMNH 36054, *Palaechthon* and *Palenochtha*, not different heights as in *Paromomys maturus*, *Paromomys depressidens*, *Pronothodectes matthewi*, and *P. simpsoni*. The present M_3 has a much smaller metaconid, as in *Palenochtha minor* and *Palaechthon*, than does *Paromomys maturus* or *Pronothodectes matthewi*. *Pronothodectes* and *Phenacolemur* both have a poorer developed ectocingulid than AMNH 36054. *Phenacolemur pagei*, *Pronothodectes matthewi*, *P. simpsoni*, *Paromomys maturus*, and *P. depressidens* all have very elongate talonids with well differentiated cusps; they differ markedly in these respects from AMNH 36054, *Palenochtha minor*, and *Palaechthon*.

In size AMNH 36054 is at least 22% shorter than the M_3 of compared specimens of *Phenancolemur pagei*, *Pronothodectes matthewi*, *P. simpsoni*, and *Paromomys* *maturus*. The M_3 in all these specimens was also much wider than AMNH 36054. *Palenochtha minor* is nearly 30% shorter and narrower than the present M_3, which is the same size as *Palaechthon problematicus*. AMNH 36054 falls in the middle of the observed size range of *Palaechthon problematicus* from Swain Quarry's 28 specimens (Rigby 1980). *Palaechthon alticuspis* (Simpson 1937) is about 8% shorter and 12% narrower than the present M_3. However, *Palaechthon problematicus* has a bifracated hypoconulid which is not seen in AMNH 36054 and *Palaechthon alticuspis*.

AMNH 36054 is questionably placed in *Palaechthon* because of its greater similarities to that genus than other known paromomyid genera in relation to: (1) paraconid position and size, (2) nearly all features of the talonid, and (3) overall size. Rigby (1980) felt that *Palaechthon problematicus* may be a large form of *P. alticuspus*. The present M_3 is not given specific asignment because it lacks the bifracated hypoconulid, as does *P. alticuspus*, but is the size of *P. problematicus*. The small North Horn Formation sample size prohibits the determination of the amount of variation.

Bown and Gingerich (1973) placed *Palaechthon* in the Microsyopidae, while Rigby (1980) placed the genus in Primates *incertae sedis*. It is here left in the Paromomyidae because of its apparent greatest similarity to that group.

Size. AMNH 36054: M_3, L = 2.60, AW = 1.40, PW = 1.60.

Order Carnivora
Family Miacidae
Genus *Protictis* (Cope, 1882)
Protictis haydenianus (Cope, 1882)

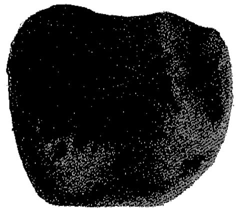
Locality and Material. Dragon Canyon: AMNH 36040, right M_1 trigonid with damaged metaconid.

Description. AMNH 36040 has a very high protoconid that is triangularly shaped in occlusal view. The paraconid is much lower than the protoconid, is transversely elongate, and is relatively flat on top. The base of the protoconid and paraconid meet and form a very distinct notch.

Discussion. The following specimens were used in identification of AMNH 36040: *Protictis haydenianus:*

EXPLANATION OF PLATE 2

Figs. 1–2—*Paromomys* cf. *P. depressidens:* 1, occlusal view of right M_2, Dragon Canyon, X12 (AMNH 36038); 2, same in lateral view. Figs. 3–4—? *Palaechthon* sp.: 3, occlusal view of right M_3, Dragon Canyon, X10 (AMNH 36054); 4, same in lateral view. Figs. 5–7—*Ectoconus ditrigonus:* 5, occlusal view of left jaw fragment with P_4-M_1, Dairy Creek, X3 (BYU 3845); 6, occlusal view of right M_2, Dairy Creek, X3 (BYU 3778); 7, occlusal view of left M_3, Dairy Creek, X3.5 (BYU 3777). Figs. 8–9—*Ectoconus symbolus:* 8, occlusal view of lower jaw fragment with right C_1, P_1, $P_{3\text{-}4}$, $M_{1\text{-}2}$ and M_3 fragment and left C_1, $P_{3\text{-}4}$, M_1, Blue Lake, X1.5 (BYU 3788); 9, occlusal view of left jaw fragment with $M_{2\text{-}3}$, Blue Lake X3 (BYU 3794). Fig. 10—*Desmatoclaenus paracreodus*, occlusal view of right M^1, Blue Lake, X5 (BYU 3800).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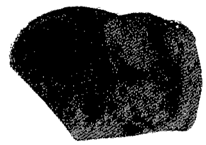
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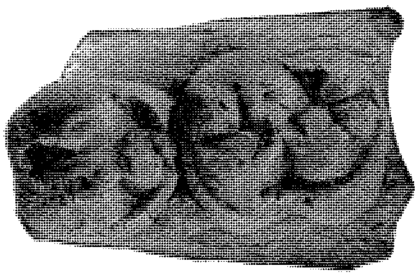
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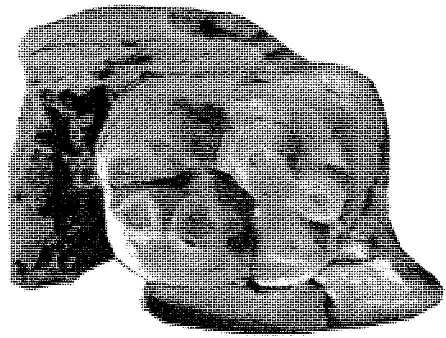
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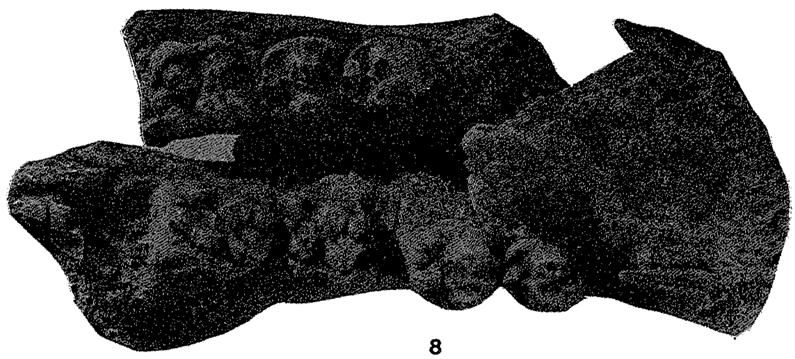
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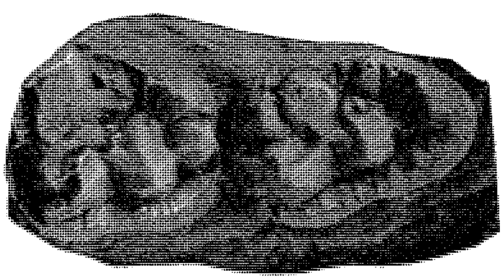
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AMNH 15992 and AMNH 16540, both illustrations of specimens from the San Juan Basin, and casts of AMNH 16536 from New Mexico and AMNH 35389 from Montana.

The very high posteriorly directed, triangular-shaped protoconid with the lower, flat, elongate paraconid of AMNH 36040 are identical to compared specimens of *Protictis haydenianus*. The distinctive notch between the protoconid and paraconid is a diagnostic feature of *P. haydenianus*. The enamel of the present M_1 descends lower on the tooth on the labial side than on the lingual side. This same feature was seen in comparative material from Montana, but not in the specimens from New Mexico where the enamel base remains horizontal. A small, low precingulid is developed in AMNH 36040 and *P. haydenianus* that does not reach the sides of the tooth. The American Museum specimen from the North Horn Formation is identical in size to that of compared specimens from both New Mexico and Montana. All the morphological features and size of AMNH 36040 are inseparable from *P. haydenianus* from the Gidley Quarry in Montana. No other known species of *Protictis* are large enough to be confused with AMNH 36040.

Size. AMNH 36040: M_1 trigonid, W (protoconid-paraconid width) = 5.15, H (base of enamel to top of protoconid on labial side) = 7.35.

Genus *Bryanictis* (MacIntyre, 1966)
Bryanictis sp.

Locality and Material. Dragon Canyon: AMNH 36035, ?M_1 trigonid, slightly damaged.

Description. The protoconid is high and relatively narrow while the paraconid is lower, elongate transversely, and has a nearly horizontal upper surface. The paraconid is anteriorly directed and closely appressed to the large metaconid. A very small precingulid is present. The pretrigonid notch is lower than the posttrigonid notch.

Discussion. Comparative material used to identify AMNH 36035 includes the following casts: *Bryanictis microlestes:* AMNH 35373 and AMNH 35377 from Montana; *Simpsonictis tenuis:* AMNH 35348 from Montana; *Prolimnocyon macfaddeni:* AMNH 100639 from Wyoming; *Acmeodon secans:* AMNH 16599, type, from New Mexico; *Ictidopappus mustelinus:* USNM 9296, illustration, from Montana; *Paleotomys senior:* AMNH 33990, type, from Wyoming; *Propaleosinopa thomsoni:* AMNH 33840, type, and P.U. 17783 from Montana; and *Propaleosinopa diluculi:* AMNH 35701 and AMNH 35702 from Montana. Rigby (1980, p. 86) stated that isolated M_1s of *Bryanictis vanvaleni* were inseparable from *B. microlestes.*

AMNH 36035 shows a strong resemblance to *Bryanictis* and to a lesser extent resembles some of the deltatheridians (Palaeoryctidae and Hyaenodontidae). The narrow and high protoconid is very similar to that of *Bryanictis vanvaleni* and *B. microlestes,* while this cusp in *Prolimnocyon macfaddeni* and *Acmeodon secans* is greatly inflated (Rigby 1980). The paraconid of *Bryanictis* and AMNH 36035 is transversely elongate, horizontal on top, anteriorly directed, and close to the metaconid. *Propaleosinopa, Prolimnocyon, Ictidopappus mustelinus, Acmeodon,* and *Paleotomys senior* have greatly inflated paraconids that are widely spaced from the metaconid. *Paleotomys senior,* in addition, has a distinct preparacristid which extends down the lingual surface of the tooth. This preparacristid is lacking in AMNH 36035 and *Bryanictis* The metaconid in *Paleotomys* and *Prolimnocyon* is much larger than that of the present specimen. A very small precingulid is present on AMNH 36035 and *Bryanictis vanvaleni* and *B. microlestes;* this is a much larger feature in *Paleotomys, Acmeodon,* and *Propaleosinopa* where it actually forms a cusp. The pretrigonid notch is higher than the posttrigonid notch in AMNH 36035 and *Bryanictis vanvaleni* and *B. microlestes;* the reverse is true in *Prolimnocyon* and *Propaleosinopa.*

AMNH 36035 is a little wider (10%) than the M_1 trigonid of *Protictis microlestes,* 3%–25% wider (dependent on comparison with M_1, M_2, or M_3) than *Paleotomys senior* (type), 20%–30% wider than *Acmeodon secans,* 10%–25% wider than *Propaleosinopa,* but the same size as *Prolimnocyon macfaddeni.*

The present trigonid is nearly identical to M_1 in *Bryanictis vanvaleni* and *B. microlestes* except size, which in this case is not a significant difference. It is also very similar to *Paleotomys senior* except in the paraconid size and construction. *Protictis haydenianus* is much larger than the present specimen—too large to be conspecific. However, because of the incompleteness of AMNH 36035 and the similarity of M_1 in *Bryanictis vanvaleni* and *B. microlestes,* it is referred to *Bryanictis.*

Size. AMNH 36035: ?M_1 trigonid, AW = (3.05).

Order Condylarthra
Family Periptychidae
Genus *Ectoconus* Cope, 1884
Ectoconus ditrigonus (Cope, 1882)
plate 2, figs. 5–7

Locality and Material. Dairy Creek: lower teeth—BYU 3753, right jaw fragment with P_4-M_3 with P_4 and M_1 severely damaged; BYU 3767, left M_1, slightly damaged; BYU 3777, left M_3; BYU 3778, right M_2; BYU 3845, left jaw fragment with P_4-M_1; BYU 3846, incomplete right M_3; BYU 3858, slightly damaged right M_3. Upper teeth—BYU 3769, right M^3; BYU 3847, damaged right M^2. Ferron Mountain: BYU 9986, damaged right M^{1-3}. The minimum number of individuals represented is five based on dental elements.

Description. P_4, based on BYU 3845 (P_4 in BYU 3753 is too badly damaged to aid in description), has a distinct low paraconid. Cristids essentially connect all three of the major cusps. The metaconid is elongate anteroposteriorly and is about as high as the protoconid and separated from the latter by a deep groove. A distinct hypoconid and a small hypoconulid are present. A small talonid is developed both labially and lingually to the hypoconid.

M_1 (BYU 3845 and BYU 3767) is squarish in occlusal view, being slightly longer anteroposteriorly than transversely. (M_1 in BYU 3753 is too badly damaged to be useful in description.) The trigonid is large with a wide central valley separating the large protoconid from the other cusps. The protoconid and metaconid are subequal in size while the paraconid is somewhat smaller. The well-developed ectocingulid is continuous with the postcingulid. A small protoconulid is present in both specimens just posterior to the protoconid. The hypoconid is the largest and anteriormost talonid cusp; the hypoconulid and entoconid are of moderate and subequal size. A small postcingulid is present between the hypoconulid and entoconid in BYU 3845, but lacking in BYU 3767.

M_2 (BYU 3753 and BYU 3778) is very similar to M_1 but is a little larger and relatively longer anteroposteriorly. The ectocingulid is not developed to the extent seen in M_1, but the postcingulid is better developed. A small paraconulid, lingual and somewhat anterior to the paraconid, is present on both M_2 specimens. The hypoconid is relatively larger and more anterior than seen in M_1 and has a labial ridge connecting it with the edge of the tooth.

M_3 is generally very similar to M_2, differing from M_2 in the following ways: (1) longer (anteroposteriorly) and narrower (transversely); (2) a smaller hypoconid (nearly as small as the entoconid); (3) a smaller entoconid; and (4) a much larger hypoconulid. BYU 3753 also has a small entoconulid that is not seen in the other specimens with M_3. BYU 3858 has a cusp, as large as the entoconid, between the hypoconid and hypoconulid. These cusps are not seen in the other M_3 specimens (BYU 3777, and BYU 3846).

BYU 3847 (M^2) is large, squarish in occlusal view, and has both the protostyle and hypocone well developed. The paraconule, metaconule, and metastyle are large and well developed. A large cusp is present labially and posterior to the metacone. The preparaconule crista interrupts the precingulum and the postmetaconule crista interrupts the postcingulum.

M^3 (BYU 3769) is elongate transversely with the paracone much more labial in position and larger than the metacone. A large parastyle is present. The paraconule is as large as the metacone; thus the trigon consists of four subequal cusps. The metaconule is small and posterior to the metacone. Both the hypocone and protostyle are distinctly lingual to the protocone.

Discussion. Teeth, especially posterior molars, of *Ectoconus* are quite variable in size and rugosity and sometimes have accessory cuspules. *Ectoconus symbolus* (from the North Horn Formation of Utah) and *E. ditrigonus* are the only two recognized species of the genus. Van Valen (personal communication 1979) believes *E. ditrigonus* is ancestral to *E. symbolus,* and that the two species intergrade.

The following casts were used in identifying the *Ectoconus* specimens in the BYU collection: *Ectoconus ditrigonus:* UCMP 30021 and UCMP 30017 from New Mexico; *Ectoconus symbolus:* USNM 16188 and UALP 11034 from Utah. Illustrations of the following were also used: *E. ditrigonus:* AMNH 3800, AMNH 16495, AMNH 880, AMNH 16496, AMNH 16500, and AMNH 16502, all from New Mexico; *E. symbolus:* USNM 16189, holotype, and USNM 16190 from Utah.

BYU 3845 (P_4) has a distinct paraconid as in compared specimens of *E. ditrigonus* of New Mexico. The presence of this paraconid was not noted in any of the specimens with P_4 of *E. symbolus.* The paraconid is, however, more medial in position than that of UCMP 30021 from New Mexico. A small hypoconulid is present in BYU 3845 that is larger than the hypoconulid seen in the comparative material of *E. ditrigonus* from New Mexico. The hypoconulid of *E. symbolus* in compared specimens is much larger. The entoconid, lacking in the present specimen and some specimens of *E. ditrigonus,* is present in *E. symbolus.*

The lower molars of the BYU specimens show no significant differences from compared material of *E. ditrigonus* from New Mexico, nor do they show consistent differences, except size, from material of *E. symbolus.*

M^1 (BYU 9986) is similar to M^2 except a little smaller. Matthew (1937) stated that the upper molars of *E. ditrigonus* are greatly variable. BYU 3847 (M^2) has a well-developed protostyle and hypocone which is common in the Periptychinae but is not developed to the extent seen in *Periptychus.* BYU 3847 also has the extra cusp labial to the metacone that is diagnostic of *Ectoconus.* All of the teeth in BYU 9986 are damaged labially, so the presence of the extra cusp cannot be determined. BYU 9986 and BYU 3847 are at least 20% larger in every feature (especially the hypocone) except the extra labial cusp which is smaller than comparative material of *E. symbolus.* This extra cusp is round, connected to the metacone by a small ridge, and sits on the broad ectocingulum as in *E. ditrigonus;* in *E. symbolus* this extra cusp is elongate, separated from the metacone by a groove, and sits on a smaller ectocingulum. The metastyle is larger and more separate from the extra cusp in BYU 3847 and *E. ditrigonus* than in *E. symbolus.*

Table 6. Measurements of Ectoconus *teeth in the BYU collection.*

Tooth		Number of Specimens	Observed Range	Mean
		Ectoconus ditrigonus		
P_4	L	1	8.70	8.70
	W		7.80	7.80
M_1	L	2	9.80–10.25	10.02
	W		8.50–9.75	9.13
M_2	L	2	11.40–12.90	12.15
	W		9.30–(11.5)	10.40
M_3	L	4	(12.4)–(14.5)	13.43
	W		(8.7)–(10.4)	9.30
M^1	L	1	(9.45)	9.45
	W		(13.0)	13.0
M^2	L	2	(10.15)	10.15
	W		12.60–(13.9)	13.25
M^3	L	2	7.80–(9.05)	8.43
	W		10.55–(11.5)	11.00
		Ectoconus symbolus		
C_1	D	2	4.40	4.40
	H		8.75	8.75
P_1	L	2	5.10	5.10
	W		4.9–5.05	4.97
P_3	L	2	7.50	7.50
	W		6.40–6.60	6.50
P_4	L	2	7.40–7.50	7.45
	W		7.15–7.30	7.22
M_1	L	2	8.65	8.65
	W		8.00–8.05	8.03
M_2	L	4	9.20–(10.2)	9.63
	W	5	(8.2)–8.40	8.31
M_3	L	2	(11.0)–(11.4)	11.20
	W		8.65–(8.95)	8.80
M^2	L	1	(9.1)	9.10
	W		(11.9)	11.90
		Ectoconus sp.		
BYU 3853				
P_2	L	1	7.10	7.10
	W		6.00	6.00

BYU 3769 (M^3) is nearly identical to the four comparative specimens of *E. ditrigonus* except that the hypocone is moderately larger than the protostyle; the opposite is true to a small degree in some comparative material of *E. ditrigonus*. BYU 3769 has a much larger protostyle, metacone, and metaconule than seen in comparative material of *E. symbolus*. In the present M^3 the metastyle and parastyle are greatly reduced and the metaconule and paraconule are much closer to the protocone than compared specimens of *E. symbolus*. *E. symbolus* lacks the complete ectocingulum seen in BYU 3769 and has a "notch" between the paracone and metacone not seen in the BYU specimen. BYU 3769 and the compared specimen of *E. symbolus* with M^3 are about the same size.

Ectoconus specimens in the BYU collection show a maximum size range in excess of 40%. M_2, in BYU 3753, is about 20% larger than M_2 in the type of *E. ditrigonus* (the larger of the two species) while M_2 in BYU 3788 is 5%–10% smaller than in the type of *E. symbolus*. Size is one of the major differences separating *E. ditrigonus* and *E. symbolus* in the BYU collection. The BYU specimens of *E. ditrigonus* display a maximum size variation of 16% while BYU specimens referred to *E. symbolus* have a maximum size difference of only 10%. The presence of the paraconid on P_4 in *E. ditrigonus* and the differences displayed in the upper teeth as explained above also help to separate the two species.

Sexual dimorphism could be a minor factor in the size range noted for *Ectoconus*. If size was the only difference in the BYU specimens, sexual dimorphism probably would not account for such a large difference. However, the differences in P_4 and upper molar morphology of the two species indicate the validity of two distinct species.

Size. Measurements of all *Ectoconus* specimens are given in table 6.

Ectoconus symbolus Gazin, 1939
plate 2, figs. 8–9

Locality and Material. Blue Lake: BYU 3788, incomplete lower jaw with right C_1, P_1, $P_{3\text{-}4}$, $M_{1\text{-}2}$, M_3 (fragment), and left C_1, P_1, $P_{3\text{-}4}$ (both slightly damaged), and M_1 (slightly damaged); BYU 3789, left M_2 (posterior portion) and right M_3 (damaged); BYU 3794, jaw fragment with left $M_{2\text{-}3}$. Jason Spring: BYU 3854, damaged right M_2. Ferron Mountain: BYU 4921, right M_2. Dairy Creek: BYU 3785, damaged left M^2. Minimum number of individuals is five based on dental elements.

Description. BYU 3788 was found in a concretion; most of the bone was missing. The canines were post depositionally displaced and are nearly horizontal in relation to the rest of the teeth with the apices posterior. The P_1s are both greatly displaced and the P_2s are not present.

The lower canines (BYU 3788) are round in cross section at the base and of smaller diameter than P_1. They are relatively short and identical to each other. The apices are somewhat flattened with distinct ridges extending from the apices anteriorly and posteriorly nearly to the base of the enamel.

P_1 appears to be single rooted with a high single cusp. A swelling is present on a large, lingual transverse ridge that may represent the metaconid which is present in that position on P_3 and P_4. A small vertical anterior and posterior ridge extends from the apex nearly to the enamel base on the large cusp. A small "talonid" having a distinct cusp is present. The left antertior premolar has a slight postcingulid which is lacking on the right anterior premolar. The talonid is also slightly better developed on the left anterior premolar.

P_3, P_4, and M_1 (in both right and left jaws of BYU 3788) are in place, thus allowing positive identification. P_3 is much more molariform than P_1. A large metaconid is present, though much smaller than the protoconid. A continuous valley separates these two major cusps. A well-developed hypoconid is connected to the protoconid by a moderately developed ridge. The talonid is relatively well developed with the hypoconid separating it into small labial and lingual basins. The rim of the lingual basin has a few small tubercles present.

P_4 is larger than P_3 and more molariform, especially in talonid characters. The metaconid of P_4 is relatively much larger and more separate from the protoconid than P_3. The paraconid is lacking. A small ridge connects the protoconid to the metaconid on the right P_4, but not on the left P_4. A small but distinct entoconid is present as well as a larger hypoconulid. The talonid basin is essentially no larger than in P_3 and is divided into two basins by the hypoconid.

The lower molars are very similar in general characters to those of *E. ditrigonus* (see description of M_1, M_2, and M_3 under *E. ditrigonus*). Specific differences will be discussed in the next section where comparisons are made.

M^2 (BYU 3785) is not so squarish in occlusal view; it greatly expands anteriorly just labial to the protostyle. Otherwise, its descriptin is as for M^2 of *E. ditrigonus*.

Discussion. The same comparative material used for *E. ditrigonus* was also used for material referred to *E. symbolus*. In the comparative material used, only $P_{3\text{-}4}$ and $M_{1\text{-}3}$ (and upper teeth) were present, so direct comparison with the anterior teeth of BYU 3788 is not possible. One of the major differences seen between the two species of *Ectoconus* is size. *E. symbolus* is much smaller, being from 16% to over 40% smaller than *E. ditrigonus* based on the BYU specimens.

P_4 of *E. symbolus* (BYU 3788) completely lacks the paraconid seen in every compared specimen of *E. ditrigonus. The P_4 of* E. *symbolus* possesses an entoconid and a relatively larger hypoconulid than *E. ditrigonus*, which helps differentiate the two species.

In addition to the above-mentioned size disparity, M_1 of *E. symbolus* differs from *E. ditrigonus* in having the trigonid cusps nearer the edges of the tooth. This is especially true of the paraconid.

M_2 of *E. symbolus* lacks the paraconulid seen in *E. ditrigonus* and also has a smaller, more medial hypoconid. The hypoconulid and and entoconid of *E. symbolus* are relatively smaller than *E. ditrigonus*, while the ectocingulid of *E. symbolus* is relatively larger.

The only consistent differences in M_3 between these species are that the entoconid is more anteriorly placed and the hypoconulid is relatively larger in *E. symbolus*.

The two species are closely related and lower molars are difficult to distinguish. The few differences previously mentioned, including size, are the differentiating characters. The incompleteness of BYU 3785 (M^2) and its odd shape make specific identification difficult. It has more similarities to *E. symbolus* than *E. ditrigonus*, and is therefore referred to *E. symbolus*, primarily on size.

Size. The measurements of all *Ectoconus* specimens are given in table 6.

Ectoconus sp.

Locality and Material. Jason Spring: BYU 3853 left P_2.

Description. BYU 3853 is similar to P_3 of *E. symbolus*. The protoconid and metaconid are small and close together with minor talonid development.

Discussion. Positive specific identification of an isolated P_2 of *Ectòconus* is unwise. The size and morphology of BYU 3853 are similar to P_3 of *E. symbolus*, but there are some slight differences. BYU 3853 is not developed to the extent seen in P_3 of BYU 3788. The two major cusps are smaller and closer together. The talonid is less developed, as is the hypoconid. BYU 3853 may represent P_2 of *E. symbolus* as it is somewhat intermediate in development between P_1 and P_3 of BYU 3788.

Size. The measurements of all *Ectoconus* specimens are given in table 6.

Genus *Periptychus* Cope, 1881
Periptychus coarctatus (Cope, 1883)
plate 3, figs. 1–3

Locality and Material. Blue Lake: BYU 3795, lower jaw fragment with complete P_2; BYU 3802, left jaw fragment with complete M_3. Dairy Creek: BYU 3848, right jaw fragment with M_2 and the trigonid of M_3.

Description. P_2 (BYU 3795) is a double-rooted tooth that has a vertically grooved labial surface, a large protoconid, a very slight precingulid, and a small metaconid. The "talonid," or postcingulid, is not as wide as the "trigonid."

M_2 (BYU 3848) has a small, very anteriorly placed paraconid with a distinct postparacristid. The paraconid is close to the metaconid and connected to it by a small ridge. A small paraconulid, lingual to the paraconid, is present. The small hypoconid is slightly larger than the entoconid and slightly more anterior. The hypoconulid is smaller than the other two talonid cusps. The ectocingulid is relatively large. The talonid is relatively low.

The trigonid of M_3 (BYU 3848) is very similar to that of M_2. BYU 3802 (M_3) is questionably referred to *P. coarctatus*.

Only a few of the vertical grooves characteristic of *Periptychus* are present on BYU 3802. The trigonid cusps are closely spaced. The paraconid is large and has a small lingual swelling that may represent a paraconulid. The hypoconid is as small as the entoconid and is distinctly anterior to this cusp. The hypoconulid is large and inflated, making the talonid heel round. A small cusp is present on the ectocingulid, anterior to the hypoconid.

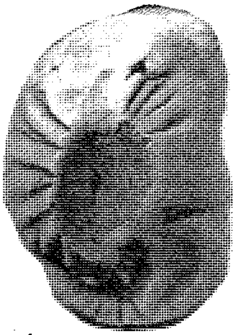
Discussion. Van Valen (1978) stated that *Carsioptychus* is not a valid genus but is best considered a subgenus of *Periptychus*.

Comparative material used to identify the *Periptychus* specimens in the BYU collection include the following casts: *Periptychus coarctatus:* UCMP V2813 and UCMP 31274 from New Mexico; *P. hamaxitus:* USNM 16179 and UCMP 51786 from the North Horn Formation of Utah; *P. gilmorei:* USNM 16226 from Utah; and *P. carinidens:* UNM B-12 6 and UCMP 30016 from New Mexico, AMNH 87579 from Wyoming, and UNM 325-1, actual specimen from New Mexico. Illustrations of the following specimens were also used: *P. coarctatus:* AMNH 16508, AMNH 850, AMNH 16517, AMNH 27601, and AMNH 3772 from New Mexico; *P. hamaxitus:* USNM 16197, type, USNM 16198, and USNM 16195 from Utah; *P. gilmorei:* USNM 15537, type, and USNM 15689 from Utah, and *P. carinidens*: AMNH 3636, AMNH 3665, AMNH 3720, AMNH 15936, AMNH 17181, AMNH 2466 and AMNH 16695 from New Mexico.

One of the diagnostic specific characters of *P. coarctatus* is the lack of the "antero-internal" cusp (the paraconid) on the lower premolars (Matthew 1937). BYU 3795 lacks this cusp. *P. coarctatus* is the only described species of *Periptychus* to lack this cusp. The slight precingulid

EXPLANATION OF PLATE 3

Figs. 1–3—*Periptychus coarctatus:* 1, occlusal view of left P_2, Blue Lake, X5 (BYU 3795); 2, occlusal view of a right jaw fragment with M_2 and M_3 trigonid, Blue Lake, X3 (BYU 3848); 3, occlusal view of left M_3, Blue Lake, X4 (BYU 3802). Figs. 4–7—*Conacodon utahensis* n. sp.: 4, occlusal view of right M_1, Gas Tank Hill, X6 (BYU 3864 holotype); 5, same in occlusal view; 6, occlusal view of a right jaw fragment with the talonid of M_2 and M_3, Gas Tank Hill, X7 (BYU 3865 paratype); 7, same in lateral view. Fig. 8—*Anisonchus athelas*, occlusal view of a right M^2, Dairy Creek, X3.5 (BYU 3770). Fig. 9—*Oxyacodon apiculatus*, occlusal view of a left M^1, Blue Lake, X8.5 (BYU 3798). Figs. 10–12—*Oxyacodon ferronensis*: 10, occlusal view of a right maxilla fragment with M^{1-2}, Blue Lake, X7 (BYU 3852 holotype); 11, occlusal view of a left M_1, Blue Lake, X8 (BYU 3843); 12, same in lateral view.



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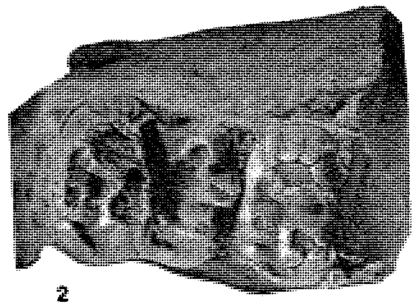

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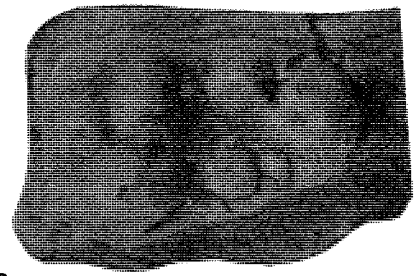

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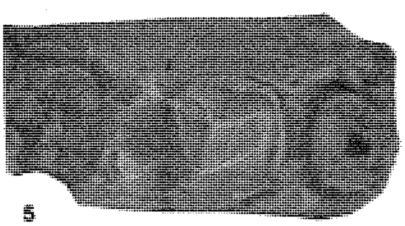

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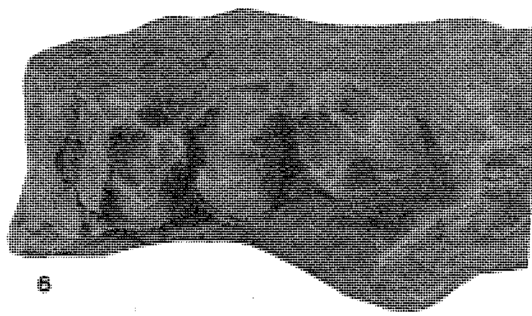

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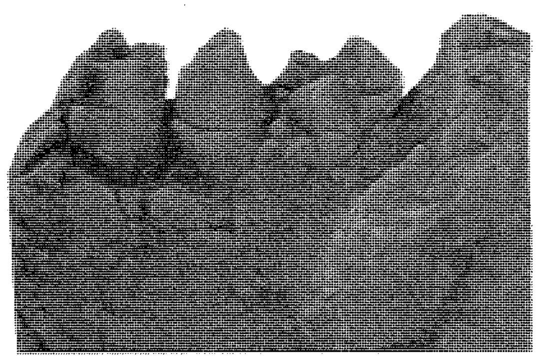

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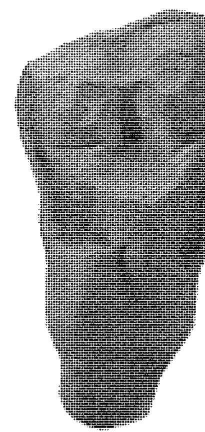

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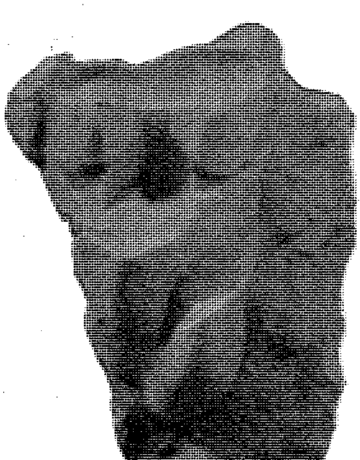

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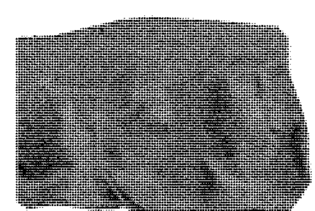

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and metaconid of BYU 3795 are also identical to compared specimens of *P. coarctatus.*

BYU 3848 (M_2) has a small paraconulid as seen in some material of *P. coarctatus* from the San Juan Basin. The hypoconid, being larger than and anterior to the entoconid of the present M_2, is also typical of *P. coarctatus* but not of *P. hamaxitus* or the other species of *Periptychus.* The ectocingulid of BYU 3848 is longer than in *P. hamaxitus*, resembling that seen in *P. coarctatus.* The trigonid of M_3 (BYU 3848) is identical to comparative material of *P. coarctatus.* BYU 3848 lacks the seventh cusp seen in *P. carinidens* where the cristid obliqua meets the postprotocristid.

BYU 3802 (M_3) differs somewhat from other specimens of *Periptychus* in trigonid construction. The trigonid cusps are a little more closely spaced and they nearly lack the vertical grooves common in *Periptychus.* The paraconulid is very small in *P. coarctatus* and in BYU 3802. However, the talonid of BYU 3802 is nearly identical to that of *P. coarctatus* in having a small hypoconid which is as small as, and anterior to, the entoconid. This feature is seen only in one species of *Periptychus, P. coarctatus.* A small cusp is present on the ectocingulid, anterior to the hypoconid as in *P. coarctatus.* This cusp is much larger in *P. hamaxitus* and the other species of *Periptychus.* BYU 3802 is a little longer and narrower than the type of *P. coarctatus.* The present M_3 lacks the seventh cusp where the cristid obliqua meets the postprotocristid. This cusp is present in *P. carinidens* (Matthew 1937) and is present on M_3 of the type specimen of *P. gilmorei* (Gazin 1941). This cusp is always lacking in *P. coarctatus* (Matthew 1937).

Size. BYU 3765: P_2, L = 9.25, W = 7.05. BYU 3802: M_3, L = 10.30, W = 6.90. BYU 3848: M_2, L = 8.65, W = 8.20; M_3, AW = 7.70.

Periptychus hamaxitus (Gazin, 1941)

Locality and Material. Jason Spring: BYU 3812, complete right P_4; BYU 3867, complete ?P^2. Dairy Creek: BYU 3774, complete left M^3. Ferron Mountain: BYU 4919, right M^2; BYU 3829, complete right P_4. Blue Lake: BYU 3801, partial left M^1. Wagonroad: AMNH 36050, complete left M^3. Sage Flat: BYU 3834, damaged left M^2.

Description. P_4 (BYU 3812 and BYU 3829) has a very large crescentic protoconid with long, labial, vertical grooves. The paraconid is small, low, and anteriorly placed. In BYU 3812, these grooves all begin along the crest of the protoconid and terminate along an ectocingulid. In both P_4s the base of the enamel extends well down onto the roots of the tooth, especially on the labial side, except posteriorly where it remains relatively high. A moderate-sized metaconid is also present at about the same horizontal level as the paraconid.

?P^2, as shown by BYU 3867 (questionably referred to *P. hamaxitus*), is very small. The inner crescent (protocone) is distinctly anterior to the outer one (metacone). These two crescents are obliquely elongate to each other. A weak ectocingulum is present along most of the labial side of the tooth that terminates the vertical grooves. A small precingulum and postcingulum are present.

BYU 3801 (questionably referred to *P. hamaxitus*) is a damaged M^1. The well-developed hypocone and protostyle are evident. The major trigon cusps have vertical grooves and are well separated. BYU 4919 (M^2) is inseparable from M^2 in the holotype of *P. hamaxitus* from Utah.

M^3 (BYU 3774 and AMNH 36050) has a reduced metacone which is lingual to the paracone. No mesostyle exists. The hypocone is large while the metaconule is very small. A small cusp, not the paraconule, is present just lingual to the paracone.

Discussion. The small paraconid displayed in BYU 3812 and BYU 3829 is very similar to that seen in *P. hamaxitus.* This cusp, lacking in *P. coarctatus,* is much larger in *P. gilmorei* and *P. carinidens.* Only in *P. hamaxitus* was the enamel base so far down on the labial side of the tooth as in the current specimens. The vertical grooves also extend down further in the BYU specimens and *P. hamaxitus* than in any of the other compared species of *Periptychus.* Both referred P_4s are about the size of this tooth in *P. hamaxitus* and are much narrower transversely than P_4 in *P. coarctatus* or *P. gilmorei. P. carinidens* is much smaller.

BYU 3867 (?P^2) is 30%–40% smaller than P^2 of *P. coarctatus* and *P. gilmorei.* The inner crescent (protocone) is distinctly anterior to the outer crescent (metacone) as in *P. hamaxitus.* The protocone is not so far anteriorly placed in *P. gilmorei, P. carinidens,* or *P. coarctatus.* As with BYU 3812 (P_4), BYU 3867 has an ectocingulum that terminates the vertical ridges.

BYU 3801 (M^2) is questionably referred to *P. hamaxitus* because *P. coarctatus* upper molars are essentially indistinguishable from those of *P. hamaxitus.* Gazin (1941, p. 42) described only one difference between upper molars of *P. hamaxitus* and *P. coarctatus:* "upper teeth relatively a little narrower transversely than in the Puerco form [*P. coarctatus*]." BYU 3801 is identical morphologically to the type specimen of *P. hamaxitus* but is slightly smaller. Specific certainty cannot be achieved here for an isolated, damaged, upper molar.

M^3 of *P. hamaxitus* is missing in the type specimen, but present in UCMP 51786. BYU 3774 and AMNH 36050 are morphologically very similar to UCMP 51786. All these lack the mesostyle seen in *P. coarctatus,* and the hypocone is not so lingual and isolated as *P. coarctatus.* The small cusp lingual to the paracone (not the paraconule) seen in the two North Horn specimens is lacking in *P. coarctatus.* BYU 3774 is 27% smaller than the type of *P. gilmorei* and 20% narrower than the type of *P. coarctatus.*

Size. BYU 3812: P_4, L = 10.60, W = 8.20. BYU 3867: ?P^2, L = 9.00, W = 10.25. BYU 3829: P_4, L = 10.90, W = 8.60. BYU 3801: M^2, L = (7.9), W = 11.7 (to base of enamel). BYU 3774: M^3, L = 7.00, W = 9.00 (to base of enamel). AMNH 36050: M^3, L = 7.00, W = 9.50. BYU 3834: M^2, L = 8.3. BYU 4919: M^2, L = 7.8, W = 10.4.

Periptychus cf. *P. gilmorei* (Gazin, 1938)

Locality and Material. Dragon Canyon: BYU 3749, slightly damaged left P_4; AMNH 36043, worn left P_3; BYU 3755, left maxillary fragment with M^2 (lingual portion) and M^3, slightly damaged; BYU 9990, damaged right M^3.

Description. P_3 (AMNH 36043) is quite extensively worn, but shows a well-developed paraconid. The metaconid is small and the enamel does not extend down onto the tooth roots on the labial side. The talonid is somewhat lingually placed and is flat on top.

BYU 3749 (P_4) is essentially identical to the P_3 just described except that it is larger and has a slight ectocingulid.

M^3 (BYU 3755) has a relatively small hypocone. The metacone is relatively labially placed for M^3. A small mesostyle is present as well as a large parastyle. A protostyle is present and the three major trigon cusps all have pronounced vertical grooves. The lingual slope on the tooth takes up about 20% of the tooth width. M^2 of this specimen is too badly broken to adequately describe or aid in specific identification.

Discussion. The same comparative specimens mentioned under *Periptychus coarctatus* were used in comparisons and identifications of specimens referred to *Periptychus* cf. *P. gilmorei*.

AMNH 36043 (P_3) has a well-developed paraconid as seen in *Periptychus carinidens* and *P. gilmorei*. The paraconid of *P. coarctatus* premolars is lacking, while that of *P. hamaxitus* is very small. As in *P. gilmorei*, the metaconid of AMNH 36043 is relatively small and does not show the development seen in P_3 of *P. carinidens*. The metaconid of UNM-B85-1 from New Mexico (actual specimen) is greatly enlarged over that seen in the present specimen. Labial extension of the enamel onto the tooth roots is not present in AMNH 36043 as it is in *P. hamaxitus*. The lingual, flat-topped talonid of the present specimen is very similar to that seen in *P. carinidens* and is more lingual than in *P. gilmorei*. However, the talonid extends further labially than in P_3 of *P. carinidens*. It is more *P. gilmorei*-like in this feature. The specific identification of AMNH 36043 is questionable because it is an isolated, well-worn premolar and because the premolars of *P. gilmorei* and *P. carinidens* are very similar. However, the tooth shows greatest similarity to *P. gilmorei*. P_3 in *P. carinidens* is smaller than the present specimen. The identification of BYU 3749 (P_4) is also questionable for the same reasons stated for AMNH 36043 above.

BYU 3755 (M^3) has a parastyle similar to that seen in *P. gilmorei* but larger than that in *P. carinidens*. It is also much larger than the parastyle in *P. coarctatus* or *P. hamaxitus*. The present M^3 lacks the very large hypocone seen in *P. carinidens*, and has a more lingually placed metacone than *P. carinidens*. BYU 3755 has a small mesostyle similar to some compared specimens of *P. gilmorei*, but this feature is lacking in compared specimens of *P. carinidens*. The BYU specimen is a little smaller than the type of *P. gilmorei* (5%–10%). The cusps in the current specimen (M^3) are not nearly so inflated as the corresponding cusps in *P. carinidens* (UNM B85-1).

Size. BYU 3749: P_4, L = 12.40, W = 9.90. BYU 3755: M^3, L = 8,00, W = 10.50. AMNH 36043: P_3, L = 11.00, W = 9.05.

Genus *Anisonchus* Cope, 1881
Anisonchus athelas Van Valen, 1978
Anisonchus eowynae Van Valen, 1978, p. 64
plate 3, fig. 8

Type. NMNH 23279, left maxilla with P^4–M^2, Gas Tank local fauna, North Horn Formation, central Utah.

Referred Material. Wagonroad: UCMP 69260, right M^{1-3}. Dairy Creek: BYU 3770, complete right M^2; BYU 3839, slightly damaged right M^2. Ferron Mountain: BYU 3816, slightly damaged left M_1; BYU 3859, slightly damaged right M_2.

Description. M^2: The paracone and metacone are subequal in size and relatively close together. The postmetaconule crista does not interrupt the postcingulum. The posterior side of the tooth is concave in occlusal view with a relatively small lingual and posterior hypocone. The precingulum is weak while the postcingulum and ectocingulum are moderately developed. The parastyle is relatively small.

M_1 (BYU 3816) has a relatively high trigonid with a large inflated protoconid. The paraconid and metaconid are small, subequal, relatively low, and widely separated. The paraconid is anterior and distinctly lingually positioned. The length of the trigonid is about 65% of the total tooth length. The talonid and trigonid are of equal width. A well-developed precingulid and poorly developed ectocingulid and postcingulid are present. The hypoconid is large and anterior. The entoconid is small and connected to the metaconid by a ridge. The hypoconulid is distinct but closely appressed to the entoconid and is lingually placed. The talonid basin is relatively short, deep, and completely enclosed. The entoconid, paraconid, and metaconid lie in a straight line.

M_2 is very similar to M_1 except that the paraconid is a little larger and more anteriorly positioned.

Discussion. Casts of the following specimens were used to help identify specimens referred to *Anisonchus* in the BYU collection: *Anisonchus athelas:* USNM 23279, holotype, from Utah, *A. "eowynae"* UCMP 69260, holotype, from Utah; *A. dracus:* USNM 16252 from Utah; *Gillisonchus gillianus* (*Anisonchus gillianus*, see Rigby, 1981) UNM B-1088a, AMNH 3600, type, and AMNH 16461 from New Mexico; *A.* cf. *oligistus:* UALP 10385 from Utah; *A. sectorius:* AMNH 35715 and AMNH 35717 from Montana, AMNH 100218, PU 16605 and PU 16608 from Wyoming; *A. willeyi:* AMNH 87623, AMNH 87624, AMNH 87649, AMNH 100260, holotype, and AMNH 100261 from Wyoming; *Haploconus angustus:* AMNH 3477, type, from New Mexico, AMNH 101102 from Wyoming; *H. inopinatus:* USNM 15760, holotype, from Utah; *Conacodon cophater:* AMNH 3488 from New Mexico; *C. entoconus:* UNM B-023 and UNM B-025 from New Mexico; *Hemithlaeus kowalevskianus:* AMNH 3578, type, and AMNH 16441 from New Mexico. Illustrations of the following specimens were also used; *Anisonchus dracus:* USNM 15745, holotype, from Utah; *A. onustus:* USNM 15788, type, from Utah; *A. oligistus:* USNM 16192, holotype, from Utah; *Gillisonchus gillianus:* AMNH 3601, AMNH 16462, and AMNH 16468 from New Mexico; *A. sectorius:* AMNH 3543, holotype, AMNH 3533, AMNH 15941, AMNH 16667, and AMNH 16674 from New Mexico, and USNM 9263 from Montana; *Haploconus angustus:* AMNH 16680, AMNH 895, AMNH 3454, AMNH 16685, and AMNH 16688 from New Mexico; *H. lineatus:* AMNH 3425, type, from New Mexico; *H. corniculatus:* AMNH 3538 from New Mexico and *H. elachistus:* USNM 16191, type, from Utah.

BYU 3770 and BYU 3839 lack the well-developed lingual protostyle that is diagnostic of *Hemithlaeus* (Matthew 1937). They differ from *Conacodon* (*C. cophater* and *C. entoconus*) as it has a large, very lingual hypocone and an endocingulum. *Haploconus* also has a large lingual hypocone and has a much better developed protostyle than seen in *Anisonchus*.

Anisonchus athelas and *A. "eowgnae"* are known only from the holotype specimens from the North Horn Formation of Utah. These two type specimens and the two BYU specimens (BYU 3770 and BYU 3839) belong in *Anisonchus (Anisonchus)* because the postmetaconule wing (postmetaconule crista) of M^2 does not interrupt or intercept the postcingulum as it does in *A. (Mithrandir)* (Van Valen 1978). *A. dracus* and *A. sectorius* (the only other known species of *Anisonchus (Anisonchus)* have a much weaker ectocingulum, larger hypocone, and larger overall size than the BYU specimens and the types *A. athelas* and *A. "eowynae."* BYU 3770, BYU 3839, *A. athelas*, and *A. "eowynae"* lack the mesostyle seen in compared material of *A. dracus* and *A. sectorius*. The overall shape of the BYU specimens is identical to *A. athelas*, not *A. dracus* or *A. sectorius*.

A. athelas and *A. "eowynae"* are very similar, the only differences are that *A. "eowynae"* is somewhat wider lingually and has a slightly better developed hypocone (Van Valen 1978). After examining casts of the two type specimens, specific separation does not appear warranted. The range of variability is unknown for either species; they come from the same geographic area and their stratigraphic separation is not great. The type specimens of *A. athelas* (P^4-M^2) and *A. "eowynae"* (M^{1-3}), together with BYU 3770 and BYU 3839, appear to form a distinct species. I believe all four specimens represent a single species, *A. athelas*. *A. "eowynae"* is here considered a junior synonym of *A. athelas*.

BYU 3816 and BYU 3859 may represent the same individual as they were found in very close association at a locality that produced relatively few specimens.

Both BYU 3816 and BYU 3859 are much too small to be *A. sectorius* or *A. dracus*. The present specimens also have higher trigonids, more acute cusps, and different trigonid structures than seen in either *A. dracus* or *A. sectorius*.

BYU 3816 differs from the type specimen of *A. onostus* in having a much narrower talonid, with a much smaller entoconid and more labial hypoconulid. The talonid is also much shorter in the BYU specimen. The paraconid and metaconid of *A. onostus* are much larger and closer together than in the present specimen while the protoconid is relatively smaller. The trigonid of *A. onostus* is relatively lower than in BYU 3816. BYU 3859 differs from the type specimen of *A. onostus* in having a larger paraconid, higher trigonid, smaller talonid, smaller entoconid, and more lignual hypoconulid. BYU 3859 also differs from *A. onostus* (type specimen) in lacking the high ridges connecting the trigonid cusps, having a much smaller metaconid and having the trigonid cusps more widely spaced.

The trigonid cusps of the type specimen of *A. oligistus* are close together and are all connected by ridges, thus differing markedly from BYU 3816. The paraconid and metaconid of the present specimens are much smaller than those seen in *A. oligistus*, as is the talonid. BYU 3816 is 14% shorter anteroposteriorly than M_1 in the type of *A. oligistus*. BYU 3859 differs from the type specimen of *A. oligistus* in lacking the high ridges connecting the trigonid cusps, in having a much smaller metaconid, and having the trigonid cusps more widely spaced.

The type specimen of *Gillisonchus gillianus* differs from BYU 3816 in being about 20% larger with the paraconid, metaconid, and entoconid relatively much larger. The cusps are not as acute and the trigonid is relatively lower in *G. gillianus*, and the paraconid and metaconid are much closer together than in BYU 3816. The hypoconulid is also too posterior in position to be conspecific with BYU 3816. However, AMNH 16461, a specimen referred to *G. gillianus*, is very similar to the present specimen except that it is a little larger.

The type specimen of *G. gillianus* has a paraconid much too labial, large, posterior, and too close to the metaconid to be the same species as BYU 3859. The BYU specimen also has a much smaller metaconid, shorter talonid, smaller entoconid, narrower trigonid, and is generally smaller than the type of *G. gillianus*. AMNH 16461 *(G. gillianus)* is more like the BYU specimen, but still has a much larger metaconid, more posterior and smaller paraconid, paraconid and metaconid too close together, and a smaller, less inflated hypoconid and protoconid.

The two present BYU specimens are specifically different from the type specimens of *Anisonchus dracus, A. sectorius, A. onostus, A. oligistus* and *Gillisonchus gillianus* as described above. The teeth are referred to *Anisonchus athelas* because of the above-mentioned differences with described species and because the teeth are generally primitive in character (as are the upper teeth of *A. athelas*), they are about the size expected for lower molars of *A. athelas*, and because they came from the same stratigraphic positon as the type specimen of *A. athelas*.

Size. BYU 3770: M^2, L = 4.10, W = 5.90. BYU 3839: M^2, L = (3.9), W = 5.90. BYU 3816: M_1, L = (4.3), W = 2.90. BYU 3859: M_2, L = 4.20, W = 3.05.

Anisonchus dracus Gazin, 1939

Locality and Material. Dragon Canyon: BYU 3838, right maxillary fragment with complete $M^{1\text{-}2}$; AMNH 36028, slightly damaged right M^1; AMNH 36039, broken left M^1; BYU 3751, left M_2; BYU 3844, left jaw fragment with M_2 and partial M_3; BYU 4920, right M^2.

Description. M^1 is somewhat elongate transversely with the paracone and metacone subequal in size. The trigon cusps are tightly compressed. Both the metaconule and paraconule are present, but small. A small mesostyle and large parastyle are present but the protostyle is lacking. The hypocone is posteriorly and lingually placed. There is a weak ectocingulum.

M^2 is very similar to M^1 except that it is larger, has a relatively smaller and more lingually placed metacone, and has a better-developed hypocone pillar. The postmetaconule crista does not interrupt the postcingulum on M^2.

BYU 3751 (M_2) has large, relatively well rounded cusps. The trigonid is not greatly elevated above the talonid. The trigonid cusps are somewhat connected by ridges, thus forming a trigonid basin. A precingulid and postcingulid are present. The talonid is broad and very open with the cristid obliqua greatly curved. The talonid cusps (hypoconid, hypoconulid, and entoconid) are present and distinct. M_2 of BYU 3844 is too incomplete to allow description.

BYU 3844 (M_3) has inflated trigonid cusps with the protoconid the largest. The paraconid is relatively large, well separated from the metaconid, lower than the other trigonid cusps, and is medially placed. The precingulid, ectocingulid, and postcingulid are all well developed while the endocingulid is absent. The hypoconid is very large and inflated while the entoconid and hypoconulid are small, subequal, and closely appressed to each other. The hypoconulid is not greatly posteriorly positioned. The tooth is broad and the trigonid relatively low.

Discussion. BYU 3838, AMNH 36028 and AMNH 36039 are nearly identical to each other; they certainly represent the same species. Each specimen lacks the well-developed lingual protostyle that is characteristic of *Hemithlaeus* (Matthew 1937). They differ from *Conacodon* (*C. cophater* and *C. entoconus*) as this genus has a large, very lingual hypocone and possesses a much better developed protostyle than seen in *Anisonchus*.

BYU 3838 is the most complete specimen of *Anisonchus dracus* upper molars in the BYU collection. It is very similar to the other specimens referred to *A. dracus* in the BYU collection, and the comparisons with other taxa discussed below were made with it. The teeth of the BYU material are relatively long anteroposteriorly as in *A. dracus* but about 10%–12% shorter than *A. sectorius* of the San Juan Basin and shorter than the smallest of five M^1 specimens of *A. sectorius* from Swain Quarry, Wyoming (Rigby 1980).

The hypocone of the BYU specimens and the type of *A. dracus* is larger and more labially placed than in the type and referred BYU specimens of *A. athelas*, but not nearly so isolated and distinct as the hypocone seen in material of *A. sectorius*. The ectocingulum of the BYU specimens and *A. dracus* is intermediate in development, being better developed than in *A. sectorius*, but less developed than in *A. athelas*. The BYU material, *A. dracus* and *A. sectorius*, have a slight mesostyle not seen in *A. athelas;* nor do they have the concave posterior edge seen in *A. athelas*.

BYU 3838 is 12% longer anteroposteriorly than the type of *A. athelas*, 20% longer than the type of *A. oligistus*, and about the same size as the type of *Gillisonchus gillianus* (Matthew 1937) and *A. dracus* (Gazin 1941). Upper molars of *A. onostus* are unknown.

BYU 3751 and BYU 3844 are too large to be conspecific with either *A. onostus, A. oligistus*, or the lower molars referred to *A. athelas*.

Describing the lower teeth of *A. dracus*, Gazin (1941, p. 46) stated the following:

The lower jaw fragments exhibit teeth comparable in size to those of A. sectorius *and show no significant differences from them, nor are differences evident in the preserved material which would serve to clearly distinguish the Dragon form from* A. gillianus. *However, the crest* *connecting the hypoconid to the trigonid* [cristid obliqua] *appears distinctly lower than that connecting the entoconid to the metaconid. This condition was noted in an* M_1 *of* A. gillianus *but not in other specimens of either this species or* A. sectorius.

BYU 3751 and BYU 3844 are too broad, cusps too inflated, and the teeth are generally too large to be *Gillisonchus gillianus*. The BYU specimens are too large to be conspecific with *A. onostus* or *A. oligistus*. The teeth are, however, very similar to the type specimen of *A. sectorius*. BYU 3751 differs from *A. sectorius*, though, by having a highly curved cristid obliqua, a distinctly shorter talonid anteroposteriorly, a more medial hypoconulid, and by having smaller cusps and slightly smaller overall tooth size. BYU 3751 is only about 4% narrower and 11% shorter than the smallest of two specimens of *A. sectorius* with M_2 from the Swain Quarry in Wyoming (Rigby 1980), and is only 5%–8% smaller than *A. dracus* (USNM 16249). These size differences are not believed to be significant.

BYU 3844 differs from M_3 in *A. sectorius* in these ways: the cristid obliqua is lower than the ridge connecting the metaconid and entoconid, the paraconid is more labial, the cingulids better developed, the hypoconulid is less distinct, and is overall a larger size. The BYU specimen is 4% wider than the widest of five specimens of *A. sectorius* with M_3 from the Swain Quarry of Wyoming but falls near the lower observed range in length. Again, this size difference is not significant.

A. dracus lower molars present in the BYU collection are difficult to differentiate from lower molars of *A. sectorius*. Although the BYU specimens are similar to *A. sectorius*, they show closest affinity to *A. dracus*. The difficulty in separating the two species may indicate that the two are actually synonymous.

An isolated P^4 from Dragon Canyon (BYU 3752) may also represent *A. dracus*. However, the lack of comparative material containing P^4 makes specific designation uncertain. Several other specimens are clearly those of anisonchines, probably *Anisonchus*, but their broken and/or incomplete nature makes positive specific (sometimes generic) assignment inadvisable. Included in this group are the following specimens from Dragon Canyon: AMNH 86676 (right P^4–M^3) and AMNH 86712 (right P^2–M^2). BYU 3841 (left P^4) from Dairy Creek also falls into this category.

Size. BYU 3838: M^1, L = 4.80, W = 6.75; M^2, L = 5.00, W = 7.60. AMNH 36028: M^1, L = 4.90, W = 6.30. AMNH 36039: M^1, L = 4.90. BYU 3751: M_2, L = 4.80, W = 3.70. BYU 3844: M_3, L = 5.55, W = 3.90. BYU 4920: M^2, L = 4.65, W = 6.5.

Anisonchus cf. *A. oligistus* Gazin, 1941

Locality and Material. Dragon Canyon: BYU 3741, left maxilla fragment with damaged $M^{1\text{-}2}$; BYU 3742, complete left M^1.

Description. The teeth are transversely elongate and triangular in occlusal view. The postmetaconule crista interrupts the postcingulum on M^2. A parastyle is present, as well as a faint protostyle. The hypocone is relatively large. The protocone has an elongate lingual slope and the ectocingulum is relatively weak.

M^1 in BYU 3741 and BYU 3742 are nearly identical to each other and represent the same species.

Discussion. BYU 3741 has a portion of M^2 preserved in which it is obvious that the postmetaconule crista disrupts the postcingulum, making this material referrable to *Anisonchus (Mithrandir)* (Van Valen 1978). Species of this subgenus are: *A. oligistus*, and *A. onostus*. Upper molars of *A. onostus* are unknown, making direct comparison with it impossible.

The BYU specimens differ from *Gillisonchus gillianus* in being much shorter lingually, having a much more elongate lingual protocone slope, a stronger more lingual hypocone, no mesostyle, a relatively smaller protostyle, and being more triangular in occlusal view. *A. oligistus* is similar to the BYU material (Gazin 1941) in these characters. However, M^2 of the BYU material is relatively much larger and has the metacone much more lingually placed than that seen in *A. oligistus*. BYU 3741 and 3742 are very similar to *A. oligistus* in overall characteristics, but references to this species is not certain because upper molars of *A. onostus* are unknown.

Three right M_3's (BYU 3817 and BYU 3820 [also containing M_2 talonid] from Ferron Mountain and BYU 3831 from Sage Flat) are questionably referred to *A. olgistus* as M_3 is undescribed in *A. athelas, A. dracus, A. onostus*, and *A. oligistus*. M_3 in these specimens is relatively small with the trigonid cusps connected by ridges. The cusps are acute, with the paraconid moderately large and the trigonid relatively high. The teeth are narrow with a wide and open talonid basin anteriorly. The hypoconulid is large and posterior.

The trigonid cusps in *Gillisonchus gillianus* are not connected with ridges as seen in the present M_3's. The trigonid of these specimens is very similar to that seen in M_2 of *A. oligistus*. The talonid basin of M_2 in BYU 3820 is very wide anteriorly, as are the talonid basins in M_{1-2} of *A. oligistus;* wider than seen in *G. gillianus*. *Anisonchus sectorius* and *A. dracus* are much larger than the present specimens.

Size. BYU 3741: M^1, L = (4.7), W = (6.3); M^2, L = (4.6), W = 6.90. BYU 3742: M^1, L = 4.30, W = 6.40. BYU 3817: M_3, PW = 3.10. BYU 3820: M_3, L = (5.25), W = 2.90.

Anisonchus onostus Gazin, 1939

Locality and Material. Dairy Creek: BYU 3856, left M_2.

Description. BYU 3856 has a large protoconid with the trigonid cusps connected by small ridges. The trigonid is relatively low and has a moderately developed precingulid. The paraconid is relatively large and medially positioned and the metaconid is large. The talonid cusps are large and widely separated with the talonid open and very wide anteriorly. The hypoconulid is medial in position.

Discussion. In all above aspects, BYU 3856 is identical to the type of *A. onostus*. No significant differences between *A. onostus* and BYU 3856 were observed. BYU 3856 is 2%–3% (an insignificant amount) larger than the type specimen of *A. onostus*. *A. dracus* and *A. sectorius* are much too large to be conspecific with the present specimen. Lower molars referred to *A. athelas* have a very different trigonid morphology, thus eliminating them from further consideration.

The type specimen *A. oligistus* differs from BYU 3856 in being about 14% narrower, having a much larger paraconid, smaller protoconid, narrower talonid anteriorly, and having a higher trigonid.

BYU 3856 differs from the type of *Gillisonchus gillianus* in having more inflated cusps, smaller entoconid, much wider and more open talonid anteriorly, a smaller, more anterior hypoconid, a shorter talonid, and a more medially placed hypoconulid.

Size. BYU 3856: M_2, L = 4.25, W = 3.30.

Genus *Haploconus* Cope, 1882
Haploconus elachistus Gazin, 1941

Locality and Material. Dairy Creek: BYU 3771, right maxilla fragment with complete $M^{1\text{-}2}$.

Description. M^1 and M^2 are very similar to each other except that M^1 is relatively longer anteroposteriorly and narrower transversely than M^2. The teeth are elongate transversely and triangular in shape. A well-developed parastyle is present as is a distinct protostyle. The paracone and metacone are very close together. The paraconule and metaconule are small. The hypocone is large and very lingual in position. The teeth lack an edocingulum; the ectocingulum at the base of the paracone is also lacking.

Discussion. The same comparative specimens used in identification of *Anisonchus athelas* were used for all BYU specimens of *Haploconus*. BYU 3771 differs from specimens of *Anisonchus* in having a distinct protostyle, closely appressed paracone and metacone, a distinct paraconule (present in *A. sectorius*), an incomplete ectocingulum, and a large and very lingual hypocone. BYU 3771 differs from *Conacodon* as the latter has a complete ectocingulum, lacks a protostyle, has a more anterior hypocone, and has a complete endocingulum. *Hemithlaeus* has a much smaller hypocone and a much larger protostyle than BYU 3771.

The M^2 of the present specimen is short anteroposteriorly as in the type specimen of *Haploconus elachistus*, but is relatively a little smaller than the type of *H. inopinatus*. The M^1 of BYU 3771 is more transversely elongate than M^1 in the type of *H. inopinatus* and has a distinct paraconule which is missing in *H. inopinatus*. The hypocone column of M^1 is more inflated and lingually positioned in the BYU specimen than in *H. inopinatus*, and the BYU specimen is much shorter anteroposteriorly, especially lingually. M^2 in *H. inopinatus* has a much larger protostyle than that seen on M^2 of the present specimen.

The upper molars of *H. angustus* and *H. corniculatus* are squarish in occlusal view, much too long anteroposteriorly, and too narrow transversely to be conspecific with BYU 3771.

BYU 3771 matches the type specimen of *H. elachistus* in all of the above-described features.

Size. BYU 3771: M^1, L = 3.70, W = 5.20; M^2, L = 3.70, W = 5.70.

Haploconus sp.

Locality and Material. Dairy Creek: BYU 3842, left M_2 (hypoconulid broken). Wagonroad: AMNH 36076, jaw fragment with left $M_{?2}$ talonid fragment and $M_{?3}$ trigonid.

Description. BYU 3842 (M_2) has a very large, inflated protoconid that is elongate anteroposteriorly. The paraconid is incipient. The protoconid and metaconid are connected by a relatively high ridge and both cusps are inflated. The precingulid is large while the ectocingulid is small. The entire tooth is wide transversely with a lingually placed entoconid. The relatively large entoconid is as large as the hypoconid and both are anteriorly placed. The hypoconulid is medial and separated from both the other two talonid cusps. The talonid basin is relatively small and enclosed. The talonid portion present in AMNH 36076 is badly damaged but appears to be very similar to BYU 3842.

$M_{?3}$ (AMNH 36076) is badly crushed but does have an inflated protoconid and metaconid with the paraconid absent.

Discussion. Both specimens represent *Haploconus* as evidenced by the enlarged protoconid and lacking paraconid. The present specimens probably do not represent *H. corniculatus* as the compared specimen from New Mexico is 25%–28% larger.

BYU 3842 differs from the type of *H. angustus* by being too short anteroposteriorly yet too wide transversely. The "paraconid" swelling on the anterior portion of the protoconid is too far anteriorly placed in *H. angustus* and the precingulid climbs the anterior portion of the metaconid. *H. angustus* also has a much too closed talonid basin and too small an ectocingulid to be conspecific with BYU 3842.

Lower molars of *H. elachistus* and *H. inopinatus* are poorly described and based only on referred material. These BYU specimens do, however, fit the description given by Gazin (1941) of *H. inopinatus* more than that of *H. elachistus* because they lack the small paraconid described in the latter.

Lower molars of *Conacodon utahensis* are wider with a larger talonid basin than the present specimens, and the entoconid is anterior to the hypoconid in *C. utahensis*. However, the same dental elements in the two taxa are poorly represented.

Three other badly damaged specimens also apparently represent *Haploconus*, but are too badly damaged to allow more than questionable generic identification. Included are: AMNH 86712, P^2-M^3, from Dragon Canyon, AMNH 36076, $M_{?1}$-$M_{?2}$, and AMNH 36067, P_4-M_1, from the Wagonroad locality.

Size. BYU 3842: M_2, AW = 3.35, PW = 3.40, L = (4.1). AMNH 36076: $M_{?2}$, PW = 3.10; $M_{?3}$, AW = 3.20.

Genus *Conacodon* Matthew, 1897
Conacodon utahensis n. sp.
plate 3, figs. 4–7

Etymology. Named for the state of Utah, this being the only reported species from the state.

Type Specimen. BYU 3864, right jaw fragment with M_1 is designated the holotype, with BYU 3865, an associated left jaw fragment with M_2 talonid and M_3, as the paratype. Gast Tank Hill locality, Gas Tank local fauna, North Horn Formation, central Utah.

Referred Material. Wagonroad locality: AMNH 36051, damaged right M_3. Gas Tank Hill: BYU 3870, maxilla fragment with the roots of M^{1-3} found in association with the holotype and paratype.

Diagnosis. Much smaller than *Conacodon entoconus*, but larger than *C. cophater*. Paraconid relatively smaller than *C. entoconus* or *C. cophater*. Smaller cingulids than *C. cophater* and relatively larger talonid basin (more posterior hypoconulid) on M_{1-2}. M_3 hypoconulid and hypoconid less inflated than *C. cophater*, yet metaconid more inflated.

Description. BYU 3864 (M_1) has a very large and anteroposteriorly elongate protoconid. The protoconid is well worn but the paraconid is apparently greatly reduced and fused to the metaconid. The anterior portion of the protoconid is somewhat lingual and very anterior in position. The metaconid is relatively small and posteriorly situated. The trigonid is large, representing over half the tooth length. The precingulid is well developed. The metaconid and entoconid are very closely appressed. The entoconid is slightly higher than and anterior to the hypoconid. The hypoconid is relatively large but short while the hypoconulid (apparently) was also relatively large and medially placed. The talonid cusps are all subequal in size and connected by low ridges. The talonid basin is relatively broad and completely enclosed. A slight postcingulid is present. Only the talonid of M_2 is present and it is nearly identical to that of M_1 described above.

M_3, as represented by BYU 3865 and AMNH 36051, has a less inflated protoconid than seen in M_1. The protoconid and metaconid are close together and the metaconid is relatively small. The paraconid is fused to the metaconid. The precingulid is present but not as well developed as in M_1. The entoconid is higher but less massive than the hypoconid. The hypoconulid is as large as the hypoconid and larger than the entoconid. The hypoconulid is medially and posteriorly positioned and separated from the talonid. Cingulids are present on the lingual and labial sides of the hypoconulid but not around the posterior portion. Ridges from the three talonid cusps join just anterior to the hypoconulid, making the talonid basin small and enclosed. The upper molars (as indicated by the roots) are very wide transversely, and have a very similar shape and relative size to other species of *Conacodon.*

Discussion. C. utahensis is most similar to *C. cophater* (AMNH 16481, 16435 and 3488) from New Mexico. The present specimens differ *C. cophater* and *C. entoconus* as described above. These specimens also are similar to *Haploconus.* Gazin (1941, p 50–51) stated that both *H. elachistus* and *H. inopinatus* show no important distinguishing characters (other than size) when compared to *H. angustus.* The type specimen of *H. angustus* is more than 40% larger than *C. utahensis. H. angustus* and *C. utahensis* will be compared, and inferred to include *H. elachistus* and *H. inopinatus.*

M_1 in *H. angustus* differs in the following ways from M_1 in BYU 3864: (1) the postcingulid, ectocingulid, and precingulid are smaller, and the endocingulid does not climb up the anterior face of the metaconid; (2) the "paraconid" swelling is not nearly so anterior or lingual; (3) the talonid is relatively narrower; (4) the entoconid is more separated from the metaconid; and (5) the metaconid is much larger and more anterior.

M_2 in *H. angustus* differs from BYU 3865 in having a narrower talonid and the entoconid is not as strongly connected to the rest of the talonid cusps. *H. angustus* M_3 has a much larger metaconid, more inflated paraconid "bump," a smaller but not so anteriorly elongate protoconid, smaller precingulid, smaller entoconid, a not so distinct and separate hypoconulid, has no postcingulid, and lacks the three talonid ridges which join just anterior to the hypoconulid seen in the present specimens possessing M_3.

Size. BYU 3864: M_1, L = 4.10, AW = 2.75, PW = 2.80. BYU 3865: M_2, PW = 3.10; M_3, L = (4.5), AW = 2.90,

PW = 2.75. AMNH 36051: M_3, L = (4.5), AW = (2.9), PW = 2.75.

Genus *Oxyacodon* Osborn and Earle, 1895
plate 3, figs. 9–12

All of the *Oxyacodon* material in the BYU collection is described and discussed in Archibald and others (1983) except BYU 3803 (damaged left M^1) from Blue Lake, described below. *Oxyacodon* species reported from the North Horn Formation include *O. ferronensis*, *O. apiculatus* (Archibald and others 1983), and *O. marshater* (Van Valen 1978).

Oxyacodon ? n. sp.

Locality and Material. Blue Lake: BYU 3803, damaged left M^1.

Description. General features of BYU 3803 are about the same as in material referred to *Oxyacodon ferronensis*. Specific differences are given below.

Discussion. BYU 3803 is specifically unlike any other known *Oxyacodon* upper molar (Rigby personal communication 1980). The present specimen differs from *O. ferronensis* by having a larger mesostyle, a more posterior protocone, a larger metaconule that is much closer to the protocone, a much more anteroposteriorly restricted trigon basin, a more bilobate labial side and in being much larger (apparently 20% longer anteroposteriorly and 30% wider transversely). Again, other than size, the major difference is that the groove up the preprotocrista is very deeply incised, very broad, and extends to the protocone apex. A very deep broad groove is also present between the metacone and metaconule. These deep, enlarged grooves are different from any known specimen (Rigby personal communication 1980).

BYU 3803 differs from BYU 3798 (*O. apiculatus*) in having a mesostyle, a more bilobed labial side, a greater metacone-metaconule separation, a smaller ectocingulum around the metacone, and the great difference in the grooves on the preprotocrista.

Size. BYU 3803 is broken and accurate measurements cannot be obtained.

Family Phenacodontidae
Genus *Desmatoclaenus* Gazin, 1941
Desmatoclaenus paracreodus Gazin, 1941
plate 2, fig. 10

Locality and Material. Ferron Mountain: BYU 3860, right maxillary fragment with damaged $M^{1\text{-}2}$. Blue Lake: BYU 3800, slightly damaged right M^1; BYU 3862, damaged left maxillary fragment with M^1 and roots of M^{2-3}. Wagonroad: AMNH 36073, left M^3.

Description. M^1 (BYU 3800, BYU 3860, and BYU 3862) is squarish in occlusal view and has a rugose surface. The three major cusps (protocone, metacone, and paracone) are large and well separated. The hypocone, metaconule, and metacone are subequal in size and lie in a straight line. The paraconule is small and the cingula are well developed.

M^2 (BYU 3860) is very similar to M^1 but is considerably larger and has the paracone labial to the metacone. M^2 also has a small protostyle and the cingula are apparently present around most of the tooth, features not seen in M^1.

M^3 (AMNH 36073) has an oval outline in occlusal view. The paracone is almost as large as the relatively large protocone while the metacone is small and relatively lingually placed. The preprotocrista and postprotocrista are large with a small paraconule and metaconule. The postcingulum is relatively wide, with a small hypocone swelling present. The endocingulum is well developed and nearly complete around the protocone base. M^3 is about 20% narrower transversely than M^2.

Discussion. Comparative material used to identify all the *Desmatoclaenus* specimens in the BYU collection includes these casts: *Desmatoclaenus paracreodus:* USNM 16201, type, from Utah; *Desmatoclaenus hermaeus:* USNM 16202, type, from Utah; *Tetraclaenodon puercensis:* AMNH 2481, UCMP 68816, and UCMP 36514 from New Mexico, AMNH 87602, AMNH 87603, and PU 16594 from Wyoming; *"Protogonodon" protoganoides:* AMNH 16396 from New Mexico. Illustrations of the following were also used: *Desmatoclaenus paracreodus:* USNM 16177 from Utah (Gazin 1941); *Desmatoclaenus dianeae:* AMNH 23177, type, from New Mexico; and *D. mearae:* UCMP 114308, type, from Montana (Van Valen 1978).

Van Valen (1978) placed *Desmatoclaenus* in the family Arctocyonidae. I choose the more widely accepted and more conservative stand and leave the genus in the family Phenacodontidae. There is, in my opinion, a lack of evidence to place *Desmatoclaenus* in the Arctocyonidae and I feel it should not be separated from the closely related genus *Tetraclaenodon;* to place *Tetraclaenodon* and *Desmatoclaenus* in different families obscures the relationship of these two genera.

West (1976) synonymized *Desmatoclaenus paracreodus* with *D. hermaeus.* After studying the BYU specimens, I believe that *D. hermaeus* and *D. paracreodus* are both separate and valid species. *D. paracreodus* will here be treated as a valid species for the reasons discussed below.

The only observable differences between M^1 of the type specimen of *D. paracreodus* and M^1 of BYU 3800, BYU 3860, and BYU 3862 is that the latter have a slightly larger ectocingulum and are about 5% larger. These differences are considered insignificant. The BYU specimens are much larger than *D. hermaeus, D. dianae,* and *D. mearae.* M^1, in compared specimens of *Tetra-*

claenodon puercensis, has a well-developed mesostyle not seen in the BYU material or *D. paracreodus*. M^2 of *T. puercensis* is relatively much smaller than BYU 3860. The principle cusps of *T. puercensis* M^{1-2} are more inflated, smaller, and closer together than seen in the BYU material while the paraconule, metaconule, and hypocone of *T. puercensis* are larger than *D. paracreodus*. The ectocingulum seen in the BYU specimens is lacking in compared material of *T. puercensis*. In the above details, *D. paracreodus* and the BYU specimens are identical.

AMNH 36073 (M^3) is 14% wider transversely than the type of *D. hermaeus*. The endocingulum of *D. hermaeus* is larger than the present specimen and *D. hermaeus* has a more labially placed metacone. M^3 of *D. dianae* and *D. mearae* are unknown, but M^2 in both species is 39%–57% narrower transversely than *D. hermaeus*, eliminating them from further consideration. *Tetraclaenodon puercensis* has a protostyle and much larger hypocone than seen in AMNH 36073.

In all features present, AMNH 36073 is inseparable from the type specimen of *D. paracreodus*, except that it is 2% shorter anteroposteriorly and 4% narrower transversely, which is not considered significant.

Size. BYU 3800: M^1, L = (8.9), W = 10.90. BYU 3860: M^1, L = (8.8), W = 9.70; M^2, W = 11.80. BYU 3862: M^1, L = 8.60, W = 8.70. AMNH 36073: M^3, L = 6.10, W = 9.50.

Desmatoclaenus hermaeus Gazin, 1941

Locality and Material. Dairy Creek: BYU 3779, right M^1. Wagonroad: BYU 4925, left M^1; AMNH 36075, a damaged right P_4. Dragon Canyon: AMNH 36029, a broken left P_4.

Description. BYU 3779 and BYU 4925 (M^1) are squarish in occlusal view with the three major cusps large and well separated. The metaconule is larger than the paraconule, and the teeth have a large preprotocrista and postprotocrista. A moderate parastyle is present and the ectocingulum is incomplete around the paracone. The protostyle and mesostyle are absent but a broad precingulum is present. The hypocone is small but a broad postcingulum is present.

P_4 (AMNH 36075 and AMNH 36029) has a small paraconid with a large protoconid and moderate-sized metaconid. The metaconid is distinctly posterior to the protoconid and the talonid heel is relatively large.

Discussion. Both of these BYU specimens display the distinguishing characteristics of *Desmatoclaenus* described by Gazin (1941), i.e., a discontinuous cingulum around the paracone, lack of a mesostyle, and hypocone development not to the extent seen in *Tetraclaenodon*. M^1 of *D. hermaeus* is unknown, making direct comparison with it impossible.

BYU material referred to *D. paracreodus* and the type of *D. paracreodus* are larger than BYU 3779 and BYU 4925 and have a larger hypocone. The present specimens are larger than *D. mearae* and/or *D. dianae* and lack the large hypocone development seen in those species.

BYU 3779 and BYU 4925 are unlike any of the described species of *Desmatoclaenus* except for *D. hermaeus*, and M^1 in comparative material of *D. hermaeus* is lacking. The BYU specimens are very similar to *D. hermaeus* and are referred to that species.

BYU 3779 and BYU 4925 are also similar to a cast of *"Protogonodon" protogonioides* (AMNH 16396), a species that Van Valen (1978) placed in *Desmatoclaenus*. BYU 3779 tends to support the placement of that species in *Desmatoclaenus*.

AMNH 36075 and AMNH 36029 were tentatively identified by Van Valen as *Desmatoclaenus*. I agree with this identification as they are very similar to and almost the exact same size as P_4 in the type of *D. hermaeus*. P_4 in *Tetraclaenodon puercensis* has a much larger paraconid and the metaconid is much more anterior. The metaconid and protoconid of *T. puercensis* are equally as far anterior, while in these American Museum specimens the metaconid is distinctly posterior to the protoconid. Their broken nature plus the fact that they are not associated with molars makes reference to a particular species of *Desmatoclaenus* questionable.

Size. BYU 3779: M^1, L = (7.40), W = 9.40. BYU 4925: M^1, L = 8.05, W = (10.0). AMNH 36075: P_4, L = 7.15, W = 4.80.

Family Arctocyonidae
Genus *Loxolophus* Cope, 1885
Loxolophus pentacus (Cope, 1888)
plate 4, figs. 1, 2

Locality and Material. Ferron Mountain: BYU 3819, left jaw fragment with M_1 talonid and M_2; BYU 3822, right jaw fragment with slightly damaged $M_{1\text{-}3}$; BYU 9987, left M_3. Sage Flat: BYU 3830, left maxilla fragment with P^4-M^1 (P^4 slightly damaged).

Description. M_1 has a relatively narrow trigonid with large inflated cusps. The paraconid is large, anterior in position, slightly lingually placed and subequal in size to the protoconid. Small ridges connect each of the trigonid cusps. A precingulid is present; the ectocingulid and postcingulid are observable only on the large crescent-shaped hypoconid. The entoconid is large and the hypoconulid is small on $M_{2\text{-}3}$ and small or not present on M_1 (the talonids of the M_1s are too worn to determine the presence of the hypoconulid). The talonid basin is deep with the talonid being wider transversely than the trigonid.

M_2 in both BYU specimens exhibits a paraconid not so anterior yet much more lingual than seen in M_1. The protoconid is relatively larger and the metaconid relatively smaller than seen in M_1. The metaconid and paraconid are closely appressed. The talonids of M_2 and M_1 are very similar.

The paraconid and metaconid of M_3 are much closer together than seen in M_2 and the paraconid is more lingual than in M_2. The hypoconid and metaconid are also relatively smaller than seen in M_2. The hypoconulid is apparently large and posterior but has been broken off in BYU 3822. The talonid is elongate anteroposteriorly, is wider transversely than the trigonid, and is relatively much higher than seen in M_2 or M_1. In overall size M_3 is much smaller than M_2, but is relatively longer. BYU 3822 and BYU 3819 could very well represent the same individual; they were found quite close to each other in a site that yielded only a few mammalian fossils.

P^4 has a small but distinct parastyle with the metacone small and closely appressed to the paracone. The protocone is relatively large but smaller than and separated from the paracone. The tooth is triangular-shaped in occlusal view.

M^1 is squarish in occlusal view with the three major cusps large and well separated. The metaconule is larger than the paraconule; the pre- and postprotocrista are large. The protostyle and mesostyle are absent but a moderately large parastyle is present. The hypocone is large, as are the cingula.

Discussion. The status of the genus *Protogonodon* is in doubt. D. E. Russell (1967) placed at least all the North Horn Formation specimens of *Protogonodon* in *Loxolophus*. Van Valen (1978) said *Protogonodon* was a junior synonym of Loxolophus for all species and placed *"Protogonodon" grangeri* in *Loxolophus pentacus:* to this latter assignment I disagree. The retention of *Loxolophus grangeri* as a valid species is held by other current workers and will be followed in this paper. Comparative material used to identify the *Loxolophus* material in the BYU collection includes the following casts*: Loxolophus pentacus:* AMNH 3192, type, and AMNH 3196 from New Mexico; *L. grangeri:* AMNH 27713, type, from New Mexico; *L. spiekeri:* USNM 15538, type, from Utah; *L. biathales:* USNM 16181, type, from Utah; *L. kimbetovius:* AMNH 16397, type, from New Mexico; *L. criswelli* (referred to *Protogonodon criswelli* by Rigby 1980): AMNH 87582, type, from Wyoming.

BYU 3822 is the most complete specimen of *L. pentacus* in the BYU collection and is nearly identical to BYU 9987 and BYU 3819. Unless otherwise noted, comparisons will be made using BYU 3822. BYU 3822 is essentially identical to the type specimen of *Loxolophus pentacus;* in all the features described above the two are inseparable.

The present specimen differs from the type specimen of *L. kimbetovius* in that it lacks a large distinct hypoconulid on M_{1-2}; it has a deeper, enclosed, and relatively wider talonid basin; the hypoconid is larger; and on M_2 the entoconid is larger. The BYU specimens also have less inflated cusps, a smaller ectocingulid, a much smaller protoconid, and a more medial paraconid than seen in *L. kimbetovius*. The trigonid is also wider than the talonid in this species; the reverse is true of the BYU specimens.

The type specimen of *L. grangeri* is much larger with more inflated cusps than BYU 3822. *L. grangeri* also has a relatively much larger protoconid on M_1, the trigonid wider than the talonid on M_{1-2}, the paraconid much more lingually placed and closer to the metaconid, and the talonid basin shorter and shallower than BYU 3822.

M_1 of the type of *L. spiekeri* differs from the present specimen in having the paraconid much more lingually placed and closely appressed to the metaconid and the paraconid more inflated and shorter. The protoconid is more medially placed; the cusps are more inflated and more rugose in *L. spiekeri* than BYU 3822. In the BYU specimens, M_1 has a larger entoconid, smaller hypoconulid, relatively lower, anteroposteriorly longer and deeper talonid basin than the type specimen of *L. spiekeri.*

M_2 of the type of *L. spiekeri* has a larger hypoconulid, a much lower hypoconid and entoconid, a stronger ridge connecting the metaconid and paraconid, and a much smaller talonid basin, yet is much larger with more inflated and rugose cusps than M_2 in BYU 3822. M_3 of *L. spiekeri* has a much smaller entoconid and more shallow talonid basin than the BYU specimen.

The type of *L. biathales* is similar to BYU 3822 except that the paraconid of M_1 is too far anteriorly and lingually placed. Van Valen (1978) synonymized *L. biathales* with *L. spiekeri,* but gave no reasons for doing so; I choose to leave it separate because of a lack of evidence to combine the two. M_2 of *L. biathales* has a paraconid more medially and posteriorly placed with a much larger protoconid than BYU 3822 and has a much wider talonid basin with a larger, more distinct hypoconulid.

Matthew (1937) gave the size range of eleven specimens of *L. priscus,* including the holotype. M_1 of BYU 3822 is 29% longer anteroposteriorly and 38% wider transversely than the largest of Matthew's eleven specimens. This size difference is sufficient to eliminate *L. priscus* from further comparison. *L. hyatianus* is 20% smaller than *L. priscus* (Matthew 1937) and will not be compared further.

BYU 3830 is identical to *L. pentacus* except for a slightly smaller parastyle on P^4 and M^1. BYU 3851 (right jaw fragment with damaged M_{1-2}) and BYU 3787 (right M_2) from Blue Lake are tentatively referred to *L. pentacus*, as they are 2%-30% smaller than the other BYU specimens referred to *L. pentacus*. Other minor differences are within the variation limits expected for the species.

Size. BYU 3822: M_1, AW = 6.70, PW = 8.00, L = 9.40; M_2, AW = 8.85, PW = 9.55, L = (10.0); M_3, AW = 7.65, PW = 6.90, L = (9.5). BYU 3819: M_1, PW = 8.45; M_2, AW = 9.00, PW = (9.75). BYU 3830: P^4, L=6.20, W=7.60; M^1, L=8.05, W=8.55. BYU 3787: M_2, AW=8.15, PW=8.70, L=9.90. BYU 3851: M_1, AW=5.85, PW=(6.5), L=8.95; M_2, AW=7.90, PW=8.80. BYU 9987: M_1, AW=7.4, PW=(6.9), L=9.95.

Loxolophus cf. *L. spiekeri* (Gazin, 1938)

Locality and Material. Dairy Creek: BYU 3768, right jaw fragment with $M_{1\text{-}2}$ and anterior half of M_3.

Description. The teeth in this specimen have been broken and recemented during preservation. The lingual half of the teeth were seriously damaged during original preparation.

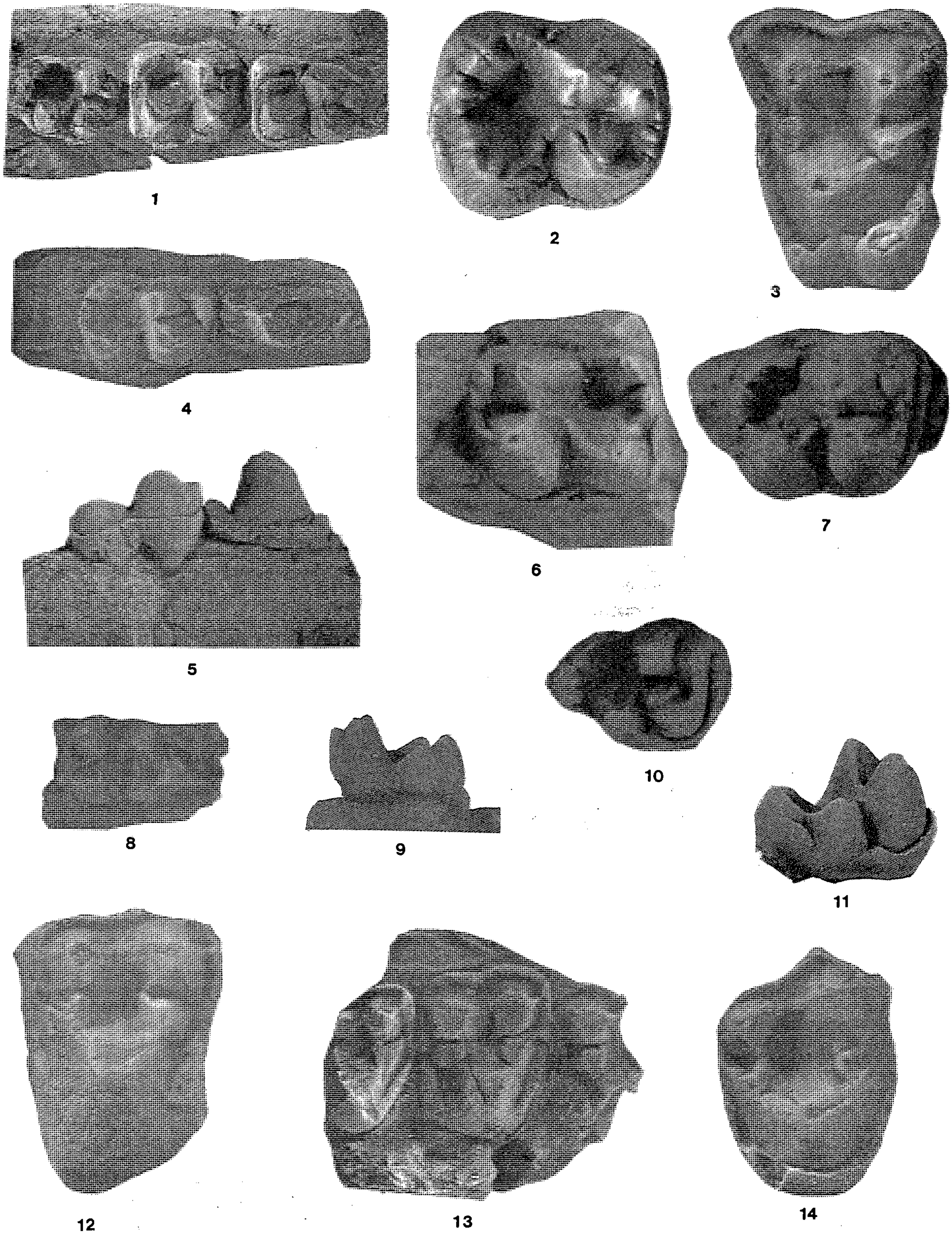
All three molars exhibit a reduced, although damaged, very lingually placed paraconid that is closely appressed to the metaconid. The teeth are all quite rugose and a distinct hypoconulid is present on M_2. General features are similar to those of *Loxolophus pentacus* described earlier.

Discussion. BYU 3768 is a large specimen of *Loxolophus* and is distinguished from the other BYU *Loxolophus* specimens by the reduced lingually placed paraconid, especially on the M_1, and the paraconid's proximity to the metaconid. Gazin (1941, p. 18) stated that *L. spiekeri* is about the size of *L. pentacus* but differs from the latter in having a smaller, more lingual paraconid, in being more rugose, and in having more distinct talonid cusps. This description is essentially that of BYU 3768. However, the broken and damaged condition of the specimen makes specific identification uncertain.

Other molar fragments, probably referrable to *Loxolophus,* are present in the collection (BYU 3850, AMNH 36073, 36078, and 36079) from Blue Lake and Wagonroad localities but their damaged or fragmentary condition does not warrant specific identification.

EXPLANATION OF PLATE 4

Fig. 1—*Loxolophus pentacus*, occlusal view of a right jaw fragment with $M_{1\text{-}3}$, Ferron Mountain, X2 (BYU 3822). Fig. 2—*Loxolophus pentacus*, occlusal view of a right M_2, Blue Lake, X4.5 (BYU 3787). Fig. 3—*Chriacus truncatus*, occlusal view of a right M^2, Dragon Canyon, X7 (AMNH 36055). Figs. 4–5—*Oxyclaenus pugnax:* 4, occlusal view of a right jaw fragment with P_4-M_1, Blue Lake, X4 (BYU 3790); 5, same in lateral view. Fig. 6—*Mimotricentes subtrigonus*, occlusal view of a left M_2, Dragon Canyon, X7 (BYU 3836). Fig. 7—*Promioclaenus lemuroides*, occlusal view of a right M_2, Dragon Canyon, X8 (BYU 4368). Figs. 8–9—*Oxytomodon perissum:* 8, occlusal view of a right M_3, Dragon Canyon, X7.5 (BYU 3784); 9, same in lateral view. Figs. 10–11—*Promioclaenus acolytus:* 10, occlusal view of a right M_3, Ferron Mountain, X8 (BYU 3818); 11, same in slightly oblique lateral view. Fig. 12—*Promioclaenus* sp., occlusal view of a right M^1, Blue Lake, X9 (BYU 3796). Fig. 13—*Litaletes gazinensis*, n. sp. occlusal view of a right maxilla fragment with the posterior half of M^1 and $M^{2\text{-}3}$, Dairy Creek, X5.5 (BYU 3773 holotype). Fig. 14—*Litaletes disjunctus*, occlusal view of a right M^3, Dragon Canyon, X8.5 (BYU 3746).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Size. The broken and recemented nature of BYU 3768 makes accurate measurements very difficult to obtain. Some approximate diameters are given. M_1, AW = (8.4); M_2, AW = (9.0), PW = (9.2), L = (11.0); M_3, AW = (8.6).

Genus *Chriacus* Cope, 1883
Chriacus truncatus Cope, 1884
plate 4, fig. 3

Locality and Material. Dragon Canyon: BYU 3765, right M^2; AMNH 36055, right M^2.

Description. The three major cusps are large and well separated. The paracone and metacone are subequal in size with acute apices. The protocone is inflated and anterior in position. The trigon basin is broad and relatively deep. A moderate-sized parastyle and small metastyle are present; the mesostyle is lacking. The paraconule and metaconule are large, as are the ridges that extend from them. The metaconule is more lingually placed than the paraconule. A relatively large, low, and lingual hypocone is present as well as a small, low, and lingual protostyle. Except for the narrow cingulum around the protocone, broad cingula encircle the tooth. The tooth is squarish in occlusal view, slightly convex anteriorly (except right before the parastyle), and concave posteriorly. AMNH 36055 has a slightly smaller metastyle and a slightly more inflated hypocone than does BYU 3765.

Discussion. The following casts were used to identify specimens of *Chriacus* in the BYU collection: *Chriacus pelvidens:* AMNH 3097, type, and AMNH 2379 from New Mexico, AMNH 100560, AMNH 100561, and PU 13288 from Wyoming; *C. calenancus:* UMVP 1472, type, from Montana; *C. truncates:* AMNH 3101, type, from New Mexico; *C. katrinae:* PU 13949, type, from Wyoming; *C. baldwini,* UNM B-199c from New Mexico; *Chriacus sp.:* UALP 10384 and UALP 11043 from Utah; *C. gallinae:* AMNH 16223, type; *Oxyclaenus pugnax* (formerly *Chriacus pugnax*): USNM 13782, type from Montana; *Metachriacus "provocator":* USNM 9278, type, from Montana; *Metachriacus punitor:* USNM 9288, type, and USNM 9286, from Montana; *Mimotricentes elassus:* USNM 16178, type, and UCMP 47239 from Utah; *Mimotricentes subtrigonus:* AMNH 3277, type, KU 7759, KU 7760, KU 9569, AMNH 2399, and UNM B-1137 from New Mexico, PU 13934 from Wyoming; *Mimotricentes mirielae:* AMNH 58219, type, from New Mexico; and *Mimotricentes sp.:* PU 16628 and PU 17546 from Wyoming.

Illustrations of the following specimens were also used: *Chriacus pelvidens:* AMNH 2387 and AMNH 2379 from New Mexico; *Metachriacus "provocator":* USNM 9259 and USNM 15126 from Montana; *Metachriacus punitor:* USNM 9270 and USNM 9331 from Montana; *Mimotricentes elassus:* USNM 16179 from Utah; and *Mimotricentes subtrigonus:* AMNH 2402, AMNH 16563 and AMNH 16581 from New Mexico.

Simpson (1937, p. 196) said the following concerning the teeth of *Chriacus:* "The pattern is a simple and generalized one, easily confused with that of allied forms, and requiring close study and good material for its certain distinction."

Van Valen (1978) synonymized *Chriacus truncatus* with *Chriacus baldwini* but gave no reasons for doing so. I here choose to leave the former as a separate species for lack of data to synonymize them.

BYU 3765 and AMNH 36055 are identical to the type specimen of *C. truncatus* from the San Juan Basin, New Mexico, except that they are about 6% larger. This is not a significant difference. *C. katrinae, C. oconostotae,* and *C. calenancus* of Van Valen (1978) are described only on the basis of lower teeth, thus prohibiting direct comparison.

Rigby (1980) gave measurements for eleven specimens of *C. pelvidens* from Wyoming; the present specimens are 25%–47% shorter anteroposteriorly and 16%–38% narrower transversely than the smallest of Rigby's specimens.

Metachriacus punitor is much too small to be conspecific with the BYU material and will not be compared further. Simpson (1937, p. 193) stated that the hypocone on M^2 of *Metachriacus* is very small and that the protostyle is lacking; such is not the case with the present specimens.

Mimotricentes lacks the comlete endocingulum seen in *Chriacus,* which is one of the distinguishing characteristics between the two genera (Matthew 1937). *Mimotricentes subtrigonus* and *M. elassus* also both lack the small protostyle seen in BYU 3765 and AMNH 36055.

Size. BYU 3765: M^2, L = 5.40, W = 6.85. AMNH 36055: M^2, L = 5.30, W = 6.85.

Chriacus sp.

Locality and Material. Dragon Canyon: AMNH 36045, damaged left M^1; AMNH 36057, upper molar fragment.

Description. Both of these American Museum specimens have essentially identical morphological features as BYU 3765 described above, except size.

Discussion. AMNH 36045 has a slightly smaller protostyle and metastyle than BYU 3765 *(Chriacus truncatus)* but the tooth is overall much larger. Both of the present specimens compare most favorably with *C. truncatus* except in size. However, because of this size difference and their broken nature, specific identification will not be made. AMNH 36057 is much smaller than *C. truncatus* while AMNH 36045 is larger; the latter fits well into the size range of seventeen specimens of *C. pelvidens* with

M^1 observed in the Swain Quarry, Wyoming (Rigby 1980).

Size. AMNH 36045: M^1, L = 7.60, W = 6.05. AMNH 36057 is too broken to allow accurate measurements.

? *Chriacus*

Locality and Material. Sage Flat: BYU 3832, jaw fragment with M_1 talonid and M_2 trigonid.

Description. M_1 is apparently much smaller than M_2. M_1 has a large hypoconid, moderatley sized entoconid, and small hypoconulid. The protoconid and metaconid of M_2 are large, subequal, and separated by a groove. The paraconid is of moderate size, lingually placed, relatively high, close to the metaconid and separated from the protoconid by a groove. Both teeth have an ectocingulid.

Discussion. BYU 3832 is very similar to *Chriacus truncatus*, but because lower teeth of *Chriacus*, *Metachriacus*, and *Mimotricentes* are very similar and because this specimen is badly broken, generic identification is very difficult.

Size. BYU 3832: M_1, PW = 3.50; M_2, AW = 4.45.

Genus *Mimotricentes* Simpson, 1937
Mimotricentes subtrigonus (Cope, 1881)
plate 4, fig. 6

Locality and Material. Sage Flat: BYU 3836, left M_2. Dragon Canyon: BYU 3756, right M^3.

Description. BYU 3836 (M_2) has a small, very lingually placed paraconid that is closely appressed to the metaconid. The protoconid and metaconid are large, subequal in size, and separated by a deep groove. The trigonid is moderately high and the talonid basin relatively large and deep. The hypoconulid is small and medially placed while the hypoconid is large and the entoconid is of moderate size. The precingulid, ectocingulid, and labial half of the postcingulid are continuous.

M^3 (BYU 3756) has a large protocone and paracone but the metacone is as small as the paraconule and metaconule. The parastyle was apparently of moderate size, but has been broken off. A relatively large mesostyle is present but the protostyle and hypocone are very small. A complete cingulum is present although very narrow around the protocone.

Discussion. The same comparative materials used for *Chriacus truncates* were used for specimens of *Mimotricentes*.

BYU 3836 is much smaller than *Chriacus pelvidens*, *C. baldwini*, and *Oxyclaenus pugnax*. *Metachriacus* "*provocator*" is similar to this BYU specimen except that *M.* "*provocator*" has a much larger hypoconid, larger cusps overall, and is differently shaped. The type specimen of *Metachriacus punitor* shows M_2 more elongate anteroposteriorly, narrower transversely, has a smaller paraconid, a more acute protoconid, a higher entoconid, a much more labial hypoconid, a more lingually placed metaconid, and a much shorter trigonid anteroposteriorly than seen in BYU 3836.

A specimen of *Mimotricentes elassus*, with M_2 preserved, UCMP 47239, is much larger with more inflated cusps than BYU 3836. In addition, *M. elassus* differs from the BYU specimen by having a much larger hypoconulid, a more medially placed paraconid, and in lacking the ectocingulid.

The only differences observed between BYU 3836 and comparative material of *M. subtrigonus* is that the paraconid of the latter is slightly more medially placed. Rigby (1980) reported 62 *M. subtrigonus* specimens with M_2 from the Swain Quarry of Wyoming. BYU 3836 is near the mean of the 62 specimens in transverse width and is at the lower observed range in length and morphologically very similar to those described by Rigby.

BYU 3756 has a complete endocingulum and a mesostyle—features lacking in all comparative material of *Chriacus*. *Chriacus* specimens also have a smaller paracone, a very much larger metacone, smaller paraconule and metaconule, yet larger parastyle than seen in BYU 3756.

Gazin (1941) reported a maxillary fragment with M^3 and part of M^2 that he questionably referred to "*Tricentes*" *elassus*. Concerning this specimen Gazin (1941, p. 23) said: "The teeth are a little smaller than in "*Tricentes*" *subtrigonus* but otherwise show no important differences." Not having this specimen, USNM 16206, for comparison leaves me uncertain if it is actually *M. subtrigonus* or *M. elassus*. BYU 3756 is referred to *M. subtrigonus* because it is so similar to the type specimen of that species. The present specimen falls within the middle of the observed range of 52 specimens of *M. subtrigonus* from Swain Quarry (Rigby 1980) in anteroposterior length and near the upper observed range in transverse width.

Size. BYU 3836: M_2, L = 5.50, AW = 4.50, PW = 4.40. BYU 3756: M^3, L = 4.55, W = 6.75.

Mimotricentes sp.

Locality and Material. Sage Flat: BYU 4227, damaged left M_3. Dragon Canyon: AMNH 36056, damaged left $M^{?1}$.

Description. BYU 4227 has a large protoconid; the paraconid and metaconid have been broken off. The hypoconid is large and the ectocingulid is lacking around the hypoconid. The hypoconulid is of moderate size, not far posteriorly placed and very close to the small, ridge-like entoconid.

The three major cusps of AMNH 36056 ($M^{?1}$) are large and well separated. The endocingulum is incomplete around the lingual side of the protocone. The paraconule and metaconule are present as is the large hypocone; the parastyle is absent.

Discussion. Chriacus and "*Metachriacus*" all have a very large and very posterior hypoconulid on M_3; *Mimotricentes* and BYU 4227 have a much smaller and more anterior hypoconulid. *Chriacus* further differs from BYU 4227 in having a larger, more lingual entoconid that is too distantly separated from the hypoconulid. The present specimen is very similar to *M. subtrigonus* and fits well within the observed width range of 75 specimens of *M. subtrigonus* with M_3 from Wyoming (Rigby 1980) but is slightly shorter anteroposteriorly than Rigby's smallest specimen. However, its damaged nature makes specific identification very difficult.

AMNH 36056 differs from *Chriacus* or *Metachriacus* in lacking a protostyle and having an incomplete endocingulum.

AMNH 36056 is very similar to *Mimotricentes subtrigonus* and fits about in the middle of the observed size range of 55 specimens of *Mimotricentes subtrigonus* M^1s described by Rigby (1980). Again, the damaged condition of the specimen prohibits specific identification.

Size. BYU 4227: M_3, L = 5.60, W = (3.75). AMNH 36056: $M^{?1}$, L = 5.00, W = 6.55.

Genus *Oxyclaenus* Cope, *1884*
Thangorodrim Van Valen, 1978, p. 55
Oxyclaenus pugnax (Simpson, 1935)
Thangorodrim thalion Van Valen, 1978, p. 55
plate 4, figs. 4–5

Locality and Material. Dairy Creek: BYU 3861, left M_1. Blue Lake: BYU 3790, right jaw fragment with M_1 and damaged P_4.

Description. The M_1's in these two specimens are nearly identical except that BYU 3790 is about 10%–11% smaller than BYU 3861. The cusps in M_1 are greatly inflated and the trigonid is relatively high. The paraconid is anterior, lingually placed, low on the trigonid, moderately large and has faint ridges connecting it with the other trigonid cusps. A ridge connects the large, inflated and subequally sized protoconid and metaconid. The hypoconid is large, inflated, and crescent-shaped with a small swelling present on the cristid obliqua. The entoconid is moderately larger and elongate anteroposteriorly while the hypoconulid is small and slightly lingually placed. The talonid basin is enclosed and almost circular in occlusal view.

P_4 has a large central protoconid with an anterior and a posterior ridge. There is no real evidence of a metaconid although wear could have removed this cusp. The paraconid has been broken off. The talonid heel cusp ("hypoconid") is large, well separated from the protoconid, and posteriorly directed.

Discussion. "*Chriacus*" *pugnax* was changed by Van Valen and Sloan (1965) to *Oxyclaenus pugnax* based on more complete material. I agree with this change because of the similarities of the BYU material here identified as *Oxyclaenus pugnax* and other species of *Oxyclaenus*. Van Valen (1978) changed *O. pugnax* to "*Thangorodrim*" *pugnax*. "*T. thalion,*" the type and only other recognized species of the genus, has as its type specimen an isolated M_1 that is nearly identical to the type specimen of *Oxyclaenus pugnax*. These two type specimens do not display specific differences, especially when compared to the BYU material referred to *Oxyclaenus pugnax*. I see no need for erecting the genus "*Thangorodrim*" when the specimens are so similar to those of the other species of *Oxyclaenus*. I do not believe "*Thangorodrim*" is a valid genus nor do I believe "*Thangorodrim thalion*" is separable from *Oxyclaenus pugnax* for the reasons discussed below.

Comparative material used to help identify BYU 3790 and BYU 3861 includes the following casts: *Chriacus pelvidens:* AMNH 3097, holotype, and AMNH 2379 from New Mexico, AMNH 100560 from Wyoming; *Chriacus gallinae:* AMNH 16223, holotype; *Chriacus katrinae:* PU 13949, type, from Wyoming; *Chriacus calenacus:* UM VP 1472, type, from Montana; *Metachriacus punitor:* USNM 9288, type, and USNM 9286 from Montana; *Metachriacus "provocator":* USNM 9278, type, from Montana; *Mimotricentes subtrigonus:* AMNH 2399, KU 7759, KU 9569, and KU 7760, from New Mexico, PU 16628 from Wyoming, PU 13934 from Montana; *Oxyclaenus simplex:* AMNH 3107, type, from New Mexico; *Oxyclaenus cuspidatus:* AMNH 794 from New Mexico; *Oxyclaenus pearcei:* USNM 16186, type, from Utah; and *Oxyclaenus pugnax:* USNM 13782, type, UM VP1473 "*Thangorodrim thalion,*" holotype from Montana.

M_1 in BYU 3790 and BYU 3861 differs from *Chriacus pelvidens* in having much more inflated trigonid cusps, closeness of the protoconid to the metaconid, a more lingually placed paraconid, a swelling on the cristid obliqua, more anterior entoconid, closeness of the hypoconulid to the hypoconid, and in being 17%–20% wider transversely. P_4 in BYU 3790 shows no real evidence of a metaconid; *Chriacus pelvidens* and *C. baldwini* have a very distinct one on this tooth.

Chriacus katrinae is much larger than the present specimens and has a higher, more medially placed paraconid, higher and larger entoconid, a greater protoconid-metaconid separation, and a relatively much larger and deeper talonid basin.

BYU 3790 and BYU 3861 differ from the type specimen of *Chriacus gallinae* in having a relatively much narrower trigonid, a more posterior paraconid, and a much better developed ectocingulid. M_1 of *Chriacus calenacus* is unknown, but M_2 appears to be much shorter, yet wider than what would be expected for the BYU specimens, and has a larger protoconid and a more lingual paraconid.

Metachriacus punitor and *M. "provocator"* are much too small to compare further with the present specimens. *Mimotricentes subtrigonus* is also much smaller and has a very different paraconid size and position than seen in BYU 3790 and BYU 3861.

Both of the present BYU specimens are nearly identical to the type specimen of *Oxyclaenus pugnax*. The only real difference is that of size. BYU 3790 is 3% shorter and 6% (AW) to 11% (PW) narrower than the type while BYU 3861 is 6% longer and 0% (PW) to 2% (AW) wider. These differences are not considered significant. The type specimen of *"Thangorodrim thalion"* has cusps not quite as inflated as the BYU material and the type of *Oxyclaenus pugnax* and a slightly greater protoconid-paraconid separation; but in every other measurement is within the size range of the BYU specimens. BYU 3790, BYU 3861, and the type specimens of *O. pugnax* and *"T. Thalion"* appear to me to represent a single species, *Oxyclaenus pugnax*. I place the species in *Oxyclaenus*, as did Van Valen and Sloan (1965), because the only real differences between the BYU material and *O. cuspidatus* and *O. pearcei* is size. *O. simplex* is also much smaller but has a more lingual paracone, shorter trigonid, and relatively smaller entoconid and hypoconid than the BYU material. In all, *O. pugnax* is much more *Oxyclaenus*-like than *Chriacus*-like as it was originally described (Simpson 1935).

Size. BYU 3790: P_4, L = (6.7), W = 3.35; M_1, L = 6.65, AW = 4.50, PW = 5.20. BYU 3861: M_1, L = 7.55, AW = 5.00, PW = 5.85.

? *Oxyclaenus* sp.

Locality and Material. Blue Lake: BYU 3799, slightly damaged left $M^{?2}$.

Description. BYU 3799 has a round-conic paracone and metacone that are connected by ridges; the paracone is slightly larger. The parastyle is large and the mesostyle is small; the tooth is damaged so the presence of a metastyle cannot be determined. The paraconule and metaconule are of moderate size and the protocone is relatively large and inflated. The cingula are damaged but were all apparently moderately large except for the endocingulum, which is lacking. The hypocone is broken but was apparently present and of moderate size.

Discussion. BYU 3799 is very *Oxyclaenus*-like, expecially in the parastyle construction and morphology. *Oxyclaenus simplex* (AMNH 3107, type, and UNM B-038 from New Mexico) is very similar to BYU 3799 but is larger, has a less inflated protocone, a slightly less acute parastyle, and an apparently larger hypocone. *O. cuspidatus* (AMNH 3252, type, from New Mexico) is also very similar to BYU 3799 but it lacks the mesostyle, is a little larger, and has a large cingulum around the metacone, which is lacking in the BYU specimen. Upper teeth of *O. pugnax* are undescribed and those of *O. pearcei* are only dubiously known. Gazin (1941) reported an upper molar of *Oxyclaenus* sp. from the Wagonroad horizon. The brief description of that tooth (USNM 16217) is similar to the present specimen.

BYU 3799 differs from *Chriacus* as it lacks the complete endocingulum of the latter and differs from *Mimotricentes, Loxolophus,* and *Chriacus* in the parastylar development. BYU 3799 is only questionably referred to *Oxyclaenus* because of its broken nature, slight differences when compared to *O. simplex* and *O. cuspidatus,* and because upper molars of *O. pugnax* are unknown and those of *O. pearcei* are poorly known.

Size. BYU 3799: $M^{?2}$, L = (4.3), W = 5.53.

Family Hyopsodontidae
Genus *Oxytomodon* Gazin, 1941
Oxytomodon perissum Gazin, 1941
plate 4, figs. 8–9

Locality and Material. Dragon Canyon: BYU 3784, right M_3 with a slightly broken metaconid.

Description. The paraconid of BYU 3784 is small, lingually placed, and tightly appressed to the large metaconid, the latter being larger than the protoconid. The trigonid is relatively high and short anteroposteriorly with a small precingulid. The hypoconid is large, anterior to the entoconid and has a well-developed postcristid and cristid obliqua. The large hypoconulid is posterior, slightly lingually placed, and higher than the other talonid cusps. The small entoconid is separated from the metaconid by a deep talonid notch.

Discussion. The following casts were used to identify BYU 3784: *Oxytomodon perissum:* USNM 16183, holotype, from Utah: *Litomylus osceolae:* AMNH 16039, holotype, from New Mexico; *L. dissentaneus:* AMNH 87543, PU 14312. Illustrations of the following were also used: *Litomylus dissentaneus:* USNM 9425, type, from Montana and *Haplaletes disceptatrix:* USNM 9500, type, from Montana.

Oxytomodon is known only by four specimens from the North Horn Formation of central Utah (Gazin 1941). Van Valen (1978) synonymized this genus with *Litomylus,* but gave no reasons for dong so. Because of the paraconid differences between *Litomylus* and *Oxytomodon* (described below), I choose to use *Oxytomodon* as a valid genus.

The type of *Litomylus osceolae* lacks the paraconid on M_3 and has a more reduced protoconid than BYU 3784. *L. dissentaneus* has only a very small shelf for a paraconid on M_3, yet has a relatively larger protoconid and entoconid but smaller hypoconulid. *L. dissentaneus* (holotype) is 8% shorter anteroposteriorly than the present specimen.

Hapletes disceptatrix also lacks a paraconid, has a complete ectocingulid, and a distinct entoconid—features different from the present specimen. The largest of six specimens of *H. disceptatrix* from Montana (Simpson 1937) is 10% shorter anteroposteriorly than the BYU specimen.

Oxyacodon has a very different trigonid structure than seen in the present specimen. The paraconid of *Oxyacodon* is much larger, higher, and much more medially placed with a much larger protoconid than is seen in BYU 3784. The hypoconulid of *Oxyacodon* is much larger and more lingual than that of the present specimen.

BYU 3784 is identical to the type specimen of *Oxytomodon perissum* in every detail and cannot be separated from it.

Size. BYU 3784: M_3, L = 3.20, W = 2.35.

Genus *Promioclaenus* Trouessart, 1904
Promioclaenus acolytus (Cope, 1882)
plate 4, figs. 10–11

Locality and Material. Ferron Mountain: BYU 3818, complete M_3.

Description. The paraconid of BYU 3818 is small, close to and slightly labial to the metaconid, and connected to the protoconid by a ridge. The bases of the metaconid and protoconid are subequal in size although the metaconid is the taller of the two. The trigonid is relatively high and has a well-developed precingulid and ectocingulid. The hypoconulid is large, medially placed, and well separated from the large hypoconid, but close to the "double cusped" entoconid. The cristid obliqua is large and the talonid basin is relatively deep and enclosed.

Discussion. Comparative specimens used for the identification of *Promioclaenus* lower molars include the following casts: *Litomylus osceolae:* AMNH 16039, type, from New Mexico; *L. dissentaneus:* AMNH 87543, PU 17408; *Haplaletes disceptatrix:* AMNH 35897, AMNH 87513, PU 14312; *Oxytomodon perissum:* USNM 16183, holotype, from Utah; *Ellipsodon sternbergi:* USNM 15755, holotype, from Utah; *Litaletes disjunctus:* PU 17453, PU 17479, PU 17475 from Wyoming and USNM 9338 from Montana; *Promioclaenus lemuroides:* AMNH 2421, type, AMNH 15952, from New Mexico; *P. shepherdi:* USNM 15721, holotype, from Utah; *P. acolytus:* KU 9629, AMNH 15949, UNM B-1380, UNM B-933, UNM B-361c from New Mexico and AMNH 87756, AMNH 87559, PU 17536 from Wyoming; *P. vanderhoofi:* UCMP 31264, type, from New Mexico; *P. pipiringosi:* USNM 20571, type, from Wyoming; *P. acolytus:* USNM 9280 (*Ellipsodon aquilonius*, type specimen, from Montana); and the illustrations mentioned under *Oxytomodon perissum.*

Ellipsodon aquilonius was described by Simpson (1935) but given the generic name of *Promioclaenus* by Wilson (1956). Van Valen (1978) and Rigby (1980) both considered *P. aquilonius* synonymous with *P. acolytus.* These taxonomic changes point out the difficulty associated with identifying hyopsodontid specimens. *P. acolytus* has a high degree of variability in its teeth (Rigby 1980).

M_3 in *Litomylus* (both *L. osceolae* and *L. dissentaneus*) differs from BYU 3818 in lacking a paraconid and cingulids, in having a much larger hypoconid, too small an entoconid, and in having a much smaller, more lingually placed hypoconulid. *L. osceolae* is too large while *L. dissentaneus* is too small, with a metaconid smaller than the protoconid, and has a too open talonid basin to be conspecific with BYU 3818.

Hapletes disceptatrix differs from the present specimen by being too small; in having the paraconid fused to the metaconid; in having a smaller, more lingually placed hypoconid; a smaller, more indistinct entoconid; a hypoconulid that is too small and too anteriorly placed; and in having an ectocingulid on the talonid.

Litaletes disjunctus is much too large and differently shaped to be conspecific with this BYU specimen, as is *Oxyclaenus pearcei.* The type of *Oxytomodon perissum* has an M_3 that is too small and relatively too narrow to be conspecific with BYU 3818 and also lacks the cingulids, has too distinct a hypoconid, a much smaller and more lingually placed hypoconulid, and a much smaller entoconid.

The type of *Ellipsodon sternbergi* (*Litaletes sternbergi* of Van Valen 1978) has an M_3 that lacks the paraconid and ectocingulid seen in BYU 3818 and is much too wide transversely and has greatly inflated cusps. The same is true of the type of *Promioclaenus shepherdi.* In addition, *P. shepherdi* has a smaller metaconid, a larger protoconid, a lower yet larger trigonid, and a less distinct entoconid than BYU 3818. However, USNM 15737, identified as *P. shepherdi* in the U.S. National Museum collection, is very similar to the present specimen.

Compared specimens of *Promioclaenus acolytus* (and *P. "aquilonius"*) are essentially identical to BYU 3818. The present specimen is within 0.05 mm in both length and width of the mean of 50 specimens of *P. acolytus* from the Swain Quarry in Wyoming (Rigby 1980).

Size. BYU 3818: M_3, L = 3.75, AW = 2.70, PW = 2.30.

Promioclaenus wilsoni Van Valen, 1978

Locality and Material. Ferron Mountain: BYU 4928, left M^{1-2}, slightly damaged.

Description and Discussion. BYU 4928 is inseparable from the holotype (KU 9446) of *Promioclaenus wilsoni* from the Puercan of New Mexico. Van Valen (1978) described this species, which description fits BYU 4928, and comparison of a cast of the holotype confirmed this identification. BYU 4928 was similar to other species of *Promio-*

claenus and *Ellipsodon*, but specific differences did exist.

Size. BYU 4928: M^1, L = (3.3), M^2, L = 3.6, W = 5.35.

Promioclaenus shepherdi (Gazin, 1939)

Locality and Material. Dragon Canyon: BYU 4924, left P_4-M_3, right P_3, M_{1-3}, ?P^4, M^1.

Description. BYU 4924 represents a more complete specimen than does the holotype. Gazin (1939, 1941) adequately described M_{2-3} and M^1; P_3-M_1 will be described here. P_3 has a small preprotocristid near the mid-line, with a very small precingulid. A "metaconid" swelling is present about mid-way up the posterior side of the protoconid. A small talonid heel is present with a single cuspid near the midline. The postprotocristid intersects the talonid heel labial to the talonid cuspid.

P_4 is about the same length as M_1, with a small and low metaconid connected to the protoconid with a small ridge. The preprotocristid has a very small "paraconid" swelling and another swelling where it joins the precingulid (very small). The talonid is small with two distinct, yet very small, cuspids. The hypoconid is connected to the protoconid with a small ridge.

M_1 is smaller than M_2, with the trigonid relatively narrower. The entoconid is relatively larger than in M_2, and the talonid is relatively longer than in M_2.

Discussion. VanValen (1978) synonymized *"Ellipsodon" shepherdi* and *Litaletes mantiensis* with *"Litaletes" sternbergi*, but gave no reasons or justification for doing so. The *Litaletes mantiensis* situation is discussed under *Litaletes gazinensis*. BYU 4924 and the holotype of *Promioclaenus shepherdi* appear to be distinct from *"Litaletes" sternbergi*.

BYU 4924 is identical to *P. shepherdi* (USNM 15721, holotype). It is much larger than *P. acolytus* and smaller than and differently proportioned (M_{1-3}) than *P. lemuroides*. *"Litaletes" sternbergi* has a relatively much smaller M_3, (relative to M_2), lacks a paraconid, and is considerably larger than *P. shepherdi*.

Size. BYU 4924: P_3, L = 3.95, W = 2.1; P_4, L = 4.1, W = 2.65; M_1, L = (4.05), AW = 3.25, PW = 3.4; M_2, L = 4.55, AW = 4.10, PW = 3.6; M_3, L = 3.75, AW = 2.75, PW = 2.15; M^1, L = 3.80, W = 5.00.

Promioclaenus lemuroides (Matthew, 1897)
plate 4, fig. 7

Locality and Material. Dragon Canyon: BYU 4368, right M_2.

Description. The paraconid of BYU 4368 is very small, lingually placed, low, and connected to the metaconid and protoconid by small ridges. The metaconid is inflated, larger than and posterior to the protoconid, and separated from the latter by a groove. The trigonid is wider than the talonid and has a moderately developed precingulid. The hypoconid is inflated and larger (but not higher) than the protoconid. A ridge on the lingual side of the circular talonid basin has two small bumps representing the entoconid and hypoconulid. The talonid notch is very low.

Discussion. BYU 4368 is inseparable from the type and another compared specimen of *Promioclaenus lemuroides*. The type specimen is 7% wider than the current specimen, but this is probably insignificant. Some slight differences are present between BYU 4368 and the type of *P. lemuroides*, but these are due to differing stages of wear in the two teeth.

The present specimen is morphologically very similar to the comparative material of *P. acolytus*, but 20%–35% larger. It is also much larger than the type of *P. vanderhoofi*.

M_2 in the type specimen of *P. pipiringosi* is badly worn, thus prohibiting a good comparison; *P. pipiringosi* is a little smaller, however.

Rigby (personal communication 1980) also positively identified this specimen as *P. lemuroides*. Rigby also made the suggestion that *P. lemuroides*, known from lower teeth, may be the lower teeth of *Litaletes "mantiensis,"* which is mainly known from upper teeth. This relationship is possible, but the very small present sample size makes any definitive statement unjustified.

Size. BYU 4368: M_2, L = 4.45, AW = 3.70, PW = 3.40.

Promioclaenus sp.
plate 4, fig. 12

Locality and Material. Blue Lake: BYU 3796, right M^1. Dragon Canyon: BYU 3743, left maxillary fragment with a damaged M^1 and M^2 fragment; BYU 3747, damaged right $M^{?1}$; BYU 3762, damaged left $M^{?1}$.

Description. All of the M^1 specimens are essentially identical; the description will be of BYU 3743 unless otherwise noted.

M^1 has subequally sized paracone and metacone with anterior and posterior ridges, a large protocone that is anteriorly placed, a very small or lacking hypocone, a very small parastyle, no mesostyle (as shown by BYU 3796, the only specimen that clearly shows that portion of the tooth), and a well-separated metacone and metaconule. The metaconule is larger than the paraconule. The postcingulum is relatively wide.

M^2 is apparently wider transversely than M^1 and has a large paraconule and metaconule (that is the only portion of the occlusal surface preserved in M^2).

Discussion. Comparative specimens used to identify upper molars of *Promioclaenus* specimens include the following casts: *Promioclaenus wilsoni:* KU 9446, holotype, from New Mexico; *Promioclaenus acolytus:* AMNH 87588 from Wyoming; *Promioclaenus shepherdi:* USNM 15790 from Utah; *Ellipsodon grangeri:* KU 13557 from

New Mexico; *E. inaequidens:* AMNH 3095, type, from New Mexico; *Litaletes mantiensis:* USNM 15747, type, from Utah, and AMNH 87595 from Wyoming; *Litaletes disjunctus:* USNM 9324, paratype, and AMNH 35885 from Montana; *Protoselene opisthacus:* KU 13997 from New Mexico; *Protoselene bombalili:* USNM 23285, type, from New Mexico; *Litomylus dissentaneus:* AMNH 87586 from Wyoming; and *Litomylus* cf. *scaphicus:* USNM 21013 from Wyoming. Illustrations of the following were also used: *Promioclaenus acolytus:* USNM 9567, USNM 9571, and USNM 9576 from Montana, KU 7836 from New Mexico; *Ellipsodon grangeri:* KU 9619 from New Mexico; *Litaletes disjunctus:* USNM 9324, paratype, from Montana; and *Litomylus dissentaneus:* USNM 9557, USNM 9580 from Montana. Upper molars of *Litaletes ondolinde* are unknown.

The BYU specimens (BYU 3796, 3743, 3747, and 3762) all apparently represent the same genus and may represent the same species. They differ from *Promioclaenus shepherdi* in being a little larger and in lacking the indented labial edge between the paracone and metacone. They differ from *P. acolytus* in having slightly narrower cingula and a slightly larger protocone. There were no significant observable differences between any of the BYU specimens and compared specimens of *Promioclaenus.*

M^1 in the type specimen of *Litaletes "mantiensis"* differs from the BYU specimens in having a larger parastyle, a mesostyle, a hypocone, a smaller protocone, and in having a better-developed precingulum. *Litaletes disjunctus* is much smaller than the present specimens as is *Promioclaenus shepherdi.*

Ellipsodon inaquidens lacks the paraconule, metaconule, and ectocingulum seen in the BYU specimens. *Litomylus* and *Protoselene* both have a very large hypocone, a feature lacking or extremely small in the present specimens.

All of the present specimens are longer anteroposteriorly than the largest of 64 specimens of *P. acolytus* from Swain Quarry (Rigby 1980). They are also longer than the largest of ten specimens of *P. acolytus* (described as *Ellipsodon aquilonius*) from Gidley Quarry (Simpson 1937), yet are all shorter than the type of *Litaletes "mantiensis."*

The similarity of these BYU specimens with compared specimens of *Promioclaenus* and their differences with closely related genera make generic assignment of these specimens relatively certain. However, the great similarity between the various species of *Promioclaenus,* plus the fact that these BYU specimens are nearly all damaged and isolated, makes specific assignment very uncertain. Their large size, however, indicates they probably do not represent *P. acolytus.*

Size. BYU 3796: M^1, L = 4.15, W = 4.45. BYU 3743: M^1, L = (4.3), W = (5.2). BYU 3747: $M^{?1}$, L = 4.25. BYU 3762: $M^{?1}$, L = 4.30.

Genus *Ellipsodon* Scott, 1892
Ellipsodon grangeri Wilson, 1956

Locality and Material. Dragon Canyon: BYU 9994, right M_2.

Description. BYU 9994 (M_2) has a fused paraconid, with only a swelling present, large inflated metaconid, very small precingulid, large hypoconid, and small talonid basin. The tooth is longer labially than lingually.

Discussion. BYU 9994 lacks the distinct paraconid seen in *Tricentes* and *Chriacus.* The present specimen is slightly smaller than *Ellipsodon grangeri* (KU 7834) from New Mexico and has a slightly more inflated metaconid than seen in that species. All other characters of the two are almost identical.

Size. BYU 9994, M_2, L = 5.4, AW = 4.65, PW = 4.1.

Genus *Protoselene* Matthew, 1897
Protoselene griphus (Gazin, 1939)

Locality and Material. Dragon Canyon: BYU 3763, right M^2; AMNH 36064, left M^1.

Description. M^2 (BYU 3763) has the three major cusps well separated with the protocone lingually placed. Anterior and posterior ridges are present on the paracone and metacone. A parastyle and a posteriorly positioned mesostyle are present while the metastyle is absent. The mesostyle is separate from the ridges on the paracone and metacone. The hypocone is small but distinct as is the protostyle. The paraconule and metaconule are both small. The ectocingulum is almost incomplete around the parastyle and the endocingulum is not present. The tooth is rectangular in occlusal view.

M^1 is similar to M^2 except that it is smaller, more triangular in occlusal view, has a slightly larger hypocone, and a slightly smaller ectocingulum.

Discussion. Casts of the following specimens were used to help identify the BYU specimens of *Protoselene griphus: Protoselene griphus:* USNM 15789, holotype, and USNM 16182 from Utah; *P. opisthacus:* KU 13997 from New Mexico; *P. bombadili:* USNM 23285, holotype, from New Mexico. The type specimens of *P. opisthacus* and *P. novissimus* (Tiffanian Age) are lower teeth only.

BYU 3763 and AMNH 36064 are identical to material referred to *Protoselene griphus* by Gazin (1941). The present specimens are slightly larger than the type specimen but identical in size to USNM 16182, referred to *P. griphus* by Gazin (1941).

P. opisthacus has a nearly complete endocingulum on $M^{1\text{-}2}$, a feature lacking in the present specimens. *P. opisthacus* is also smaller and lacks the protostyle development seen in the present specimens and has the mesostyle connected to the metacone and paracone by ridges.

The type of *P. bombadili*, an isolated M^2, lacks the mesostyle, is triangular shaped in occlusal view, and is 20% to 25% smaller than the present specimens.

Two isolated upper premolars (AMNH 36048 and AMNH 36063) from Dragon Canyon have been identified in the American Museum collection as *"Dracoclaenus"* (now *Protoselene*). BYU 3750, also an isolated upper premolar from Dragon Canyon, and the two American Museum specimens identified as *"Dracoclaenus"*, are very similar to material of *P. griphus* illustrated by Gazin (1941). However, specific identification of isolated hyopsodontid premolars is extremely difficult.

Size. BYU 3763: M^2, L = 5.95, W = 8.10. AMNH 36064: M^1, L = 5.55, W = 6.80. BYU 3750: $P^{?4}$, L = 4.55, W = 6.05. AMNH 36048: $P^{?3}$, L = 5.20, W = 6.70. AMNH 36063: P^4, L = 5.30, W = 7.25.

Genus *Litaletes* Simpson, 1935
Jepsenia Gazin, 1939, p. 285
Litaletes disjunctus Simpson, 1935
Litaletes mantiensis in part (Gazin, 1939, p. 285)
(not *L. mantiensis* of Rigby, 1980)
plate 4, fig. 14

Type Specimen. USNM 9323 (as originally described by Simpson, 1935).

Diagnosis. As given by Simpson, 1935, p. 242.

Referred Material. As described by Simpson (1935) plus from Dragon Canyon: USNM 15745, right maxilla with M^{1-3} (previous type of Litaletes mantiensis); USNM 15544, M^2; AMNH 36060, left M^2; BYU 3746, damaged right M^3.

Description. The paracone and metacone of AMNH 36060 (M^2) are closely appressed, round-conic in shape, and connected with a ridge; the paracone is larger and more labially placed than the metacone. The moderately sized paraconule and metaconule are closely appressed to the crescentic protocone and well separated from the paracone and metacone. The parastyle is broken yet was apparently moderately large; the mesostyle is very small. The precingulum and postcingulum are relatively large, the ectocingulum is small (absent around the metacone), and the endocingulum is absent. The tooth is much narrower lingually than labially.

The paracone and metacone of BYU 3746 (M^3) are well spaced, the paracone being larger and more labial. The parastyle is broken and the mesostyle is absent. The protocone is large and inflated. A cingulum completely surrounds the tooth except around the corner of the tooth by the metacone.

Discussion. Van Valen (1978) synonymized *Litaletes mantiensis* and *Promioclaenus shepherdi* with *Litaletes sternbergi* (previously *Ellipsodon sternbergi*) but gave no reasons for doing so. I disagree with this synonymy. *Litaletes mantiensis* of Gazin (1939) is not a valid species, it should be synonymized with *Litaletes disjunctus* for the reasons discussed below. However, *L. mantiensis* of Rigby (1980) is a valid species and should retain the name *L. mantiensis*. AMNH 87595 (right P^4–M^3) from the Swain Quarry, Fort Union Formation, south-central Wyoming is here designated as the type. The same comparative specimens listed under *Promioclaenus* sp. were used to help identify the *Litaletes* specimens in the BYU collection. When *L. "mantiensis"* in quotation marks is used, it indicates the material referred to *L. mantiensis* by Gazin (1939, 1941).

The present specimens appear to be intermediate between *Litaletes disjunctus* and *L. "mantiensis."* The major differences between the two species (Gazin 1941) are: (1) the presence of a mesostyle in *L. "mantiensis"*; (2) an anteroposteriorly longer protocone in *L. "mantiensis"*; (3) a larger, more distinct paraconule and metaconule that are more widely separated from the paracone and metacone in *L. "mantiensis"*; (4) a weaker hypocone in *L. "mantiensis"*; (5) the ectocingulum of *L. "mantiensis"* is weaker; and (6) the paracone is smaller and not so labially placed in *L. "mantiensis."* The present specimens are intermediate between *L. "mantiensis"* and *L. disjunctus* in all of these aspects. However, AMNH 36060 is more *L. "mantiensis"*-like while BYU 3746 is more *L. disjunctus*-like. Each of these specimens show characters of both species, but not so pronounced. They are also intermediate in size.

There is a continuum between the two "species." Gazin (1941, p. 33) also reported two specimens (included with material numbered USNM 15544) that were "inter-mediate." These present two specimens (and those described by Gazin 1941) are intermediate between *L. disjunctus* and *L. "mantiensis,"* and show that *L. "mantiensis"* is really a junior synonym of *L. disjunctus*.

Rigby (1980) reported several specimens he referred to *L. mantiensis* from the Swain Quarry of Wyoming. All of Rigby's specimens were larger (up to 35% larger) than the present specimens (and the type of *L. "mantiensis"*) which represent a separate, valid taxa, distinguished mainly by size.

Size. AMNH 36060: M^2, L = (4.45), W = 6.25. BYU 3746: M^3, L = (3.75), W = (5.1). The actual width of BYU 3746 was certainly greater than that shown.

Litaletes gazinensis n. sp.
plate 4, fig. 13

Etymology. Named after Charles Lewis Gazin, who did so much of the early work on the mammalian fauna of the

North Horn Formation, especially the Dragon local fauna.

Type Specimen. BYU 3773, right maxilla fragment with the posterior half of M^1 and M^{2-3}, from the Dairy Creek locality, Gas Tank local fauna, Puercan, North Horn Formation, central Utah.

Distribution. The type is the only known specimen.

Diagnosis. Smaller than either *Litaletes disjunctus* or *L. mantiensis*, with a much smaller parastyle. Lacks a meso-style on M^{1-3} and a metastyle on M^1. Paraconule and metaconule much more closely appressed to the paracone and metacone respectively than in *L. disjunctus* or *L. mantiensis*. M^3 relatively much smaller than M^2 in *L. disjunctus* or *L. mantiensis*.

Description. Only the posterior half of M^1 is present, but it shows a relatively large round-conic metacone with an anterior and posterior ridge. The metaconule is relatively large and the protocone apparently was also. A postcingulum is present.

M^2 is apparently very similar to M^1. M^2 has a very large, inflated protocone and relatively large, subequal paracone and metacone. Anterior and posterior ridges are present on the paracone and metacone—the latter cusp being more lingually placed than the former. The trigon basin is deep and enclosed. The paraconule is larger than the large metaconule. A very small parastyle and hypocone are present. All of the cingula are present except the endocingulum. The tooth is nearly square in occlusal view.

M^3 is very short anteroposteriorly and is narrower transversely than M^2. The metacone is very small, as small as the metaconule, and is somewhat lingually placed. The parastyle is very small while the protocone is large. A hypocone is not present on M^3. The endocingulum is not present nor is the cingulum continuous around the metacone. The postcingulum is poorly developed.

Discussion. The same comparative specimens used to identify *Promioclaenus* sp. were used to help identify BYU 3773. Van Valen (1978) placed *Litaletes* in the family Mioclaeninae but gave no reasons for doing so. I choose to leave it in the generally accepted Hyopsodontidae because of a lack of evidence for elevating Mioclaeninae to family level.

Litaletes disjunctus from the North Horn Formation of Utah differs from BYU 3773 in having a mesostyle on M^{1-3}, a much larger parastyle on M^{2-3}, a small metastyle on M^1, a less inflated protocone, a larger and more distinct hypocone, smaller metaconula cristas, the conules more separate from the paracone and metacone, and more acute cusps. BYU 3773 is about the same size as *L. disjunctus* from Utah (USNM 15747) (M^3 is 9% wider in the present specimen) but much smaller than the smallest of 24 specimens referred to *L. mantiensis* from Wyoming by Rigby (1980, p. 123). AMNH 87595 P^4-M^3, from Wyoming *(L. mantiensis)*, differs from BYU 3773 in the same ways described above for *L. disjunctus* (USNM 15747) plus the fact that it is much larger.

M^3 of *L. disjunctus* has a cingulum completely around the tooth and a much larger metacone and parastyle than the present specimen. M^1 of *L. disjunctus* is relatively smaller than the BYU specimen.

L. ondolinde is known only from lower teeth, thus prohibiting direct comparison.

The type specimen of *Protoselene bombadili* is somewhat similar to BYU 3773 except that the former has much better developed cingula, a much larger parastyle, smaller conules, and less inflated cusps.

Litomylus dissentaneus and *L.* cf. *scaphicus* (USNM 21013) show a greatly enlarged hypocone, and *L. dissentaneus* is also much smaller than the present specimen.

Promioclaenus wilsoni is much smaller, has a much larger parastyle, hypocone, and ectocingulum, yet a smaller precingulum than seen in BYU 3773. *P. acolytus* differs from the BYU specimen in having a much smaller protocone and conules, less inflated cusps, a weaker ectocingulum and a larger hypocone. M^2 is relatively much larger in *P. acolytus* than in BYU 3773.

Ellipsodon inaequidens is markedly smaller than the BYU specimen, as is *Promioclaenus shepherdi*. Upper molars of *E. grangeri* differ from the present specimen in having a mesostyle, a weaker ectocingulum, less inflated cusps, and in having the conules too far from the paracone and metacone.

BYU 3773 is similar to material referred to *Litaletes disjunctus* from the North Horn Formation and may be ancestral to it because it shows more primitive features (i.e., no mesostyle, smaller parastyle and a smaller hypocone) and because it comes from a stratigraphically lower locality.

Size. BYU 3773: M^2, L = 4.50, W = 6.30; M^3, L = 2.90, W = 5.00.

Subfamily Mioclaeninae Osborn and Earle, 1895
gen. and sp. indet.

Locality and Material. Dragon Canyon: BYU 3754, left M_2; BYU 3766, right M_3; BYU 3783, left M_3; AMNH 36030, right M_2; AMNH 36044, left M_2; AMNH 36046, left M_2.

Description. The M_2s present (BYU 3754, AMNH 36030, AMNH 36044, and AMNH 36046) are all very similar to each other and show these characters: a very small, low and lingual paraconid; a moderately developed protocristid; a small precingulid; a large inflated protoconid, metaconid, and hypoconid; the trigonid wider than the talonid; a very small entoconid and hypoconulid; a short talonid; a high cristid obliqua; and a very low talonid notch.

The two M_3s present (BYU 3766 and BYU 3783) are also very similar to each other and share these features: trigonid is wider than the talonid, the protoconid larger than the metaconid, a larger paraconid than seen in M_2 (described above), the hypoconulid is relatively large, the hypoconid is reduced, the talonid notch is not as low as that seen in M_2, and the entoconid and hypoconulid form a ridge. In other features, the M_3s are very similar to the M_2s.

Discussion. Isolated mioclaenid lower molars are very difficult to identify. Many species have been shifted from one genus to another, as *Ellipsodon shepherdi* was changed to *Promioclaenus shepherdi* by Wilson (1956) and then to *Litaletes sternbergi* by Van Valen (1978). Most of these present specimens appear to represent some species of *Promioclaenus*, but because of the great similarities between genera and species of the Mioclaeninae, assignment of these isolated teeth to a given taxa will not be done. There are probably at least two different species present as evidenced by the size differences.

BYU 3783 is identical to M_3 in the type of *"Ellipsodon" shepherdi* (now *Litaletes sternbergi*, after Van Valen 1978). BYU 3766 is almost identical to the type of *"Ellipsodon" sternbergi* (now *Litaletes sternbergi*, after Van Valen 1978). However, these specimens will not be referred to *Litaletes sternbergi* because of the great similarity of mioclaenid lower molars and the high degree of variability seen in hyopsodontid M_3s.

Size. BYU 3783: M_3, L = 3.80, AW = 2.85, PW = 2.15. BYU 3754: M_2, L = 5.40, AW = 4.70, PW = 4.25. BYU 3766: M_3, L = 4.55, AW = 3.40, PW = 2.95. AMNH 36030: M_2, L = 4.20, AW = 3.40, PW = 3.40. AMNH 36044: M_2, L = 5.00, AW = 4.40, PW = 4.20. AMNH 36046: M_2, L = 5.00, AW = 4.30, PW = 3.90.

SUMMARY

The discovery of five new Paleocene mammal localities in the North Horn Formation of central Utah and renewed collection in known localities have increased the faunal representation of this formation, thus allowing more precise correlation, especially with faunas of the San Juan Basin of New Mexico.

Stratigraphic and paleontological data indicate the presence of three distinct local faunas: the Gas Tank, Wagonroad, and Dragon. The Gas Tank local fauna is believed to be of Puercan age based on the presence of the condylarths *Ectoconus ditrigonus, Periptychus coarctatus, Oxyacodon ferronensis, O. apiculatus, Loxolophus pentacus, Oxyclaenus pugnax, Conacodon,* and cf. *Taeniolabis taoensis.*

The Wagonroad local fauna is also believed to be Puercan in age as indicated by the presence of *Taeniolabis, Ectoconus, Oxyclaenus, Periptychus (Carsioptychus), Loxolophus, Onychodectes, Conacodon,* and *Desmatoclaenus.* The Wagonroad local fauna is, however, younger than the Gas Tank local fauna because its beds are stratigraphically about 50 m higher than the highest Gas Tank localities, most of the forms are more derived, and because of the presence of *Protoselene, Ellipsodon,* and a paromomyid primate (Tomida and Butler, 1980).

The Dragon local fauna is here considered early Torrejonian in age as indicated by the presence of *Aphronorus, Neoplagiaulax macintyrei, Myrmecoboides,* ? *Palaechthon, Paromomys, Protictis haydenianus, Periptychus (Periptychus), Chriacus truncatus, Chriacus* sp. (near *C. pelvidens*), *Mimotricentes subtrigonus, Protoselene, Promioclaenus lemuroides, P. shepherdi, Ellipsodon grangeri,* and *Litaletes disjunctus.* The early Torrejonian age comes from the presence in the fauna of *Loxolophus* and *Oxyclaenus* plus the fact that many of the taxa present are somewhat more primitive in nature than similar taxa in the San Juan Basin Torrejonian. The Dragonian Land Mammal "Age" is here considered invalid.

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