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LATE PALEOCENE MAMMALS FROM NEAR COCHRANE, SOUTHWESTERN ALBERTA

by

GORDON PAUL YOUZWYSHYN

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled LATE PALEOCENE MAMMALS FROM NEAR COCHRANE, SOUTHWESTERN ALBERTA submitted by GORDON PAUL YOUZWYSHYN in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE.

Richard C. Fox
Supervisor

Date 5 October 1988

ABSTRACT

The Cochrane 2 locality (Cochrane, Alberta: Porcupine Hills Formation) preserves fluviatile deposits containing fossil mammals of earliest Tiffanian age. The fossiliferous layer consists of mollusc-bearing siltstones and shale overlain by massive, cross-bedded sandstone. This study documents and identifies previously collected mammalian dental remains as well as newly collected material. New matrix quarried from the site for this study was screen-washed and resistant matrix was additionally soaked in weak acetic acid and then re-washed. Approximately 2000 dental specimens (primarily isolated teeth: 700 from previous collections, 1300 from present study), representing 86 species (11 orders: 9 confidently assignable, 1 uncertain, and 1 questionable) are identified. Seven new species and one new genus are described. New taxa named from Cochrane 2 include new species of: Ptilodus, Baiotomeus and Acheronodon (Multituberculata); Litomylus (Condylarthra); Pararyctes and Paleotomus (Eutheria, incertae sedis); and a new genus and species of Carnivora. Several new genera and species are described but left unnamed. This study documents the earliest occurrences of: the genera Pentacosmodon and Limaconyssus; the species Neoplagiaulax cf. N. hunteri, Elpidophorus cf. E. elegans and Plesiadapis cf. P. anceps; the order Creodonta; and suggests the earliest occurrence of the Rodentia. The latest occurrences of ?Pronothodectes, ?Oxyprimus and Jepsenella are also documented. Taxonomic composition appears temporally intermediate between the Keefer Hill (Fort Union Formation, Wind River Basin, Wyoming) and Douglass Quarry (Melville Formation, eastern Crazy Mountain Basin, Montana) localities. The Cochrane 2 locality preserves the small mammal component of the earliest Tiffanian fauna in a more accessible form than any other known locality of comparable age. In addition, the species richness is far greater than at any other described Paleocene locality. This site also documents the

coexistence of 3 distinct species for each the following genera: Ptilodus, Parectypodus, Anconodon, and Prodiacodon. Evidence from Cochrane 2 coupled with recent studies from other Tiffanian localities suggests that the mammalian species diversity of the time did not correlate with climatic conditions, as hypothesized by a recent paleoecological study. The results challenge current ecological theory relating climate to mammalian species richness.

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I. INTRODUCTION

The Porcupine Hills Formation is a relatively narrow strip of non-marine strata that runs northwest-southeast along the foothills of western Alberta. It extends from the southwest corner of the province, through the Porcupine Hills, northward to an unknown distance north of the city of Calgary (Carrigy, 1971). The formation is formed from fluviatile, continental sediments deposited during the Paleocene. Limited exposures of the Porcupine Hills Formation occur along the banks of the Bow River at and near the village of Cochrane. Additional exposures existed along the banks of the Elbow River in Calgary.

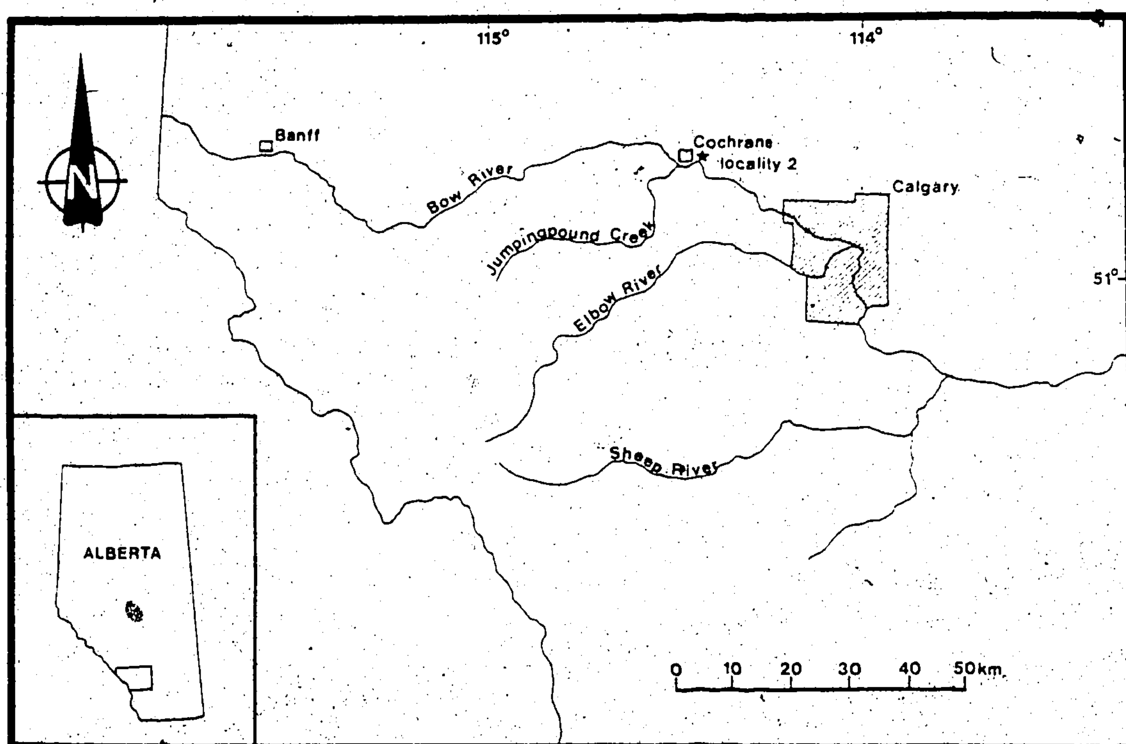
Several authors (Russell, 1926b; Russell in Rutherford, 1927; Russell 1929b; Tozer 1953, 1956; Germundson, 1965) have attempted to correlate the Porcupine Hills Formation using invertebrate fossils; Tozer (1956), relying on molluscs, correlated the Porcupine Hills with the upper part of the Paskapoo Formation in central Alberta. In general, however, these attempts have been found to be less satisfactory than those based on mammals due to the relatively wider time ranges of the molluscs. The most effective correlations of the Porcupine Hills Formation with early Tertiary, non-marine strata elsewhere in western North America have been based almost exclusively on mammals.

Mammalian remains are now known from several localities in the Porcupine Hills Formation and were initially discovered and studied by Russell (1926a; Russell in Rutherford, 1927; Russell 1929), with subsequent descriptions by Russell (1932, 1948, 1958) and by Fox (1968). Collection of the fossil mammals at the Cochrane 2 locality (the richest of the localities in the formation) by field parties from the University of Alberta began in 1969 and has continued to the present (summer, 1988), with the most recent study by Krause (1978).

Russell (1929) believed the localities at Cochrane occur in the Paskapoo Formation and considered the Cochrane fauna to indicate an "uppermost Paleocene" age. He also felt the mammalian assemblage was similar to those of the "Clark Fork horizon", late Paleocene of Wyoming. Despite the opinion that the thick strata in the vicinity of Cochrane "...should represent more than just one division of Paleocene time" (p. 47), Russell (1958) still maintained his original age determination for the Cochrane localities. This interpretation was also advocated by Carrigy (1971) in a study of the lithostratigraphy of the formation. Nevertheless, mammalian specimens from other localities indicate a greater range of ages of the formation, from late Torrejonian (Russell, 1948, 1958) to even Puercan age (Fox, 1968; Johnston and Fox, 1984). Further, Krause (1978) interpreted Cochrane 2 to be of latest Torrejonian or earliest Tiffanian age, based on primates, while Gingerich (1982b) suggested an earliest Tiffanian age from condylarths.

My study of mammals from the Cochrane 2 locality was initiated in 1983, and is based on all known identifiable specimens from the locality (about 2000 in total). The fossils at Cochrane 2 come from a mollusc-bearing, sandy to silty layer of the Porcupine Hills Formation, exposed 16 meters (55 feet) above the main line of the Canadian Pacific Railway in the foothills east of Cochrane, in Ls. 4, sect. 1, Tp, 26, R. 4, W. 5 (Text-fig. 1). The mammals from this layer are unexpectedly diverse, taxonomically, and are represented mainly by isolated teeth and dentigerous jaw fragments.

The diversity of the Cochrane 2 mammals appears to contradict proposed hypotheses suggesting a relationship between mammalian species richness and climatic cooling trends in the North American Tiffanian.



Text-fig. 1. Geographic location of the Cochrane 2 fossil mammal locality of southwestern Alberta.

II. THE LOCALITY: HISTORICAL BACKGROUND

The Cochrane 2 locality was discovered during the field season of 1926 by R. L. Rutherford and L. S. Russell. Initially, two sites that preserved mammalian fossils were identified at Cochrane (Rutherford, 1927); both were considered to occur in the Paskapoo Formation. The first, designated by the field number "1", was located on the north bank of the Bow River, across from the mouth of Jumpingpound Creek (Rutherford, 1927). L. S. Russell later referred to this locality both as Cochrane locality "1" (1932, 1958) and as locality "I" (1929). According to Russell (1929), the productive horizon at Cochrane 1 consisted of a mollusc-bearing shale layer exposed near the water level of the Bow River. The locality yielded three identifiable, isolated teeth and was subsequently never relocated.

Cochrane mammal site 2 was given the field number "11" (eleven) in Rutherford, 1927. It was later referred to as both locality "II" (Russell, 1929) and locality "11" (Russell, 1932, 1958). R. C. Fox (in press) has recently standardized the title of this site to locality "2". The mammalian fauna collected at locality 2 was subsequently described by Russell (in Rutherford, 1927). The initial collection was of five identifiable, isolated teeth and an anterior jaw fragment with two premolars. Russell assigned these teeth to six distinct mammalian taxa (subsequent study reduced this number to five separate taxa [Gingerich, 1982b]).

The mammalian fauna from the Cochrane 2 locality was described in a series of papers by Russell (in Rutherford, 1927, 1929a, 1932, 1958). It consisted of a total of twelve specimens and less than a dozen taxa. Field parties from the UALVP began collecting at Cochrane 2 in 1969. More intensive collections from the Cochrane 2 locality, resulting in approximately 200 specimens, were made during the period from 1972—1977 by D. W. Krause for UALVP. Only the primates (represented by twelve isolated dental specimens) from these latter collections were described, increasing the known fauna by four taxa (Krause, 1978). Collections by UALVP continued in 1981 and 1982. The most intensive and significant collections, however, occurred between 1984 and 1987, in the course of this study.

III. GEOLOGICAL SETTING AND REGIONAL STRATIGRAPHY

The Porcupine Hills Formation is restricted to a relatively narrow depositional belt in Alberta exposed roughly parallel to the Alberta-British Columbia border. The type area of the formation is the Porcupine Hills, a prominent topographical feature rising from the ;plains in southwestern Alberta, and ranging from a elevation of 3300 feet to 5800 feet above sea level (Carrigy, 1971). The western extent of most of the Porcupine Hills Formation is abruptly truncated by the disturbed belt of thrust faults extending along the front of the Rocky Mountains.

The strata of the Porcupine Hills Formation were observed by Rutherford to be virtually flat-lying between Cochrane and Calgary; however, "if the strata in this distance [between Cochrane and Calgary] have a regional dip it is probably to the east being about 300 feet lower north of Calgary than at Cochrane" (1927, p. 10). Rutherford indicated that this difference could be due, in part, "to a slight inclination of the strata" (p. 10), but was most likely due to erosion. With respect to the Cochrane localities: "The beds are flat-laying, or nearly so, at all exposures along the Bow from the traffic bridge at Cochrane east to Glenbow" (Rutherford, 1927, p. 10). Carrigy noted that the Porcupine Hills strata "form an asymmetrical syncline with 25 degree dips to the east on the western limb and low dips to the west on the eastern limb" (1971, p. 12)..

In the Porcupine Hills area, the formation unconformably overlies the Willow Creek Formation (Dawson, 1883; Tozer, 1956; Carrigy, 1971). The Willow Creek Formation is considered to include both Upper Cretaceous and lower Paleocene strata (Tozer, 1953; Russell, 1968; Carrigy, 1971). In the Calgary area, the Porcupine Hills Formation is believed to overlie the Paskapoo Formation (Carrigy, 1970, 1971). However, the exact location of the boundary between the two formations remains unknown due to a lack of adequate exposures north of this region and because the erosional contact, if any, between these formations apparently exceeds corehole depths (Carrigy, 1971). According to Carrigy, "[t]he maximum preserved thickness of the formation is probably in the order of 3000 feet, but because the upper boundary is an erosion surface, the original thickness cannot be determined" (1971, p. 12).

In his description of the facies exposed along the Bow River at Cochrane, Rutherford noted:

> The lithological units vary in thickness from a few inches up to several feet and some of the sandstone beds are over 40 feet thick. The sandstones are fine-grained and usually buff to light grey in colour, whereas the shales are frequently darker. Cross-bedding is prevalent in the sandstones and the shales are not well stratified. The whole series is typical of freshwater deposition (1927, p. 38).

Carrigy states: "In outcrops, the Porcupine Hills Formation is characterized by calcareous siltstones and hard, lenticular, cross-bedded sandstones" (1971, p. 19).

The origin of these sediments, according to Carrigy (1971), was probably "from an area underlain by limestones and dolomites similar to the present day Front Ranges of the Canadian Rockies" (p. 75). Paleocurrent data indicate that the source of deposition was "south and west of the Porcupine Hills, in the southern extension of the Rocky Mountains where Precambrian sedimentary rocks now outcrop" (Carrigy, 1971, p. 75).

Russell (1929, 1932, 1958) had long considered the outcrops in the foothills of southwestern Alberta to represent the westerly extension of the Paleocene Paskapoo Formation of central Alberta. Tozer (1956) concurred with this interpretation, correlating the molluscan fauna with a similar assemblage in the upper part of the Paskapoo Formation. According to Carrigy: "Tozer (1956) arbitrarily defined all Paleocene beds north of township 13 in western Alberta as Paskapoo, thus obscuring the true relationship between the Porcupine Hills and Paskapoo Formations" (1971, p. 12). Based upon extensive lithostratigraphic evidence, Carrigy (1970, 1971) extended the Porcupine Hills

Formation from the type area in the southwestern-most corner of the province, northward to include the vertebrate fossil localities in and around the Calgary area.

The Cochrane 2 locality has been recorded at some 300 feet above Cochrane 1 (Rutherford, 1927; Russell, 1929), and about 3900 feet above sea level. The site is capped with a massive, highly cross-bedded, resistant sandstone. The fossils occur in a layer approximately 30 meters along strike, and is from a few centimeters to 0.5 meter thick. The layer consists of variable greenish-grey to yellowish-grey, calcareous shales and siltstones.

The most resistant fossiliferous matrix at Cochrane 2 contains a certain amount of quartz sandstone, unlike the matrices at mammal sites elsewhere in the province. Gastropod and pelycopod (bivalve) shells of various sizes, coalified fragments of wood and leaves, and occasional well-rounded pebbles and ironstone nodules are also found in the matrix. The presence of highly cross-bedded sandstones, coupled with the relatively large size of many of the pelycopod shells, suggests that the fossil deposit was probably deposited by briskly flowing streams or rivers.

IV. ABBREVIATIONS, DEFINITIONS AND SYMBOLS

Abbreviations used in the text are as follows:

A. Institutions:

AMNH — American Museum of Natural History, New York

CM — Carnegie Museum of Natural History, Pittsburgh

KU — Museum of Natural History, University of Kansas, Lawrence

MCZ — Museum of Comparative Zoology, Harvard University, Cambridge

NMC — National Museum of Natural Sciences, Ottawa

PU — Princeton University Museum, Princeton

SUNY — State University of New York, Stony Brook

SMM — Science Museum of Minnesota, St. Paul

UA — University of Alberta, Edmonton

UALVP — Laboratory for Vertebrate Paleontology, University of Alberta, Edmonton

UCMP — Museum of Paleontology, University of California, Berkeley

UM — Museum of Paleontology, University of Michigan, Ann Arbor

UMVP — Vertebrate Paleontology Collection, University of Minnesota, Minneapolis

USGS — United States Geological Survey, Denver

USNM — United States National Museum of Natural History, Smithsonian Institution, Washington, D. C.

UW — Geological Museum, University of Wyoming, Laramie

B. Localities:

MHBT — Medicine Hat Brick and Tile quarry

Rav W-1 — Ravenscrag West-1

RBN — Robaic- Nord

UADW — University of Alberta, Dennis Wighton (discoverer)

C. Statistics:

CV — Coefficient of variation

M — Mean

N — Sample size

OR — Observed range

P — Parameter

SD — Standard deviation

D. Dentitions:

I, i — Upper or lower incisor, respectively

D, d — Upper or lower deciduous tooth, respectively

P, p — Upper or lower premolar, respectively

M, m — Upper or lower molar, respectively

X — Tooth unidentifiable as to position

R — Ridge

E. Measurements:

AW — Greatest width across anterior part of tooth

L — Maximum length of tooth

PW — Greatest width across posterior part of tooth

Tal. W — Talonid width

Tri. W — Trigonid width

TH — Maximum height of the trigonid

TL — Maximum length of the trigonid

W — Maximum width of tooth

Definitions of terms used in test are as follows:

cf. — used to indicate tentative identification of specimens

Height — "... measured from the highest point of the crest to the baseline" (multituberculate p4's only: Novacek and Clemens, 1977:704)

Length 1 — "... parallel to B (baseline), is measured from the anterior end of the blade to a point directly below its highest point" (multituberculate p4's only: Novacek and Clemens, 1977:704)

Depth — "... measures the distance between the baseline and the lowest point at the base of the exodaenodont lobe" (multituberculate p4's only: Krause, 1987:596).

Symbols used in the text are as follows:

* — estimated measurement(s)

V. METHODS AND DENTAL TERMINOLOGY

Fossils at Cochrane 2 were collected by quarrying: rock matrix from the producing layer was hand-split into dime-size pieces to reveal the larger preserved bones and teeth. The residual matrix was then sacked and returned to the laboratory for screen-washing using D. W. Krause's (unpublished) method. Particularly resistant matrix was immersed in 10%-20% acetic acid solution to break-down the calcareous component, and re-screened. After drying, the screened concentrates were sorted under a dissecting microscope at 10X, and identifiable dental elements were removed for study.

In this paper all measurements of mammalian teeth are in millimeters and were estimated to the nearest 0.10 mm by the author, using a Wild M-7 zoom binocular microscope with 20 magnification oculars. An ocular micrometer disc divided into 0.10 intervals was inserted into the microscope and calibrated against the millimeter scale of a Starrett vernier bar caliper. Measurements of multituberculate p4's follow Novacek and Clemens (1977).

Nomenclature for multituberculate p4's follows Krause (1977), Sloan (1981) and Johnston and Fox (1984). Nomenclature and measurements for multituberculate dentitions other than p4 follow Simpson (1937), Jepsen (1940) and Krause (1977). The construction and superimposition of the lateral profiles of multituberculate p4's follow Jepsen (1940), Krause (1977) and Johnston and Fox (1984). The drawings of multituberculate p4's were made using a camera lucida attached to a Wild M-3 binocular microscope. Measurements of therian dentitions follow Clemens (1966) and Gingerich and Winkler (1985). Dental terminology for therians follows that of Van Valen (1966), as modified by Szalay (1969) and Schiebout (1974, fig. 4). Carnivoran nomenclature follows MacIntyre (1966). The terms pre-, sub-, and semimolariform are used as by Krishtalka (1976a).

VI. SYSTEMATIC PALEONTOLOGY

Class Mammalia

Subclass Allotheria

Order Multituberculata Cope 1884

Suborder Ptilodontoidea Sloan and Van Valen 1965

Family Neoplagiaulacidae Ameghino 1890

Genus Mesodma Jepsen 1940

Mesodma pygmaea Sloan 1987

(Plate 2, figs. A—G; table 1)

Type: AMNH 35298, left dentary fragment with p4-m2.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality) and Wyoming (Rock Bench Quarry, Fort Union Formation, Polecat Bench [Sloan in Holtzman 1978; Sloan 1978]; Swain Quarry, Fort Union Formation, Washakie Basin [Sloan in Holtzman 1978; Sloan 1978]); latest Torrejonian of Montana (Medicine Rocks I locality, Tongue River Formation, Carter County [Sloan 1987]); earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill [Shotgun] locality, Fort Union Formation, Wind River Basin, Fremont County [Sloan in Holtzman 1978]); early Tiffanian (late Paleocene) of Wyoming (Saddle locality, Fort Union Formation, Bison Basin [Sloan in Holtzman 1978; Sloan 1987]); middle Tiffanian of North Dakota (Brisbane locality, Tongue River Formation [Holtzman 1978]); late Tiffanian of Saskatchewan (Roche Percée local fauna, Ravernscrag Formation [Krause 1977]).

Referred specimens: UALVP 18421, 24423—24432, 24448 and 24451—24469, p4's (total: 31); UALVP 24435, 24447, 24470 and 24484, P4's.

Description: p4. — UALVP 24423—24 and 24448 are slightly larger, but are, otherwise, virtually identical to p4 on the type specimen from the Torrejonian Gidley Quarry (Sloan 1987). In contrast, most of the other p4's referred to this taxon (UALVP 24451—69) differ from p4 of the type. It is evident, especially in occlusal view, that these latter teeth are more robustly constructed, having wider anterior and posterior diameters. In lateral profile, the crown is high and the arc of the apical crest peaks relatively far anteriorly with the apogee located anterior to the midpoint of the crown directly above the ventral peak of the exodaenodont lobe. The highest point of the crown is at the second or third serration. The posterior slope descends in a moderately straight line at about a 20 degree angle from the axis of standard length. The anterior margin is vertically oriented and peaks dorsally well below the first serration, forming a prominent break in the anterior slope and occasionally developing an incipient anterior serration. Excluding this incipient serration, there are usually 11 serrations on the crown. The serration number on these p4's ranges from 10 (2 specimens) to 11 (5 specimens). The first serration is small and inconspicuous, little more than a break in the anterior slope of the tooth. On all specimens in which it is present, this initial serration is formed by the convergence of the labial and lingual margins of the anterior slope. The distance between the second and third serration (in those specimens which bear a distinct initial serration) is greater than the distances between the remaining serrations on the crest. The third or fourth posterior serration is largest on the crown, followed by a progressive decrease in size posteriorly to the last serration, which is developed as a cuspule on some specimens.

The exodaenodont lobe is inflated and rounded ventrally (rather than [illegible]). The anterior root bears a deep wedge-shaped anterior groove, which gives the [illegible] lateral ridges. The anterobasal concavity is shallow but has a well-developed anterior extension of enamel overhanging it.

P4. — Cusp formula, 1-2:6:0. These teeth differ from the P4's identified as "M. sp. P." (M. pygmaea) by Krause (1977) in averaging slightly smaller and in having one fewer labial cusp. Except for their smaller size, these P4's are also similar to P4's of Mesodma formosa Marsh 1889b from the Late Cretaceous of Montana and Alberta (Clemens 1964; Lillegraven 1969). Nothing can be added to the description of these P4's which has not already been provided by Krause (1977) for M pygmaea and by Clemens (1964) for M. formosa.

Discussion: This species has only recently been formally described by Sloan (1987). In his description of M. pygmaea, Sloan (1987, Table 5) referred a single P4 (MCZ 18789) and provided the mean lengths of six additional P4's to this species. These specimens are larger (his measurement: 2.3) than the P4's referred to M. pygmaea by Krause (1977) and substantially larger than the Cochrane 2 sample for this tooth. Inexplicably, Sloan's mean P4 length contradicts the modal value for P4, P. pygmaea, that he cites elsewhere (see Sloan 1987, Table 4), a measurement (2.0) consistent with the Roche Percée sample (Krause 1977) and only slightly larger than the mean P4 length from Cochrane 2 (see Table 1).

Genus Mimetodon Jepsen 1940

Mimetodon silberlingi (Simpson 1935)

(Plate 2, figs. H, I; table 2)

Type: USNM 9798, left dentary fragment with i1, p4-m2.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality [Simpson 1937]; Medicine Rocks I locality, Tongue River Formation, Powder River Basin [Sloan 1971, unpubl. data]) and Wyoming (Rock Bench Quarry, Fort Union Formation, Polecat Bench [Jepsen 1940]; Swain Quarry, Fort Union Formation, Washakie Basin [Sloan 1971, unpubl. data]); earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin [Sloan in D. E. Russell 1967]); early Tiffanian of Texas (localities 40147 and 41365, Black Peaks Formation, Big Bend National Park [Schiebout 1974]); middle Tiffanian of Alberta (UADW-1 and UADW-2 localities, Paskapoo Formation, Blindman River [Fox 1984b; Fox, in press]; Joffre Bridge locality, Paskapoo Formation, Red Deer River [Fox, in press]); late Tiffanian of Montana (Olive locality, Tongue River Formation [Sloan 1971, unpubl. data]), Alberta (Police Point locality, Ravenscrag Formation [Krishtalka 1973]; Swan Hills site 1, Paskapoo Formation, Swan Hills [G. J. Stonley, pers. comm 1985]) and Saskatchewan (Roche Percée local fauna, Ravenscrag Formation [Krause 1977]).

Referred specimens: UALVP 24394—24398 and 24416, p4's (total: 6); UALVP 24402—24410, m1's (total: 9); UALVP 24411—24413, m2's (total: 3); UALVP 18439, 24399—24401 and 24415, P4's (total: 5); UALVP 18374, 18445, 24414 and 24417, M1's; UALVP 18517 and 24418—24422, M2's (total: 6).

Description: p4. — The apical crest can bear 10 (UALVP 24396), 11 (UALVP 24394 and 24397), or 12 (UALVP 24395) serrations. There are no appreciable differences between these teeth and the p4's of M. silberlingi from the late Torrejonian (Gidley Quarry [Simpson 1937]) or the late Tiffanian (Roche Percée local fauna [Krause 1977]) of western North America. The morphology of the p4 has been adequately described by Krause (1977).

m1. — Cusp formula, 8-9:4-5 (mode 8:4). These teeth are essentially identical to those of M. silberlingi from other Paleocene localities. Krause (1977) has provided an adequate description of this tooth position and nothing further need be added.

m2. — Cusp formula, 5-6:2. The m2's referred here are similar in structure to the comparable tooth present on the type specimen from Gidley Quarry. Krause (1977) has already provided an adequate description for the m2 of M. silberlingi.

P4. — Cusp formula, 3-5:6-7:0 (mode 3:7:0). The five complete specimens (UALVP 18439, 24399, 24401, and 24415) representing the P4 of this species are slightly smaller and generally lower crowned, but are, otherwise, very similar to the P4's referred to M. silberlingi by Krause (1977) from the Roche Percée local fauna (Ravenscrag Formation) of Saskatchewan. No further treatment of the description provided by Krause (1977) is required.

M1.—UALVP 24414 (a fragment preserving the posterior two-thirds of this tooth) is the most nearly complete of the referred specimens. These specimens are referred to M. silberlingi on the basis of their similarity to the M1's from Roche Percée in the UALVP collection (Krause 1977). A thorough description of the morphology of these teeth is provided by Krause (1977).

M2. — Cusp formula, 1:3:3-4 (mode 1:3:3). Krause (1977) provides a thorough description of the M2's of M. silberlingi.

Discussion: Teeth referred to M. silberlingi from Cochrane 2 more closely resemble those from Torrejonian localities (Simpson 1937) than those from late Tiffanian sites (Krause 1977); the latter are slightly larger at most positions. It should be noted, however, that this observation is based upon a small sample size (36 teeth) in comparison with the more abundant material (over 300 teeth) from the late Tiffanian Roche Percée localities (Krause 1977).

Genus Ectypodus Matthew and Granger 1921

Ectypodus cf. E. szalayi Sloan 1981

(Plate 3, figs. A—D; table 3)

Type of Ectypodus szalayi: AMNH 35536, left and right associated dentaries, each with i1-m2.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution for Ectypodus szalayi: Middle Torrejonian (middle Paleocene) of New Mexico (KU locality 13, Nacimiento Formation, Kutz Canyon, San Juan Basin [Sloan 1981]); late Torrejonian of Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Sloan 1981]) and Montana (type locality [Sloan 1981]); latest Torrejonian of Montana (Medicine Rocks site I, Tongue River Formation, Carter County [pers. obs.]).

Referred specimens: UALVP 24383, 24384 and 25632—25635, p4's (total: 6); UALVP 24386, m1; UALVP 24388, m2; UALVP 24385, P4.

Description: p4. — The two complete specimens, UALVP 24383 (L=3.1, W=1.1) and 24384 (L=3.0, W=1.1), are both outside of the size range reported by Sloan (1981) for E. szalayi (2.6—2.8) from the type locality (Gidley Quarry) but are, nevertheless, similar in lateral profile and serration number to the late Torrejonian p4's. The Cochrane specimens further differ from the type material in possessing slightly longer (ventrally) and pointed exodaenodont lobes. UALVP 24383 differs from UALVP 24384 in bearing a shorter labial ridge on the second serration. Both specimens bear 10 serrations on the apical crest.

In the shape of the exodaenodont lobe, these specimens are closely similar to Ectypodus powelli Jepsen 1940 from the late Tiffanian of Wyoming.

m1. — Cusp formula, 7:4. UALVP 24386 is an m1 (L=2.0, W=1.0) that is within the dimensions cited by Sloan (1981) for E. szalayi, but differs in possessing only seven cusps in the external row (as opposed to the eight to nine reported in Sloan 1981). The specimen is, however, virtually identical to the m1 on the holotype of E. powelli (PU 13979).

m2. — Cusp formula, 3:2. UALVP 24388 (L=1.3, W=1.1) is an unworn m2 that is larger than the m2 of E. szalayi, but similar to m2 in E. powelli (type specimen), but differing from the latter mainly in lacking the development of a fourth external cusp on the posterolabial lobe. The Cochrane 2 specimen also differs in having a relatively wider separation of the two cusps on the internal row.

P4. — Cusp formula, 2:6:0. Although similar in size, UALVP 24385 (L=2.0, W=0.8) is elongate anteroposteriorly and bears a high medial crest in comparison with the P4's of Mesodma and Mimetodon. The ultimate cusp is highest, followed by the remaining cusps in succession. The medial crest forms a slightly convex arc in lateral view. The more posterior cusp of the external row is the larger of the two. The more anterior external cusp is located directly across from the most anterior cusp of the medial row. The second cusp of the external row is positioned directly across from the valley separating the third from the second most anterior medial cusp.

Discussion: The p4's of the Cochrane species are intermediate in morphology between the Torrejonian E. szalayi and the late Tiffanian E. powelli (Sloan 1987). The referred lower molars are also reminiscent of the molar structure in E. powelli. The P4 referred to E. cf. E. szalayi from Cochrane 2, however, has a lower apical crest than does P4, E. powelli, and is more similar to P4, E. szalayi. This observation provides additional support for Sloan's (1987) hypothesis of relationship for these two species — with E. szalayi being ancestral to E. powelli. An increase in size and crown height for p4/P4, and a more posterior orientation for the labial and lingual ridges on p4, is all that would be required to change these teeth into an E. powelli-like structure.

Ectypodus sp.

(Plate 3, figs. E, F)

Referred specimens: UALVP 24390 and 24391, p4's; UALVP 24392, m1.

Description: p4. — UALVP 24390 (L=2.4, W=0.9) and 24391 (L=2.3*, W=0.9) are small specimens that, together, show the entire crown structure for p4. UALVP 24391 is missing most of the posterior quarter of the crown. In lateral profile this tooth is anteroposteriorly short and relatively high-crowned, forming an almost symmetrically arcuate apical crest. The crest bears nine small, closely-spaced serrations, and probably had 10 to 11 serrations when complete. The third or fourth serration appears to be highest above the base of the crown. The first six labial and lingual ridges extend to the anterior margin of the crown. The exodaenodont lobe on UALVP 24391 is small and has its ventral apex located directly below the third apical serration. The anterobasal concavity is wide, flat and shallow.

The basal margin on the lingual side of the blade is straight and the interradicular crest is only moderately developed. UALVP 24390 has the anterolabial portion of the crown missing. This tooth bears well-defined serrations, increasing in size from anterior to posterior on a fully arcuate apical crest.

m1. — Cusp formula, 7:4. UALVP 24392 is the same length as m1 in the holotype of M. pygmaea Sloan 1987 (L=1.5, W=0.7), but differs in being transversely wider across its entire length and in bearing one extra cusp in the external row. In these characters UALVP 24392 resembles the m1's in other species of Ectypodus and is referred to this taxon on this basis.

Discussion: The p4's referred to Ectypodus sp. from Cochrane 2 are similar in size to the p4 in Mesodma pygmaea. In comparison with the p4 on the holotype of M. pygmaea (AMNH 35298), UALVP 24390 and 24391 are shorter, higher-crowned, and have a more arcuate apical crest and smaller exodaenodont lobe (preserved on UALVP 24391). The first serration on p4, Ectypodus sp., is nearly twice the height, by comparison. UALVP 24390 and 24391 resemble p4 in E. aphronorus Sloan 1987 in lateral profile and in the structure of the anterior margin. The Cochrane p4's differ from p4, E. aphronorus, in being substantially smaller and in bearing one fewer serration on the apical crest (Sloan 1987).

Genus Parectypodus Jepsen 1930a

Parectypodus sinclairi (Simpson 1935)

(Plate 3, figs. G, H; pl. 4, figs. A—C; table 4)

Type: USNM 9770, left dentary fragment with p4-m2.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality [Simpson 1937]); latest Torrejonian of Montana (Medicine Rocks site I, Tongue River Formation, Carter County [pers. obs.]); earliest Tiffanian of Wyoming (Keefer Hill locality ["Shotgun local fauna"] Fort Union Formation, Wind River Basin, Fremont County [pers. obs.; Sloan 1987]).

Referred specimens: UALVP 24361—24363, 24645 and 24646, p4's (total: 5); UALVP 24366—24368 and 24442, m1's (total: 4); UALVP 24371 and 24372, m1's; UALVP 18390, 24364, 24365 and 24370, P4's.

Description: p4. — These teeth are essentially identical to p4 on the holotype from Gidley Quarry (USNM 9770), except for being slightly wider on the anterior margin than in the type specimen. The only complete specimen (UALVP 24361) bears 12 serrations.

m1. — Cusp formula, 7-7.5:4-4.5 (mode 7.5:4). In size and morphology these specimens are virtually identical to m1 on the holotype.

In occlusal view, the only unworn specimen (UALVP 24366) is much wider posteriorly than anteriorly and is stoutly shaped with a low length to width ratio (1.9). The most anterior portion of UALVP 24366 is convex in lateral view with the apex of the first lingual cusp leaning more anteriorly with respect to the apices of the remaining cusps.

P4. — Cusp formula, 2:7:0. UALVP 24364 and 24365 are short, high-crowned posteriorly, and display a steep and slightly concave posterior slope. The penultimate cusp is highest on the apical crest and is twinned with the ultimate cusp. There is no posterior basal cuspule developed on either specimen.

The referred specimens are virtually identical to the P4's described and illustrated by Sloan (1987) for P. sinclairi.

Discussion: The occurrence of P. sinclairi at the Cochrane locality is only the second report of this taxon from the earliest Tiffanian of North America (also found at the Keefer Hill locality of Wyoming [Sloan 1987]) and in addition, represents a geographic range extension for the species.

Parectypodus cf. P. sylviae (Rigby 1980)

(Plate 4, figs. D—F; table 5)

Type of Parectypodus sylviae: AMNH 100939e, p4.

Type locality: Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County, Wyoming.

Known age and distribution for Parectypodus sylviae: Late Torrejonian (middle Paleocene) of Wyoming (type locality [Rigby 1980; Sloan 1987]); latest Torrejonian of Montana (Medicine Rocks I locality, Tongue River Formation, Carter County [Sloan 1987; pers. obs.]).

Referred specimens: UALVP 18403 and 24373—24376, P4's (total: 5).

Description: P4. — Cusp formula, (0-3)3-6:7-9:0 (mode (2)6:8:0). In size, these teeth are similar to the P4's of Mesodma. However, they bear two long rows of external and medial cusps and usually a third row of anterolabial cusps on the crown. The medial row is low and arcuate with the fifth or sixth cusp highest. Cusp height increases from anterior to the highest cusp and then decreases posteriorly. The medial cusps usually extend to the very posterior of the crown. No posterior slope is developed on the apical crest in contrast to other species of neoplagiaulacids. The external row of cusps extends far posteriorly on the crown. The ultimate cusp of this row usually is opposite the penultimate or antepenultimate cusp of the medial row.

A small anterolabial bulge is developed on most specimens. This bulge may bear as many as three cusps or cuspules of various sizes.

Discussion: This taxon was originally described as a species of Ectypodus Matthew and Granger 1921 by Rigby (1980) and has recently been transferred to the genus Parectypodus by Sloan (1987), who cited the characteristically high anterior margin on the lower fourth premolars and the development of additional external cusps on the upper fourth premolars (Sloan 1981, 1987). The P4's described here are virtually identical to comparable specimens (PU 18203a and b) from the Medicine Rocks I locality of Montana (pers. obs.) that have been referred to P. sylviae by Sloan (1987, p. 194). These P4's differ from the P4's in all other known species of Parectypodus in possessing a more arcuate medial cusp row and in lacking a distinct posterior slope on the apical crest.

The presence of P. sylviae at the Cochrane 2 locality represents a northerly range extension and is the first reported occurrence of this taxon from the late Paleocene of North America.

<u>Parectypodus</u> n. sp.

(Plate 5, figs.A—E)

Referred specimens: UALVP 24377, p4; UALVP 18507, 24378 and 24379, P4's.

Description: p4. — The crown of UALVP 24377 is elongate and narrow (L=3.8, W=1.1) and bears 14 'true' serrations and a single anterior incipient serration.

The apical crest has the incipient to sixth serration forming a symmetrical arc in lateral profile. Serrations seven through thirteen decrease in height in a linear progression and at a 45 degree angle to the longitudinal axis of the crown. The exodaenodont lobe has the ventral apex damaged; however, judging from the remaining portion, the lobe was long, narrow, and probably pointed ventrally.

The incipiently developed serration bears no labial or lingual ridges. The first 'true' serration is more prominent, located relatively high on the apical crest, and has short, poorly developed labial and lingual ridges. The second serration has well-developed labial and lingual ridges. The descending labial ridge of the second serration is deflected ventrally, to form a steeper angle, halfway down its length. In turn, the ridge of the third serration is similarly distorted in the same region. The labial ridge of the fourth serration bends anteriorly towards the ridge of the fifth serration but fades into the face of the crown before contacting it, disappearing well before the termination of the surrounding ridges. Posteriorly, the labial valleys between the last four serrations recurve posteroventrally.

A broad wear facet covers the posterolabial side of the crown from below the sixth to the ultimate serration. The posterolabial shelf is weakly developed.

P4. — Cusp formula, 2:8:0. UALVP 24378 and 24379 are equal in size (L=2.9, W=1.1) and bear relatively low, elongate apical crests. The penultimate cusp is highest on the apical crest and the posterior slope is slightly concave.

Discussion: The high arcuate profile of p4, Parectypodus n. sp., from Cochrane 2 and the relatively high position of the first serration identifies this species as belonging to Parectypodus (Sloan 1981). Although the p4 of P. n. sp. is known only from a single specimen (UALVP 24377), it is unique in morphology and is readily distinguished from that of Parectypodus sinclairi from the Cochrane 2 locality and from p4, P. sylviae (see Sloan 1987).

The p4 of P. n. sp. does not closely resemble the comparable tooth in any of the species of Parectypodus known from the Torrejonian or Tiffanian of North America (see Sloan 1981, 1987). However, vague similarity exists between UALVP 24377 and a p4 (UALVP 15119) from the Puercan Rav W-1 locality (MHBT Quarry, Ravenscrag Formation) of southwestern Saskatchewan, described as Parectypodus sp. by Johnston and Fox (1984). P. sp. of Johnston and Fox (1984) is also represented by only a single p4 (UALVP 15119) (and a single P4 [UALVP 16183]) and is similar in length (3.9) and lateral profile to UALVP 24377, with an equal number of serrations (14), plus one small incipient serration. The apogee for both specimens is at the fourth serration.

The Puercan p4 differs from UALVP 24377 in having its greatest height located more anteriorly on the crown. UALVP 15119 is also higher crowned and considerably wider anteriorly. The first serration of the Cochrane p4 is equal in height to the incipient anterior serration of the Puercan form. In addition, the exodaenodont lobe of the Puercan specimen is larger and more rounded ventrally and the lingual serrations extend further anteroventrally.

The referred P4's (UALVP 24378 and 24379) from Cochrane 2 also compare well with the P4 (UALVP 16183) referred to P. sp. by Johnston and Fox (1984), differing mainly in being somewhat smaller and having fewer labial cusps.

The significance of the similarities between the p4/P4's of P. n. sp. from Cochrane 2 and P. sp. of Johnston and Fox (1984) can not be determined on the available evidence. Although UALVP 24377 and 24378 are probably representative of a new Paleocene species of Parectypodus, its diagnosis and naming is deferred until a larger sample and a better estimate of variability within the species is obtained.

Parectypodus n. sp. is represented by virtually identical p4's from the latest Torrejonian Medicine Rocks I locality and Mehling site (Tongue River Formation, Carter County) of Montana (pers. obs.).

Genus Neoplagiualax Lemoine 1882

Neoplagiaulax nelsoni Sloan 1987

(Plate 5, figs. F, G; pl. 6, figs. A—E; table 6)

Type: UMVP 6030, left p4.

Type locality: Purgatory Hill, McCone County, Montana.

Known age and distribution: Late Puercan (early Paleocene) of Montana (type locality [Sloan 1987]); late Torrejonian (middle Paleocene) of Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980; Sloan 1987]; Rock Bench Quarry, Fort Union Formation, Polecat Bench, Park County [Sloan 1987]); latest Torrejonian of Montana (Medicine Rocks I locality, Tongue River Formation, Carter County [Sloan 1987]); earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [Sloan 1987, pers. obs.]) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]); early Tiffanian of Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]).

Referred specimens: UALVP 18880, dentary fragment with p4-m2; UALVP 18378, 18813, 18814, 18818—18824, 18827, 18830—18833, 18836, 18845—18847, 18849, 18857—18879, 18881—18884 and 18915, p4's (total: 48); UALVP 18853—18855 and 18916—18950, m1's (total: 38); UALVP 18951—18955 and 24270—24286, m2's (total: 23); UALVP 18505, 18506, 18782, 18816, 18817, 18825, 18828, 18844, 18848, 18850, 18851 and 18886—18915, P4's (total: 41); UALVP 18853, 18856 and 24288—24312, M1's (total: 25); UALVP 18379, 18521, 18523 and 24313—24353, M2's (total: 44).

Description: p4. — The p4's referred to this species are highly variable in morphology, but are similar in lateral profile to the p4's of N. hunteri Simpson 1936, described by Simpson (1936) and Krause (1977) from the early Tiffanian Scarritt Quarry (Melville Formation), Montana and late Tiffanian Roche Percée local fauna (Ravenscrag Formation), Saskatchewan, respectively. However, they are smaller and each bears only 12 (10 specimens) to13 (6 specimens) serrations (mean for N. hunteri=15 [Krause 1977]). In both shape and serration number, the Cochrane p4's resemble those identified as "N. cf. hunteri" by Rigby (1980) from the Swain Quarry of Wyoming and later included in N. nelsoni by Sloan (1987). Both size and serration number are well within the range for the Torrejonian N. nelsoni (Rigby 1980; Sloan 1987).

The referred p4's display narrow exodaenodont lobes; resembling the condition seen in Rigby's "N. cf. hunteri", but have the lobe less inflated than in N. hunteri from Scarritt Quarry (Simpson 1936) or the Roche Percée local fauna (Krause 1977). The exodaenodont lobe is variably developed but is pointed (ventrally) in most specimens. Another variable feature is the labial outline of the anterior margin of the exodaenodont lobe. The margin is strongly sinusoidal in outline in some specimens and less so in others. However, all specimens maintain some degree of curvature on the margin. The anterior root is anteroposteriorly long and narrows anteriorly. A deep vertical anterior groove is formed, indicating the presence of p3. The anterior concavity is straight and relatively shallow.

The p4's from Cochrane 2 are less convex labially, and less concave lingually, than p4, N. hunteri. They also bear more widely spaced serrations on the apical crest. The fourth or fifth serration is usually the highest above the base of a line drawn from the anterobasal concavity to the posterolabial self.

m1. — Cusp formula, 7:4. The referred specimens bear seven well-defined external cusps on a crown that is slightly concave ventrally.

m2. — Cusp formula, 3-4:2. The referred specimens do not differ significantly from the m2 morphology described in detail by Krause (1977) for "Neoplagiaulax cf. hazeni".

P4. — Cusp formula, 2-3:7-8:0 (mode 2:8:0). The P4's referred here are highly variable in morphology and display two to three conical cusps on a prominent anterolabial bulge, with the more anterior cusp consistently the smallest. Except for being smaller, less robust, and having a greater labial cusp number (formula for N. hunteri, 0-1:8-9:0), UALVP 18816—17 and 18825—28 are very similar in lateral profile to the P4's of N. hunteri (described by Krause [1977], and Krause and Gingerich [1983]). These teeth are slightly more robust and higher crowned than the other P4's referred to this species. The remaining specimens have lower median cusps and, except for size, are morphologically identical to the P4's described by Holtzman (1978) for "Neoplagiaulax sp. (1)" (N. jepi of Sloan 1987) from the Brisbane and Judson localities (Tongue River Formation) of North Dakota. For these teeth, nothing further need be added to Holtzman's (1978) description.

M1. — Cusp formula 6-8:8-9:4-5. The morphology of these specimens is virtually identical to that of M1, "N. cf. hazeni", from the Roche Percée local fauna (Ravenscrag formation), Saskatchewan, which has been adequately described by Krause (1977). The M1's referred here closely occlude with the m1 on UALVP 18880.

M2. — Cusp formula 1:2-3:3. The referred M2's are similar in morphology to the comparable teeth described in detail by Krause (1977) for "N. cf. hazeni". These teeth closely occlude with m2 on UALVP 18880.

Discussion: UALVP 18880, a dentary fragment referred to N. nelsoni from Cochrane 2 also shows similarity to the type specimen of Neoplagiaulax macrotomeus Wilson 1956 (KU 7908, a dentary fragment with p4-m2) from the late Torrejonian Nacimiento Formation of New Mexico. Although, the apex of the crown of p4, N. macrotomeus, is broken, the lateral profile of the crown would have been, nevertheless, quite similar to the shape of p4, on UALVP 18880 (see Sloan 1987). The two species also differ by only one cusp in both the internal and external rows of m1.

Sloan (1987) has recently described N. nelsoni and lists its temporal and geographic range as from the late Puercan of Montana to the late Torrejonian and earliest Tiffanian of Wyoming, and latest Torrejonian of Montana. This species is also found in the earliest Tiffanian Douglass Quarry and early Tiffanian Scarritt Quarry of Montana, where it is sympatric with N. hunteri (pers. obs.).

Neoplagiaulax cf. N. hunteri Simpson 1936

(Plate 6, figs. F, G; pl. 7, fig. A)

Type of Neoplagiaulax hunteri: AMNH 33865, right dentary with i1-m2.

Type locality: Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County, Montana.

Known age and distribution for Neoplagiaulax hunteri: Earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]); early Tiffanian of Montana (type locality [Simpson 1936]); middle Tiffanian of North Dakota (Brisbane and Judson localities, Tongue River Formation, Williston Basin, Grant and Morton Counties [Holtzman 1978]) and Wyoming (Cedar Point Quarry, Polecat Bench Formation, Bighorn Basin, Bighorn County [Rose 1981a]); latest Tiffanian of Saskatchewan (Roche Percée local fauna, Ravenscrag Formation [Krause 1987] and Alberta (Swan Hills local fauna, Paskapoo Formation, Swan Hills [G. J. Stonley, pers. comm. 1985]).

Referred specimens: UALVP 18838, p4; UALVP 18840, P4; UALVP 18839, M1.

Description: p4. — UALVP 18838 is the posterior half of a p4 similar in lateral profile and serration morphology to the p4's of N. hunteri from Scarritt Quarry (Simpson 1936). In comparison with p4's from Roche Percée described by Krause (1977), UALVP 18838 differs in being narrower and lower-crowned, with smaller, more gracile serrations.

P4. — Cusp formula, 1:9:0. UALVP 18840 (L=2.3, W=1.2) is a P4 that resembles both the P4's referred to N. hunteri from Scarritt Quarry (Simpson 1936) and those from the Roche Percée local fauna (Krause 1977). The similarities include a virtually identical lateral and occlusal outline and cusp number. UALVP 18840 differs from the late Tiffanian P4's described by Krause (1977) in being shorter and narrower (less inflated) with slender cusps on the medial row; cusps that are heavily wrinkled to the base of the crown. In addition, UALVP 18840 bears a single well-developed external cusp which is absent in the large Roche Percée sample. UALVP 18840 is closer in size and overall morphology to the P4's of N. hunteri from the type locality (Simpson 1936) and from Douglass Quarry (Krause and Gingerich 1983; pers. obs.). However, the Cochrane specimen differs in having a narrower (less inflated) crown and in possessing well-developed wrinkling of the enamel on all of the cusps, including the single external cusp.

M1 — UALVP 18839 is the posterior two-thirds of a long, relatively narrow M1 (W=1.3) similar to the M1 (UALVP 10614) from the Roche Percée local fauna referred to N. hunteri by Krause (1977) . Although slightly crushed on the external cusp row, UALVP 18839 appears to have been very similar to the Roche Percée specimen in crown shape and cusp number. The only differences observed from the Roche Percée M1 is in the slightly narrower posterior width and in the less prominent grooving of the cusps in the Cochrane specimen.

The description of M1 in N. hunteri has been adequately detailed by Krause (1977) and nothing further can be added by the referred specimen.

Discussion: The referred specimens are slightly smaller and more gracile, but otherwise more similar to the teeth of N. hunteri than to the sample of N. nelsoni from Cochrane 2. The material of early N. hunteri from the Douglass Quarry of Montana is larger and more robust than the Cochrane specimens (pers. obs.).

R. E. Sloan (1987) has recently suggested that <u>Neoplagiaulax</u> <u>hunteri</u> is the descendant of <u>N</u>. <u>nelsoni</u>. The presence of <u>N</u>. <u>nelsoni</u> with a neoplagiaulacid close to <u>N</u>. <u>hunteri</u> at Cochrane 2 would require the evolutionary divergence of the latter taxon at some time before the earliest Tiffanian.

Neoplagiaulacidae unident. gen. and sp.

(Plate 7, figs. B—F)

Referred specimens: UALVP 24485, p4; UALVP 24486, P4.

Description: p4. — UALVP 24485 (L=2.8*, W=0.9) is the anterior half of a p4. The specimen is low crowned and has a small exodaenodont lobe. The basal concavity is deep and the enamel prominently overhangs dorsally. The anterior margin is almost vertical, and bears two well developed incipient serrations that lack these ridges are more closely approximated to each other than to the remaining anterior cusps. Although posterior damage prevents a cusp count for UALVP 24485, there were probably no fewer than 10 'true' serrations on the crown.

The first three labial and lingual ridges extend anteriorly to terminate near the edge of the anterior margin. The second or third serration was probably the highest on the apical crest. The first labial and lingual ridge each bifurcates into a short ridge that forms the first 'true' serration and into a longer ridge that extends posteriorly to produce the second serration.

P4. — UALVP 24486 has a cusp formula of 3(+4):6:0 and is similar in size (L=1.6, W=0.6) to P4, <u>Mesodma pygmaea</u>, from Cochrane. UALVP 24486 differs in possessing a low apical crest and a long external cusp row, with three main cusps interspaced with four tiny accessory cuspules. These external cusps and cuspules extend anteriorly to the penultimate cusp of the medial row.

Discussion: UALVP 24485 is similar in size and superficially reminiscent of p4 in <u>Mesodma pygmaea</u>. Although the anterior half of this tooth is preserved, its unique morphology clearly separates it from the variable p4's of M. pygmaea that are presently recognized from Cochrane 2 (see above). The low crown, coupled with its poorly developed exodaenodont lobe and prominent incipient serrations, are features seen elsewhere only in the genus Xyronomys Rigby 1980. UALVP 24485 differs from the anterior morphology in p4, Xyronomys, by possessing a higher anterior slope (Rigby 1980; Johnston and Fox 1984; Sloan 1987).

UALVP 24486 (P4) is tentatively referred to this same species from its size and low apical crest. The latter character might be predicted on the P4 of a neoplagiaulacid with a low-crowned p4. P4 in Xyronomys is unknown (Rigby 1980; Sloan 1987).

Family Ptilodontidae Gregory and Simpson 1926

Genus Ptilodus Cope 1881a

Ptilodus sp. T Krause 1987

(Plate 8, figs. A-C; pl. 9, fig. A; table 7)

Type: PU 14584, right dentary fragment with i1, p3-4, m1.

Type locality: Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County, Montana.

Known age and distribution: Latest Torrejonian (middle Paleocene) of Montana (?Medicine Rocks site I, Tongue River Formation, Powder River Basin, Carter County [Krause 1982]); earliest Tiffanian (late Paleocene) of Montana (type locality [Krause 1982, 1987; Krause and Gingerich 1983]) and Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]); middle Tiffanian of Alberta (Joffre Bridge Road Cut locality, lower level, Paskapoo Formation, Red Deer River [Fox, in press]).

Referred specimens: UALVP 18644, i1; UALVP 18620, dentary fragment with p3-p4; UALVP 18643, p3; UALVP 18641, 18642, p4's; UALVP 18638, 18639, 18640 and 18646, m1's; UALVP 18629, 18630, 18632 and 18633, m2's; UALVP 18624, 18625, 18628 and 18635, P3's; UALVP 18622, 18623, 18626, 18634, 18636 and 18647, P4's (total: 6); UALVP 18621, maxillary fragment with M1-M2; UALVP 18627 and 18637, M1's; UALVP 18631, M2.

Description: p3. — UALVP 18643 (isolated specimen) and the p3 on UALVP 18620 (dentary fragment) are mushroom-shaped with domed, bulbous crowns.

p4. — This tooth is best preserved on UALVP 18620. The crown of p4 on UALVP 18620 is oblong in lateral profile, rather than arcuate, and has 14 serrations. The anterior margin is slightly flattened and curves posteriorly approximately midway between the anterobasal concavity and the first serration, from a gentle posterior inclination of the margin above the concavity. The exodaenodont lobe is wide anteroposteriorly but reduced and rounded ventrally. The posterolabial shelf is narrow. In lateral profile, the crown is kidney-shaped.

The first serration is located above the ventral apex of the exodaenodont lobe and has three ridges — anterolabial, medial, and anterolingual — descending from it. The medial ridge becomes weak and eventually obscured on the anterior margin.

The highest point of the crown is further posterior than in other species of Ptilodus and the orientation of p4 in the dentary is more nearly vertical along a line from the peak of the anterobasal concavity to the top of the posteroexternal ledge.

UALVP 18641 is the anterior half of a p4 and is almost identical in size to comparable parts of the p4's of P. sp. T from Douglass Quarry (see Table 1).

m1. — UALVP 18639 and 18640 are posterior fragments of m1's that are typically Ptilodus-like in structure, having broad pyramidal posterolabial cusps with prominent ridges running posterolingually from their apices. The labial faces of these external cusps have wrinkled enamel. The last two lingual cusps are partly fused together in both specimens. They are especially high on UALVP 18639 (unworn specimen) and bear many vertically oriented ridges on their external surfaces.

m2. — Cusp formula, 4:2. These teeth are of characteristic Ptilodus construction but possess larger, more robust cusps and more numerous deep vertical grooves on the medial surfaces of these cusps than on the m2's of other species of the genus.

P3. — The number of cusps can be seven or eight (mean 7.25; mode 7). There are, consistently, six main cusps, subequal in height and equidistantly arranged in two rows, forming a square at the center of the crown. The seventh or eighth cusp is always developed posterolabial to the main rows and usually positioned on the side of the crown. UALVP 18634 displays additional cuspules at the bases and between the spaces of the larger central labial cusps.

These P3's are the first to be described for P. sp. T. Except for greater size and cusp number, they do not differ from P3's described for other species of Ptilodus.

P4. — Cusp formula, (0-2)7-8:10:0 (mode (1)7:10:0). In outline, the crown is swollen anterolabially, and shows a well defined anterolingual constriction opposite this swelling. The enamel on the cusps is papillate or wrinkled. Cusps on the anteroexternal bulge range in size from small to near the largest on the crown. The cusps in the external row increase and then decrease in size, with the third cusp largest on all specimens. The cusps of the middle row are subequal in height and size, and are arranged in virtually a straight line marred by a slight lingual deflection of the first three cusps, as a consequence of the anterolingual constriction.

M1. — Cusp formula, 9:10:5-6. The crown is of characteristic Ptilodus construction, but with a greater number of cusps in all rows.

M2. — Cusp formula, 1:2:3. The occlusal surface of the crown is concave anteriorly and convexly rounded posteriorly. The single cusp in the external row is the smallest and lowest. The anterior ridge extending lingually from the apex of this cusp is deflected posteriorly and merges with the first cusp in the middle row, approximately half-way up its anterior face, ending anterolingually at the base of the cusp. The first cusp of the middle row is high and pyramidal. The second cusp is subcrescentic, tallest on the crown, and curved anteriorly. Both cusps have wrinkled enamel on their sides.

Discussion: The occurrence of this species at the Cochrane 2 locality is the first earliest Tiffanian report outside of Montana (Krause 1982) and represents a geographic range extension. The species is also represented by a number of isolated specimens from the earliest Tiffanian Keefer Hill ("Shotgun") locality of Wyoming (pers. obs.). Ptilodus sp. T is also known from the middle Tiffanian Paskapoo Formation (Joffre Bridge Road Cut locality, lower level, Red Deer River) of Alberta (Fox, in press).

Ptilodus sp. C Krause 1987

(Plate 9, fig. B; table 8)

Type: UM 63094, right dentary fragment with i1, p3-4.

Type locality: Cedar Point Quarry, Polecat Bench Formation, northern Bighorn Basin, Wyoming.

Known age and distribution: Early to middle Tiffanian (late Paleocene) of southcentral and southeastern Alberta, North Dakota, Montana, and Wyoming (numerous localities [see Krause 1982, 1987; Fox, in press]).

Referred specimens: UALVP 18659—18662 and 18668, p4's (total: 5); UALVP 18648, 18649, 18654 and 18656, m1's; UALVP 18655, m2; UALVP 18409, 18650 and 18651, P1's; UALVP 427, 18652 and 18667, P3's; UALVP 18663, 25630 and 25631, P4's; UALVP 18657, 18658 and 18665, M1's; UALVP 18653 and 18664, M2's.

Description: p4. — These teeth are low crowned with 15 (estimated) serrations. The referred specimens are fragmentary, but otherwise, comparable to virtually identical p4's referable to this taxon from elsewhere (Krause 1982; Fox, in press).

m1. — Cusp formula, 6-7:6. These teeth are indistinguishable from the m1's referred to P. sp. C by Krause (1982) and possess a greater cusp number in the internal and external rows than the m1's of Ptilodus species of comparable size (pers. obs.).

m2. — Cusp formula, 4:2. These m2's are morphologically similar to the comparable teeth of other medium-sized members of the genus.

P3. — UALVP 427 was collected and subsequently described by L. S. Russell (1929a), and was later redescribed by Krause (1977), as "Ptilodus sp." This specimen and UALVP 18652 clearly belong to P. sp. C, based on their size and cusp number (6 and 7 cusps, respectively).

P4. — UALVP 25631 is an anterior fragment and UALVP 25630 is a posterior fragment of P4, smaller than P4's referred to P. sp. T and larger than P4's of Ptilodus gnomus n. sp. from Cochrane 2 (see below). These specimens, along with UALVP 18663, are similar in size to the P4's of Ptilodus montanus and are almost identical to specimens of P. sp. C, to which they are referred.

M1. — UALVP 18658 (damaged posteriorly) and 18657 (posterior fragment) are almost identical to undescribed material of P. sp. C from the middle Tiffanian of Alberta (R. C. Fox, pers. comm. 1985).

M2. — Cusp formula, 1:3:4. These teeth are morphologically like the the M2's of other species of the genus.

Discussion: The material referred to P. sp. C documents the presence of a medium-sized ptilodontid species, similar to the Torrejonian P. montanus, at the Cochrane 2 locality and provides the first recognized evidence for the contemporaneous occurrence (in time and space) of this species with P. sp. T.

Teeth referable to this species have also been recovered from the earliest Tiffanian of Wyoming (at the Keefer Hill locality ["Shotgun local fauna"] Fort Union Formation, Wind River Basin, Fremont County) and Montana (from Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County) (pers. obs.).

Ptilodus gnomus n. sp.

(Plate 9, figs. C, D; table 9)

Etymology: gnomus, New Latin, noun, meaning "diminutive fabled being" or "dwarf". In allusion to the small size of this species and its association in the same fauna with P. sp. T, the largest recognized species of Ptilodus.

Holotype: UALVP 18669, left P4.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Hypodigm: Type specimen and UALVP 18670, left dentary fragment with i1, p3-p4; UALVP 18671—18685 and 18738, p4's (total: 16); UALVP 18707—18713; 18717, 18721, and 18722, m1's (total: 10); UALVP 18484, 18486, 18715, 18716 and 18718—18720, m2's (total: 7); UALVP 18742, 18743, 18746, 18748, 18749, 18751, 18763, 18765, 18770, 18771, 18776 18778, 18779, 18781 and 18785, P1's (total: 15); UALVP 18512, 18739, 18745, 18747, 18753, 18755, 18756, 18760—18762, 18769, 18772 and 18783, P2's (total: 13); UALVP 18740, 18741, 18744, 18750, 18752, 18754, 18757—18759, 18764, 18766, 18767, 18768, 18773—18775, 18777, 18780, 18782, and 18784, P3's (total: 20); UALVP 18413, 18500, 18502 and 18686—18706, P4's (total: 24); UALVP 18425, 18452, 18514, 18666, 18731—18734, 18736 and 18737, M1's (total: 10); UALVP 18416 and 18723—18730, M2's (total: 9).

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta (type locality) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]) and Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]).

Diagnosis: P4 differs from P4 in all other species of Ptilodus, in being substantially smaller (approximately 20% smaller than P4 of Ptilodus fractus Dorr 1952, the smallest recognized species of the genus [Krause 1982]). Further differs from P. fractus in possessing a teardrop-shaped P4; higher, more arcuate, crown on p4, with less obtuse and more evenly curved slope along the anterior margin; p4's with anterobasal concavity truncating to a peak dorsally; and consistently bears at least one fewer serration on p4 (11, five specimens; 10, one specimen) compared with P. fractus (12, two specimens).

Description: i1. — The lower incisor is relatively long and narrow but of characteristic ptilodontid morphology.

p3. — This small tooth is peg-like with a bulbous, featureless enamel crown.

p4. — The crown is high and symmetrically arcuate in lateral profile, it has 10 (one specimen) to 11 (five specimens) serrations. The anterior margin gently curves posteriorly midway between the anterobasal concavity and the first serration, displaying only a very weak break in slope. The anterobasal concavity is well-developed and is truncated at its most dorsal point to from an acute peak or narrow wedge on all specimens. In contrast, the anterobasal concavity is flat or rounded dorsally on p4, P. fractus (pers. obs.).

The enamel is heavily wrinkled with dorsoventral ridges just above the posterolabial shelf. The exodaenodont lobe is wide (over two-thirds of the crown length) and deep.

m1. — Cusp formula, 5-6:4. Except for their diminutive size, these teeth are Ptilodus-like in morphology (see Krause 1977).

m2. — Cusp formula, 4:2. Except for their diminutive size these teeth are Ptilodus-like in morphology (see Krause 1977).

P1, P2, and P3. — With the exception of smaller size, the anterior upper premolars are identical in morphology to the homologous teeth of other species of Ptilodus, but especially to P. mediaevus Cope 1881c.

The P3 usually bears only four cusps (UALVP 18757 and 18764 have 4.5 and UALVP 18764 bears 5.0), clearly resembling the condition observed in P. mediaevus (mean=4.39 cusps [Krause 1982]).

P4. — Cusp formula, (0)4-5:6-8:0 (mode (0)4:8:0). In occlusal outline the tooth resembles a "teardrop", with the anterior aspect much wider than the posterior (which tends to narrow to a point). The anterolabial bulge is weakly developed and bears no cusps or cuspules. The enamel is wrinkled on all cusps on the crown. Occlusally, the cusps of the external row turn slightly towards the middle row. The second cusp in the external row is the largest on all specimens. The cusps of the middle row are arranged in a relatively straight line running anterolingual to posterolabially. They are subequal in size and height, with the exception of the first cusp, which is smaller on some specimens.

M1. — Cusp formula, 9:9:4-5. Of characteristic ptilodontid morphology (see Krause 1977), these teeth differ only in size from the M1 's of other species of Ptilodus.

M2. — Cusp formula, 1:3:3. Except for their smaller size, the morphology of these teeth is comparable to that in other species of Ptilodus (see Krause 1977).

Discussion: Although more similar in size to the comparable teeth in P. kummae Krause 1977 (from the Roche Perée local fauna, Ravenscrag Formation, Saskatchewan) and P. fractus, the upper and lower fourth premolars of this new species resemble those of Ptilodus mediaevus in overall morphology. The crown of p4 is high with low serration number and a comparable length:height ratio to that of p4, P. mediaevus (Krause 1982). The occlusal outline of P4 is teardrop-shaped in both species and is wider anteriorly relative to length than in other species of Ptilodus. As was previously noted, the anterior premolars are also more similar to P. mediaevus than to those of other Ptilodus species.

Krause (1982) has proposed an ancestor-descendant relationship (and therefore a size reduction) between the late Tiffanian P. kummae and P. fractus based on their strong similarity in size and morphology, and on their stratigraphic succession. A suitable Torrejonian ancestor for P. kummae was left unresolved by Krause (1982; D. W. Krause, pers. comm. 1986), due to the substantial size and morphological differences seen in the teeth of this species and other Ptilodus species (see also Krause 1977). The discovery of P. gnomus cannot resolve this problem. Although temporally older, the dentition of P. gnomus is 20% smaller than that of P. kummae and the only complete P4 referred to P. fractus (UMVP 5808, from the late Tiffanian Olive locality, Tongue River Formation, Powder River Basin, Montana [Krause 1982]) is approximately 20% larger than P4, P. gnomus In addition, the p4 of P. gnomus has a less "erect anterior margin" (Krause 1982) than p4, P. fractus and P. kummae (P. fractus, according to Krause [1982], differs from P. kummae only in size). On the available evidence, I consider a relationship for P. gnomus with either P. fractus or P. kummae to be less parsimonious than the hypothesis proposed by Krause (1982).

Ptilodus gnomus is also present in the earliest Tiffanian Douglass Quarry fauna of Montana (pers. obs.), where the comparable specimens are virtually identical to the Cochrane 2 material. This species also occurs at the early Tiffanian Scarritt Quarry, Montana (pers. obs.)

An isolated p4 (USNM 20878) identified by Gazin (1956a, p. 13; Pl. 1, fig. 2) as "cf. Ectypodus hazeni", from the early Tiffanian Saddle locality (Bison Basin) of Wyoming, appears referable to this species, both in respect to lateral profile and serration number (pers. obs.). The specimen is, however, slightly smaller (p4 L=5.0) than the p4's from the Cochrane 2 locality (see Table 9).

The recognition of P. gnomus n. sp. at Cochrane 2 documents the presence of three species of Ptilodus from this locality. The occurrence of three sympatric species of Ptilodus from a single locality occurs, elsewhere, only at Douglass Quarry (pers. obs.; D. W. Krause, pers. comm. 1986).

Genus Baiotomeus Krause 1987

Baiotomeus russelli n. sp.

(Plate 10, figs. A-D; table 10)

Etymology: Named for Dr. Loris Shano Russell in recognition of his early work on the mammals from the Cochrane 2 locality and his contributions to vertebrate paleontology in general.

Holotype: UALVP 18787, left P4.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Hypodigm: Type specimen and UALVP 18786, 18800—18803 (total: 4), p4's; UALVP 18791—18798 (total: 8), m1's; UALVP 18788—18790 (total: 3) and 18799, P4's; UALVP 18381, M1.

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta — known only from the type locality.

Diagnosis: Smallest known species of the genus; P4's approximately 45% smaller than those of B. douglassi (Simpson 1935) and 40% smaller than the P4's of B. lamberti Krause 1987.

Description: p4. — UALVP 18786 and UALVP 18803 are tentatively referred to B. russelli n. sp. on the basis of their similarity in lateral profile with the p4's of B. douglassi and B. lamberti. They are also the appropriate size to occlude with the P4's upon which the new species is based.

The crown in both specimens is vaulted less posteriorly than in Ptilodus, and UALVP 18786 (complete specimen) possesses a relatively deep and anteroposteriorly narrow exodaenodont lobe. UALVP 18786 is heavily water-worn and has an estimated 10 or 11 serrations on the crown.

These p4's are relatively gracile compared to those of B. lamberti and low crowned in comparison with the similar-sized p4's of Neoplagiaulax from Cochrane 2.

m1. — Cusp formula, 6(?7):4. In occlusal view, the anterior margin of m1 is essentially straight. The external row possesses from six to seven well-separated cusps. The first external cusp is small and cone-shaped and almost half the size of the second labial cusp, which is pyramidal and vertically oriented. The third labial cusp is also pyramidal but is slightly recurved. The last two external cusps are subcrescentic. The cusps of the internal row are similar in size and shape, but are taller than the cusps in the external row. Each internal cusp is isolated by deep bordering troughs. Faint vertical grooves are present on the medial surfaces of the internal cusps and on the most posterior external cusps.

P4. — Cusp formula, (3-4)5:8:0. The P4 is subrectangular in occlusal outline, with blunt to rounded anterior and posterior ends and a weakly developed anterolabial bulge. Cusps on the anterolabial bulge range in size from tiny cuspules to just smaller than the cusps in the external row. The external cusps curve anteriorly, with the third cusp largest, and extend posteriorly over two-thirds of the crown length. The cusps of the middle row form a gentle arc anteriorly with the anterior cusps lower in height and increasing in both height and size posteriorly from the first to the fifth cusp. The remaining three cusps decrease in size and height posteriorly, but to a lesser degree, with the fifth cusp largest and highest in the row. The first and second cusps are smallest in the row.

The enamel on the crown is very weakly wrinkled.

Discussion: In both occlusal outline and lateral profile these lower and upper fourth premolars strongly resemble the teeth of other species of Baiotomeus. They are, however, much smaller than the comparable premolars of both B. douglassi and B. lamberti from the Torrejonian of North America.

At present, the upper and lower fourth premolars are the only teeth from Cochrane 2 referable with confidence to the genus. Although the referred material is relatively meagre, I consider the naming of a new species justifiable based upon the distinctive nature of these teeth and the taxonomic importance of fourth premolars in ptilodontid systematics (see Krause 1982).

Ptilodontidae unident. gen. and sp.

(Plate 10, fig. E)

Referred specimens: UALVP 18804 and 18805, m1's.

Occurrence: Earliest Tiffanian (late Paleocene) Cochrane 2 locality, Porcupine Hills Formation, southwestern Alberta.

Description and discussion: Cusp formula, ?7:?5. UALVP 18804 preserves the posterior three-quarters of a very large ptilodontid m1 (L=5.8*, W=2.9), approximately 20 percent larger than m1 of Ptilodus sp. T. A minimum of six robust external cusps are present: these are arranged on the crown as in m1's of other ptilodontids, with the last two (ultimate and penultimate) buttressed against each other. Prominent branching ridges with deep grooves are present on the lingual faces of the external cusps. Similar well developed ridges are found on the labial surfaces of the three preserved internal cusps. The labial sides of the external cusps are wrinkled as in P. sp. T, with the antepenultimate cusp revealing the additional development of two shallow vertical ridges bordering a small central groove. A small anterolabial cusp is present, positioned low on a basal swelling that normally occurs at the second cusp in the external row on Ptilodus m1's (Krause 1977).

The lingual and anterior surfaces of the first internal cusp on UALVP 18805, the anterior fragment (W=2.6), are deeply wrinkled. Further, two deep grooves are present on the internal surface of the first internal cusp. UALVP 18805 compares well, both in size and structure, with the damaged anterior of UALVP 18804.

Family Cimolodontidae Marsh 1889

Genus *Anconodon* Jepsen 1940

Anconodon gidleyi (Simpson 1935)

(Plate 11, figs. A—C)

Type: USNM 9763, left dentary fragment with p4 and broken m1.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Middle Torrejonian (middle Paleocene) of New Mexico (KU locality 13, Nacimiento Formation, Kutz Canyon, San Juan Basin [Sloan 1981]); late Torrejonian of Montana (type locality [Simpson 1937]) and Wyoming (Rock Bench Quarry, Fort Union Formation, Polecat Bench [Jepsen 1940]); latest Torrejonian of Alberta (Calgary 2E locality, Porcupine Hills Formation, Elbow River, Calgary [Russell 1958]); earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [Keefer 1961]; Little Muddy Creek locality, Evanston Formation, Lincoln County [Gazin 1969]) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983; pers. obs.]).

Referred specimens: UALVP 24487, p4; UALVP 24488—24490 (total: 3), P4's.

Revised diagnosis: p4's average 18% larger than in A. cochranensis (Russell 1929a); range of p4 length, 5.6-6.6 (including one specimen from KU locality 13 [L=6.0], three specimens from Gidley Quarry [M=6.03], one specimen from Rock Bench Quarry [L=6.6], two specimens from Calgary 2E [M=5.60], and two specimens from Douglass Quarry [M=5.90]), mean of nine specimens=5.97; further differs from A. cochranensis in having a longer anterior margin that inclines more posteriorly (see Text-fig. 2); 14-15 serrations on p4; P4's average 26% larger than in A. cochranensis; range of P4 length, 5.0-5.4 (including specimens from Rock Bench Quarry [L=5.1] and Little Muddy Creek [L=5.4]), mean of three specimens=5.17; P4 with greater than 10 apical cusps in middle row.

Description: p4. — UALVP 24487 preserves only the anterodorsal portion of a p4. Nevertheless, the size and spacing of the serrations and their ridges is greater than in A. cochranensis (Russell).

P4. — Cusp formula, 1-2:12:0. UALVP 24488 (L=5.0, W=1.8) is elongate and high-crowned. The tooth is subcrescentic in occlusal outline and bears a prominent anterolabial bulge. UALVP 24488 has twelve cusps in the middle row which increase and decrease in height in a gently convex arc, with the seventh cusp highest. These cusps also decrease in size posteriorly. The first seven cusps are pyramidal with prominent labial and lingual ridges. The four most anterior of these cusps incline posteriorly while the largest cusps in the row are wrinkled on their labial slopes. There are two conical anterolabial cusps; the second is twice the size of the first and located opposite the third cusp of the middle row. The two additional specimens (UALVP 24489 [AW=1.8] and24490) are fragmentary and possess only the large posterior cusp on the anterolabial bulge.

UALVP 24488 differs from the P4's of Anconodon cochranensis (see below) in its larger size, greater cusp number in the middle row, wrinkling of the enamel on the cusps, and in possessing a posterior slope (after the last cusp) that is convex (unlike P4, A. cochranensis, which is slightly concave posteriorly).

Discussion: UALVP 24488 from Cochrane 2 is virtually identical to PU 14470, a left P4 described by Jepsen (1940, pp. 292, 293, Pl. II, fig. 5, 5a) and identified by him as "Anconodon? sp." from Rock Bench Quarry. The referral of these specimens to A. gidleyi is supported by similarity of size with the known p4's of this species and by the apparent association of similar upper last premolars with A. gidleyi p4's at Gidley Quarry (Jepsen 1940).

This species also appears to be represented by USNM 25674 (RP4) from the Little Muddy Creek locality of Wyoming (Gazin 1969). Gazin (1969, p. 4) identified the specimen as "Neoplagiaulax cf. grangeri" on advice from R. E. Sloan, while at the same time noting its resemblance to Jepsen's (1940) P4 from Rock Bench Quarry. Structurally, USNM 25674 is more similar to PU 14470 and UALVP 24488 than to P4, Neoplagiaulax grangeri, as recently illustrated by Sloan (1987, fig. 11).

A single complete p4 (NMC 9104) from the Calgary 2E locality (Porcupine Hills Formation, Elbow River), identified as "Ectypodus cochranensis" by L. S. Russell (1958), is referred here based on its larger size and more posteriorly inclined anterior margin in comparison with the p4's of A. cochranensis. Similarly, two p4's (PU 14619A and B) identified by Krause and Gingerich (1983) as A. "cochranensis" from the Douglass Quarry of Montana (see below) are herein referred to A. gidleyi (see Text-fig. 2).

Anconodon cochranensis (Russell 1929a)

(Plate 11, figs. D—H; pl. 12, fig. A; table 11)

Type: UALVP 129, left P4.

Type locality: Cochrane site 1, Porcupine Hills Formation, southwestern Alberta.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County [Simpson 1937]) and Wyoming (Rock Bench Quarry, Fort Union Formation, Polecat Bench [Jepsen 1940]); latest Torrejonian of Alberta (Calgary locality 2E, Porcupine Hills Formation, Elbow River, Calgary [Russell 1932]), Montana (Medicine Rocks I locality and Mehling site, Tongue River Formation, Carter County [pers. obs.]), and Wyoming (Locality V-82004, Polecat Bench Formation, southern Bighorn Basin [Hartman 1986]); earliest Tiffanian (late Paleocene) of Alberta (type locality [Russell 1929a]; Cochrane 2 locality, Porcupine Hills Formation [Russell 1932]), Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]), and Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]; Localities V-81054 and V-82015, Polecat Bench Formation, southern Bighorn Basin [Hartman 1986]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]).

Referred specimens: UALVP 337, 338, and 24492-24506, p4's (total: 17); UALVP 24541, m1; UALVP 18485, 18504, 24507-24528 and 24530—24533, P4's (total: 28)

Revised diagnosis: p4's average 18% smaller than in *A. gidleyi*; range of p4 length, 4.4-5.4 (including five specimens from Gidley Quarry [M=5.16], three specimens from Rock Bench Quarry [M=5.30], and a single specimen from the Saddle locality [L=5.2]), mean of 24 specimens=4.89; further differs from p4, *A. gidleyi*, in having a shorter anterior margin that is inclined more nearly vertical (see Text-fig. 2); 13-16 serrations on p4; P4's average 26% smaller than in *A. gidleyi*; range of P4 length, 3.6-4.0 (Cochrane specimens only); mean of twelve specimens=3.81; P4 with 9-10 apical cusps in the middle row.

Description: p4. — The serration number on specimens from Cochrane 2 ranges from 13 to 15. The p4's of *A. cochranensis* have been adequately described and illustrated by Russell (1929a; 1932), Simpson (1937), Jepsen (1940), and Vianey-Liaud (1986). The comparatively large sample from Cochrane 2 adds no new information to these treatments.

m1. — Cusp formula, 11:5. UALVP 24541 is a long and narrow tooth (L=2.8, W=1.0), virtually identical to the m1 illustrated by Simpson (1937, fig. 10b) on USNM 9765 (left dentary fragment with p4-m2) and identified as "?*Ectypodus russelli*". UALVP 24541 is wider posteriorly than anteriorly and has a progressive increase in size of the internal cusps from anterior to posterior. The external cusps each bear a vertical groove on their labial surfaces.

P4. — Cusp formula, 1-2:9-10:0. With the exception of their smaller size, and lower cusp number in the middle row, these teeth are nearly identical to the P4's described for *A. gidleyi* in this paper (see above), as well as those of *A. gidleyi* described by Jepsen (1940, pp. 292-293), and by Krause and Gingerich (1983, p. 162). Unlike the P4's of *A.*

gidleyi, the Cochrane specimens possess a slightly concave posterior slope on the apical crest. This feature is also evident on the camera lucida outline of the P4 referred to "Liotomus russelli" (AMNH 35502) by Vianey-Liaud (1986, text-fig. 49: b2). Apical wear is invariably developed on the cusps of the posterior half of the middle cusp row. In addition, a broad vertical shear facet is developed on the posterolingual side of the crown on numerous specimens.

Discussion: The taxonomic problems associated with Anconodon cochranensis historically stem from a lack of knowledge of p4 variability in comparing the Canadian and American material.

The first specimen of this taxon (UALVP 129) was collected in 1926 by R. L. Rutherford from the Cochrane 1 locality, and was initially identified by L. S. Russell as "Ptilodus trovessartianus?" (Russell in Rutherford 1927). Two years later Russell described the specimen as the holotype of a new species of "Ptilodus" — "P." cochranensis (Russell 1929a). Still later, in his 1932 paper, Russell redescribed the new species, placing it into the genus "Ectypodus", and mentioned the inclusion of two additional specimens (UALVP 337 and 338, p4's), collected by him from Cochrane 2, as plesiotypes.

The referral of several more specimens from both Cochrane 2 and from the latest Torrejonian Calgary 2E locality was also made by Russell (1932). Of these other specimens, I consider only a fragmentary uncatalogued p4 from Calgary 2E as correctly identified.

In his 1929 paper, Russell mentioned the collection of p4's similar to the holotype from "the Fort Union beds of Montana" but claimed that "...these teeth differ markedly from the present specimen in having a pronounced undercutting in the anterior margin of the crown" (Russell 1929a: 173). The specimens to which Russell (1929a) made reference were subsequently identified by Simpson (1935) as pertaining to a new species —.

"?Ectypodus russelli" — from the late Torrejonian Gidley Quarry. Simpson, in his diagnosis (1935) and later in his description of the Montana material (1937), brought attention to the close similarity between his "?Ectypodus russelli" and Russell's "Ectypodus" cochranensis and maintained that the only structural difference between the two forms was a larger and deeper anterobasal concavity in "?E. russelli" (as did Russell [1929a]). Simpson (1937) considered this difference to be important and included such factors as geographic and age differences, and the fact that only p4 could be compared, to maintain the taxonomic separation.

Shortly after Simpson's (1937) description, Jepsen (1940) erected the genus Anconodon into which he placed "?Ectypodus russelli" (along with some specimens incorrectly referred to "?Ectypodus" grangeri by Simpson [1937]) and Simpson's "?Ptilodus" gidleyi, which became the type species of the new genus. Jepsen (1940, p. 258) considered "E." cochranensis to be a valid species of Ectypodus and the final referral of this taxon to Anconodon (and to the Cimolodontidae) was not made until 1966 by Van Valen and Sloan. The synonomy of Anconodon "russelli" with A. cochranensis has only recently been considered valid (Krause and Gingerich [1983]; Sloan [1987]). My own comparisons indicate that A. "russelli" is indeed the junior synonym of A. cochranensis and that the difference in structure of the anterobasal concavity, as cited by both Russell (1929a) and Simpson (1935; 1937), is a variable feature easily accommodated in the larger sample of A. cochranensis from Cochrane 2.

The specimens identified as "Ectypodus cochranensis" from Calgary locality 2E (NMC 9104 and 9111, p4's) by L. S. Russell (1958) are not referable to this taxon. NMC 9104 is better placed in Anconodon gidleyi (see above) and NMC 9111 is from a species of Neoplagiaulax (pers. obs.). In addition, specimens from the Swan Hills locality (Paskapoo Formation) of Alberta and referred by Russell (1967) to A. cochranensis have since been placed in other taxa (Krause 1977; Stonley, in prep.).

In their description of A. cochranensis from the Douglass Quarry of Montana, Krause and Gingerich (1983) referred two p4's (PU 14619A and B) to this taxon. I consider these specimens better referred to Anconodon gidleyi based upon their larger size and longer anterior margins (see A. gidleyi for further discussion).

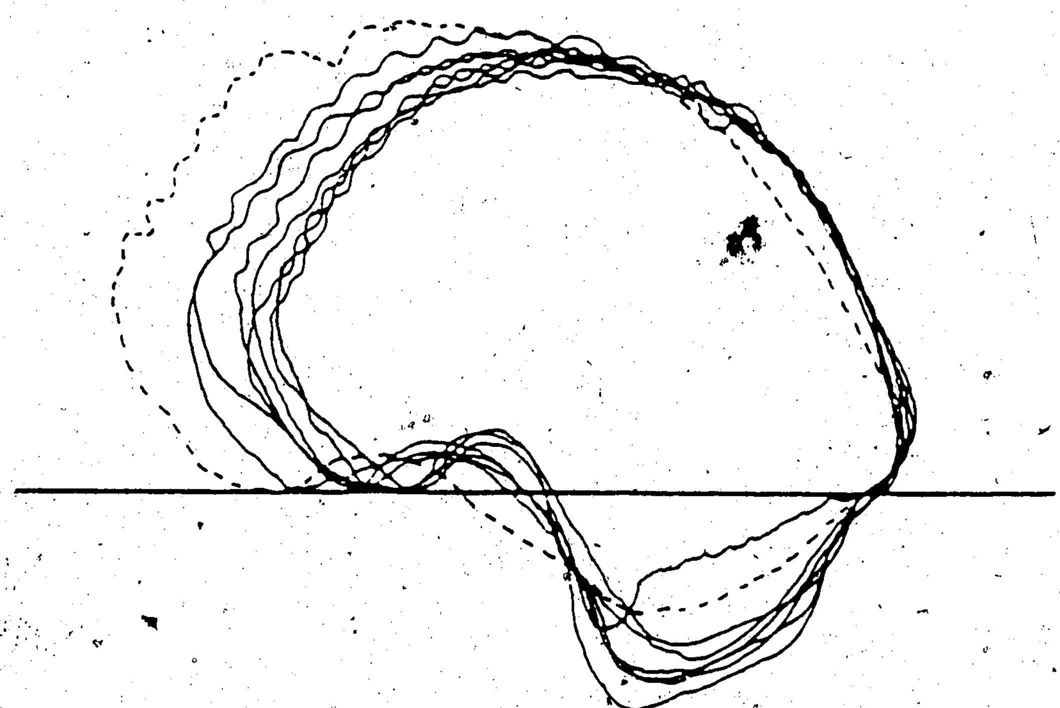
Recently, Vianey-Liaud (1986), in her study of Thanetian (late Paleocene) multituberculates from France, has revised the taxonomy of the Cimolodontidae by removing A. "russelli" and placing it in the genus Liotomus Cope, 1884 along with the European L. marshi (Lemoine, 1883), as members of the Neoplagiaulacidae. The justification for her actions rests on shared derived similarities of p4/P4 in both forms, and a possible ancestor—descendant relationship between them (Vianey-Liaud 1986, pp. 146, 153, 160). Nevertheless, Vianey-Liaud retains A. gidleyi in Anconodon and as a cimolodontid (1986, p. 146), considering its similarities to A. "russelli" to be the result of parallelism (1986, text-fig. 58). Although she provides many camera lucida outlines in her study to support her interpretations, Vianey-Liaud does not, however, include overlapping outlines of p4/P4 for L. marshi and "L. russelli".

However, in evaluating Vianey-Liaud's (1986) revision, I have found that the p4's of Anconodon "russelli" differ from those of Liotomus marshi in 1) a relatively shorter anterior slope that inclines less posteriorly; 2) a higher, more arcuate posterior profile of the apical crest; and 3) a higher, less elongate crown with gently curving lateral ridges.

The large sample of P4's of A. cochranensis from Cochrane 2 indicates that this tooth possesses a higher posterior slope of the apical crest, a lower anterior slope, and a well-developed anterolabial bulge in comparison with the P4 of L. marshi as illustrated by Vianey-Liaud (1986, Pl. 2, figs. 13, 14). The P4 of A. cochranensis is clearly more similar to that of A. gidleyi (see above) than are either of these to P4, L. marshi. In addition, the only articulated m1's of A. "russelli" are preserved on USNM 9765 and 9766 from Gidley Quarry (Simpson 1937). These teeth are relatively long and narrow (as illustrated in Simpson 1937, fig. 10b), and have 11 external and six internal cusps (Jepsen

1940) (the molar referred to L. marshi by Vianey-Liaud [1986, Pl. 1, fig. 2], is relatively broad and has a cusp formula of 8:5).

The differences between A. cochranensis and L. marshi are not only disparities of size, but also of morphology, comparable to differences in these teeth between other genera of cimolodontids. Nevertheless, the similarities between A. cochranensis, A. gidleyi and L. marshi are probably indicative of close affinity, as Sloan has consistently indicated (1966 [with Van Valen]; 1979) [emphasis added]. The question of whether the genera Anconodon and Liotomus are better placed in the Neoplagiaulacidae rather than in the Cimolodontidae is beyond the scope of this paper and I therefore maintain the traditional classification (sensu Sloan, in Van Valen and Sloan 1966; Sloan 1979).



Text-fig. 2. Superimposed camera lucida outlines of labial surface of p4's referred to Anconodon cochranensis (solid lines) from Cochrane 1 and 2 and A. "cochranensis" (broken line) from Douglass Quarry, Montana (PU 14619B): profiles oriented using highest point of enamel between roots and datum line through this point and top of anterobasal concavity; x 19.

Anconodon sp.

(Plate 12, figs. B—F; table 12)

Referred specimens: UALVP 24540 and 24601, p4's; UALVP 24529 and 24534—24539 (total: 6), P4's.

Description: p4. — UALVP 24540 is missing the enamel from the ventral portions of the labial and lingual sides. All of the serrations are intact and only the anterior margin is damaged. In size, cusp number, and general morphology the specimen is similar to p4, Parectypodus sinclairi (Simpson). However, UALVP 24540 differs strongly from p4, P. sinclairi in being higher-crowned, and in possessing a wider anterobasal concavity, a prominent interradicular crest, and a greater ventral extension of the lingual ridges. Damage to the anterior margin prevents the recognition of the flat anterolingual corner on this tooth, characteristic of the genus Anconodon (Jepsen 1940). Nevertheless, the lateral profile of UALVP 24540 is similar to that of Anconodon cochranensis and is virtually identical in profile to the recently described Anconodon lewisi Sloan 1987 from the earliest Tiffanian Keefer Hill locality ("Shotgun local fauna") of Wyoming. UALVP 24540 exhibits 12 serrations, as do some specimens of A. lewisi (Sloan 1987, p. 195), but is smaller (L=3.0, W=1.0) than the p4's of the Keefer Hill species.

P4. — Cusp formula, 1-3:9:0. The referred specimens are 26% smaller than the P4's of A. cochranensis. These teeth further differ from A. cochranensis P4's in possessing a more variable cusp number in the anterolabial row (one more anterolabial cusp on two of six specimens) and no more than nine medial cusps, and in having crowns that are shorter anteroposteriorly with respect to their widths. The medial crest is gently arcuate and the posterior slope is consistently convex on all specimens. The largest anterolabial cusp is positioned across from the third (anterior) cusp of the medial row, except on UALVP 24535, where a tiny additional cusp is developed anterior to the first cusp of the apical crest.

Discussion: Should a more nearly complete p4 be discovered preserving a rounded rather than flattened anterior margin, UALVP 24540 may have to be referred to Parectypodus. For the present, this p4 is closest to A. lewisi and the referred P4's posssses all of the structural characters for Anconodon, indicating that these specimens most likely represent a new species of this genus.

A still smaller species of Anconodon also appears to be present in the latest Torrejonian Medicine Rocks I and Mehling site (Tongue River Formation, Carter County) of Montana (pers. obs.).

Suborder Taeniolabidoidea (Granger and Simpson 1929)

Family Eucosmodontidae (Jepsen 1940)

Subfamily Eucosmodontinae Jepsen 1940

Eucosmodontinae unident. gen. and sp.

(Plate 13, figs. A—C)

Referred specimens: UALVP 24681—24683, M1's (total: 3).

Description: M1 — Cusp formula, ?7-8:8-9:8. UALVP 24681 (L=6.6, W=3.4) and 24682 (L=7.0, W=3.6) represent the only two specimens that permit inspection of the entire crown. A third specimen, UALVP 24683 (L=7.0, W=3.5*) is obscured by hard matrix over most of the occlusal surface but shows eight distinct cusps in the external row. These teeth are most similar in size to the M1's of Ptilodus sp. T. In comparison with the M1's of P. sp. T from Cochrane 2 and elsewhere, these teeth differ in possessing higher crowns, fewer and more robust cusps in the external and medial rows, and in being wider posteriorly. The crown's of UALVP 24681 and 24682 are concave in lateral view to a greater extent than is seen in the M1's of P. sp. T or any other ptilodontid, and approach the curvature of M1's of microcosmodontines. The medial and internal cusp rows in all three specimens curve lingually to a much greater extent than is observed in Ptilodus. The length and number of cusps in the internal row is greater than in P. sp. T. The internal row in UALVP 24682 extends anteriorly to the penultimate cusp of the medial row and bears eight distinct cusps. The possibility of even more cusps or cuspules anterior to the eight is obliterated by wear.

The shapes of the cusps and their wear patterns on UALVP 246813 differ from M1, P sp. T, in the following: 1) all cusps on the crown are strongly recurved, robust and pyramidal in shape; 2) cusps in the medial row are well-spaced and have their four sides nearly equal in length; 3) the apices of the cusps in the external row are all pointed and have slightly concave anterior and posterior faces; 4) the enamel on the labial surfaces of the external cusps is strongly wrinkled or rugose; 5) wear on the lingual surfaces of the external cusps results in sharply bordered, diamond-shaped patterns. (In contrast, the wear pattern observed on homologous cusps in ptilodontid M1's shows a more rounded, circular pattern [pers. obs.]); 6) the ultimate cusp of the external row is much smaller than the [illegible]e and both are consistently fused for most of their length.

[illegible] addition, the anterior lobe of the medial row is enlarged and extends further ventrally and the angle of inclination of the anterolingual face is slightly steeper in anterior view compared with P. sp. T.

Heavy wear is observed on the occlusal surface of the anteromost portion of UALVP 24683. The facet has completely obliterated the last cusps of the medial and external rows on this specimen.

Discussion: In all of the above characters UALVP 24681-3 most closely resemble the M1 fragment of Neoliotomus conventus Jepsen 1930a (PU 13297) most closely. N. conventus is known from the late Tiffanian of Wyoming and Colorado (Krause 1980; Rose 1981a). While the complete cusp formula for M1, N. conventus, is unknown, it is reported to be 8:8:9 for the closely related N. ultimus (Granger and Simpson 1928) of Wasatchian age (Krause, unpubl. Phd diss. 1982). The Cochrane specimens differ from M1 in these species in being smaller, lacking well-developed cusps on the anteromost part of the external shelf, and in lacking deep grooves on the lingual faces of the anterior cusps in the medial row.

A structurally similar, but much smaller M1 is known from the Diss locality (R. C. Fox, pers. comm. 1986), suggesting that the lineage represented by the Cochrane M1's was present in North America since the Torrejonian. A clear increase in the length of the internal cusp row is observed from the Diss specimen to the Cochrane specimens and, finally, to M1, N. conventus.

Uncertainty in identification of these specimens as M1's of Neoliotomus or of an unidentified eucosmodontine species reflects the absence of any referable large gliriform incisors from Cochrane 2. Due to the unreliable nature of multituberculate M1's in taxonomy, a more confident familial and generic assignment must await the collection of diagnostic dental elements referable to this species. These M1's do appear, however, to be indicative of a large Neoliotomus-like eucosmodontid or perhaps something new that has upper molars that converge on those of Neoliotomus.

Subfamily Microcosmodontinae Holtzman and Wolberg 1977

Genus Acheronodon Archibald 1982

Type: Acheronodon garbani Archibald, 1982

Included species: "Microcosmodon" woodi Holtzman and Wolberg 1977; Acheronodon vossae n. sp.

Age and distribution: Pre-Mantuan (earliest Paleocene) to middle Tiffanian (late Paleocene) of western North America including UCMP loc. V74111, lowermost Tullock Formation, Montana (Archibald 1982); Cochrane 2 locality, Porcupine Hills Formation, Alberta (this study); UADW-2 locality, Paskapoo Formation, Alberta (Fox 1984b; Fox, in press); New Anthill locality, Shotgun Member, Fort Union Formation, Wyoming (Holtzman and Wolberg 1977); Circle locality, Tongue River Formation, Montana (Holtzman and Wolberg 1977); Brisbane locality, Tongue River Formation, North Dakota (Holtzman and Wolberg 1977).

Revised diagnosis: p4 low-crowned and triangular in lateral profile with deep interserrational valleys; first serration is vertically oriented and positioned low on the anterior margin (between the anterobasal concavity and the second serration); external ridges set at a 45 degree angle to the vertically oriented first serration; ultimate serration distinct and separate.

<u>Acheronodon</u> <u>vossae</u> n. sp.

(Plate 13, figs. D, E; pl. 14, figs. A—G; pl. 15, figs. A—G; tables 13, 14)

Etymology: Named for Mrs. Asta Voss, whose diligence in the laboratory resulted in discovery of the holotype and much of the hypodigm.

Holotype: UALVP 24550, left p4.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Hypodigm: Type specimen and UALVP 24608, 24610—[illegible] 24614—24616, 24618, 24619, 24621, 24622, 24624, 24627, 24628, 24631—24634, 24641 and 24643, i1's (total: 20); UALVP 24542—24549 and 24562—24564, p4's (total: 11); UALVP 18389, 18522, 24565—24574 and 24576, m1's (total: 13); UALVP 15460, 18392, 18494, and 24577—24587, m2's (total: 14); UALVP 18338, 18417, 18462, 24603—24607, 24609, 24613, 24617, 24620, 24623, 24625, 24626, 24629, 24630, 24635—24640, 24642 and 24644, I2's (total: 24); UALVP 24551—24561, P4's (total: 11); UALVP 18495 and 24593—24600, M1's (total: 9); UALVP 24588—24592, M2's (total: 5).

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta — known only from the type locality.

Diagnosis: p4 larger than in either Acheronodon garbani Archibald 1982, Microcosmodon conus Jepsen 1930b, or Microcosmodon rosei Krause 1980, and having ridges more prominent than in the latter two but less so than in the former; six serrations present on p4 (one more than in either M. conus or Pentacosmodon pronus Jepsen 1940) and three more than in M. rosei); p4 narrower than in Microcosmodon arcuatus Johnston and Fox 1984 and P. pronus with less prominent ridges, and averages 37% smaller and is relatively less elongate than in "Microcosmodon" woodi Holtzman and Wolberg 1977; P4 approximately 25% smaller than in "M." woodi. Further differs from "M." woodi in having p4 shorter than m1. Differs from all other microcosmodontines, except "M." woodi and P. pronus, in having the length of p4 greater than the maximum diameter of the lower incisor.

Description: i1. — Based on a number of fragments the lower incisor of A. vossae is similar to that of "M." woodi, M. conus, and M. rosei, except for its narrower maximum diameter. The root, shown on UALVP 24627, reveals a shallow longitudinal trough or groove, which deepens proximally as the root thickens. This region possesses no enamel. The enamel on both the labial and lingual sides of the crown pinches out ventrally as the trough of the root begins. In comparison to an uncatalogued i1 referred to M. arcuatus, these incisors are much narrower, measuring less than one-half the diameter (pers. obs.).

p4. — The p4 is low crowned and triangular in lateral profile, and has six serrations. The first serration is positioned halfway between the anterobasal concavity and the second serration and is slightly recurved anteriorly, owing to a distinctly concave anterior margin just above the anterobasal concavity.

The remaining five serrations are inclined posteriorly at a 45 degree angle, with the second serration highest on the crown and the remainder lowering in height sequentially.

and increasing in transverse width. The second, third and fourth serrations are offset to a small degree from the adjacent posterior serrations.

Short, indistinct ridges arise both labially and lingually from each serration other than the first, with the shortest on the last serration. These ridges can extend ventrally approximately one-third the distance to the base of the crown and the most anterior ridge deflects at a slightly steeper angle than those that follow. A middle ridge, which deflects labially in joining with the first serration, is present on the second serration. The interserrational valleys are deep.

The presence of a small anterobasal concavity on all p4's, coupled with the presence of a distinct alveolus below this structure on the dentary of UALVP 24550 (type), indicates that p3 was present.

Compared to the p4's of "Microcosmodon" woodi, Acheronodon vossae is relatively much less elongate and more arcuate with the apex of the first serration curving anteriorly, rather than posteriorly as in the remaining serrations. The p4 in A. vossae is slightly shorter than m1, while in "M." woodi the p4 is significantly longer than m1 (pers. obs.). In addition, the p4 in A. vossae is equal in width or slightly wider posteriorly than anteriorly, while the p4 of "M." woodi is slightly wider anteriorly.

Comparison of the major characters of the p4's of A. vossae to the p4's of other microcosmodontines is outlined in Table 15.

m1. — Cusp formula, 7:4-5 (mode 7:4). These teeth are similar to the m1's of Microcosmodon conus described by Krishtalka (1975) and Krause (1977); however the unworn specimens have less prominent vertical grooves and ridges on the valley-facing slopes of each cusp. In addition, the crown in m1, A. vossae is relatively straight and not convex in lateral profile as in M. conus. As a result, the cusp rows do not curve dorsally (as in M. conus) but remain almost parallel with the horizontal plane of the tooth (as in Pentacosmodon and Microcosmodon arcuatus).

m2. — Cusp formula, 4:2. These teeth are essentially identical to the m2's of M. conus as described by Krause (1977).

I2. — Based upon frequency of occurrence, several I2's are assigned to A. vossae. They are morphologically identical to the I2's referred to M. conus by Krause (1977), but are approximately twenty-five percent smaller in all linear dimensions.

The progressive wear patterns on these small incisors are similar to the stages of abrasion described in Krause (1977).

P4. — Cusp formula, 2-3:5-6:1. The cusps of the main row are arranged diagonally across the crown. The first two anterior cusps are small, pyramidal, and slightly curved posteriorly. They are well-separated and unworn, with the second slightly higher than the first. Crown height gradually increases posteriorly.

The third and fourth medial cusps are largest and highest and are fused for most of their height. The ultimate cusp is positioned slightly lingual to the medial row and is lower in height than the penultimate. All four posterior cusps in this row are fused to each other at their bases and are heavily worn on their lingual surfaces. In comparison, the third and fourth medial cusps do not fuse in "M." woodi (pers. obs.).

The posterior region of P4 is squared in occlusal outline. A deep longitudinal, wedge-shaped groove separates the ultimate and penultimate cusps of the median row from a prominent ridge or crest, forming the posterolingual corner of the crown. The groove extends from the third and fourth medial cusps to the posterior edge of the tooth. When unworn, the internal surface of the groove is usually wrinkled. A low basal cusp forms the posterior end of the crest, which extends anterolabially from this cusp and merges with the third medial cusp approximately halfway up its lingual side. The lingual face of this crest is vertically rugose.

Two or three smaller cusps are found on the anterolabial crest; they are conical and increase in size posteriorly. In occlusal view the crown is only marginally wider posteriorly.

As in "M." woodi, wear consists of a broad abrasion surface on the posterior face and a longitudinally striated facet on the lingual face.

M1. — Cusp formula, 7:7:4. These teeth differ from the M1's of "M." woodi described by Holtzman and Wolberg (1977) and those of M. conus described by Krause (1977) in being slightly smaller and in having one fewer cusp in the medial row. The internal cusp row is also better defined and expanded linguad (compared to the condition seen in M. conus) with the second cusp distinctive and largest in the row.

M2. — Cusp formula, 1:3:4. The referred specimens do not differ significantly from the M2's referred to M. conus and M. rosei by Krishtalka (1975) and Krause (1980), respectively. They are adequately described by Krishtalka (1975) and illustrated in Krause (1980).

Discussion: The dentition of this new species of microcosmodontine resembles the known teeth of "Microcosmodon" woodi more so than any other Tiffanian form — especially in the upper and lower fourth premolars. Both species possess low-crowned p4's with triangular lateral profiles and deep interserrational valleys reminiscent of the condition seen in the earliest Paleocene Acheronodon garbani, described by Archibald (1982).

The above similarity elaborates upon an hypothesis of relationship first proposed, and adequately argued, by Johnston (1980) and later in Johnston and Fox (1984), suggesting, based upon p4 morphology, that "M." woodi probably represents a member of a generically distinct lineage, separate from the one to which Microcosmodon arcuatus and M. conus belong.

In the description of the p4's of M. arcuatus from the Puercan of southwestern Saskatchewan, Johnston and Fox (1984) noted that, based on lateral profile, this form would make a very good structural ancestor for the late Tiffanian M. conus.

The similarity between the p4's of "M." woodi and A. garbani was first reported by Archibald (1982).

Acheronodon garbani and M. arcuatus represent the earliest known Paleocene microcosmodontines, but each is morphologically distinct, with the p4 of M. arcuatus revealing several derived features (i.e., high arcuate crown, shallow interserrational valleys [see Table]). These characters suggest that the two species may have represented separately evolving lineages.

Further support for the interpretation that "M." woodi and M. conus are less closely related than is "M." woodi to A. vossae comes from the discovery of a large (uncatalogued) lower incisor (max. dia.=2.0, min. dia.=1.0) from the Puercan (Rav W-1, MHBT Quarry) of southwestern Saskatchewan and referred to M. arcuatus by R. C. Fox (collected subsequent to the study by Johnston and Fox [R. C. Fox, pers. comm. 1985]). This specimen is morphologically like i1, M. conus, but larger, and much wider than the p4 length of M. arcuatus. This indicates that another defining character for the genus Microcosmodon Jepsen 1930b may include the possession of a p4 whose length is less [illegible] maximum diameter of the lower incisor. This was a character first employed by [illegible] (1940) to differentiate M. conus from Pentacosmodon pronus and it appears equally valid in separating species of Microcosmodon from A. vossae and "M." woodi, which both, apparently, exhibit p4 lengths larger than the lower incisor diameter (pers. obs.).

Using the distinctive p4 and its size ratio with i1 as the criterion, M. arcuatus, M. conus, and M. rosei (the probable descendant of M. conus described in Krause 1980) appear more closely related to each other than are any of these to "M." woodi or to A. vossae. The latter two appear sufficiently different from other Tiffanian microcosmodontines to be congeneric and, consequently, should be placed within a separate genus. Similarity of the p4's in these species to the single p4 (UCMP 116953) from the basal Tullock Formation of Montana (Archibald 1982) implies a possible ancestor—descendant relationship and I therefore propose that the generic name Acheronodon be applied to both the Cochrane 2 species and to "M." woodi.

Together these three species form a line closely related to but separate from Microcosmodon and distinct from Pentacosmodon.

The Acheronodon lineage shows a trend towards increasing p4 size (especially in A. woodi), while the Microcosmodon line reveals a steady reduction in p4 size and serration number with time. Pentacosmodon retains a primitive upper and lower molar morphology and a unique P4 and i1 structure (see Pentacosmodon sp. below), suggesting an even earlier divergence from the Acheronodon—Microcosmodon ancestry.

Genus Pentacosmodon Jepsen 1940

Pentacosmodon sp.

(Plate 16, figs. A—H; pl. 17, figs. A—D; table 15)

Referred specimens: UALVP 24661—24675, 24677 and 24678, i1's (total: 17); UALVP 24649—24651, m1's (total: 3); UALVP 24647 and 24648, m2's; UALVP 24679 and 24680, ?DI2's; UALVP 24652 and 24653, P4's; UALVP 24654—24656 and 24658—24660, M1's (total: 6).

Description: i1. — UALVP 24671 is referred to Pentacosmodon on the basis of its shorter (stouter) chisel-like, rather than blade-like, appearance in comparison to i1, Acheronodon vossae and Microcosmodon conus. The crown is not as tightly curved as in Microcosmodon or Acheronodon. Although this tooth has a shorter diameter than the i1's of Microcosmodon or Acheronodon, it is wider proximally and crudely triangular, rather than elliptical, in cross-section.

The tip of the crown is laterally compressed and displays a small horizontal wear facet. The facet is bordered medially by a prominent ridge that extends proximally halfway down from the side of the facet, presumably, to the root. This ridge forms the labial corner of the triangular crown. The dorsal and medial sides of the ridge do not possess enamel.

As in Acheronodon vossae, there is a vertical wear facet developed on the labial surface medial to the horizontal facet. The wear on this surface obscures the presence of a narrow ridge of enamel extending down the labioventral margin of the crown.

m1. — Cusp formula, 4:3. With the exception of more robust cusps on the external and internal rows, UALVP 24649 and UALVP 24650 are almost identical to m1 on the holotype of Pentacosmodon pronus (PU 14085; see Jepsen [1940]), and on a second dentary, MCZ 20066 (pers. obs.).

m2. — Cusp formula, 3:2. UALVP 24647 and 24648 differ from m2 on the holotype of P. pronus in possession of a distinct posterior cusp in the external row where Jepsen (1940) described a posterior "cuspule". Irrespective of this better developed cusp, these two m2's are virtually identical to the type material.

P4. — Cusp formula, 0-1:3-4:1. UALVP 24652 and UALVP 24653 possess three and four cusps, respectively, in the main row. In occlusal view, these cusps are arranged less diagonally on the crown than in Acheronodon vossae or A. woodi, with the ultimate and penultimate cusps set at a 30 to 40 degree angle from the anterior cusp(s). The ultimate cusp is highest on the crown, but is fused for almost all of its height with the penultimate cusp.

The posterior longitudinal groove is much deeper than on P4, A. vossae, and extends posterolingually as an arc bordered by a high crest, which extends from the ultimate cusp of the main row to a well-developed posterolingual cusp developed from the base of the crown. In the unworn condition, a tiny cuspule is present in the center of this crest resulting in a small bulge or wrinkle on the posterolabial (interior) corner of the groove.

The posterolingual basal cusp is curved anterolabially in the unworn specimen, UALVP 24652, and is subequal in height with the penultimate medial cusp. The presence of the large posterolingual basal cusp results in a prominent asymmetrical expansion or swelling of this region (especially in UALVP 24652) causing the posterior portion of the crown to be much wider than the anterior, and giving the tooth a "keyhole"-shaped occlusal outline. A small anterolabial cusp or cuspule occurring on UALVP 24652 creates a further, but smaller, bulge on the crown directly labial from the single anterior cusp of this specimen.

The posterior root is transversely wider than the anterior root.

In comparison to the P4's of A. vossae, these similarly-sized teeth are distinctive in their asymmetrical occlusal outline; their enlarged posterior crest and posterolingual cusp development, and in their higher penultimate and ultimate main row cusps.

Wear patterns are best illustrated on UALVP 24653, which has abrasion limited to the curved surface of the posterior crest and its cuspule, as well as on the apex and internal (labial) face of the posteriolingual basal cusp. In addition, a longitudinally striated facet is present on the lingual face of this cusp and across the apices and upper lingual faces of the ultimate and penultimate cusps of the main row.

M1. — Cusp formula, 5:6:R-?2. Occlusally, UALVP 24660 is strikingly primitive in morphology. The crown is concave in lateral profile and quadrate in occlusal outline, with straight labial and anterolingual margins. The external and middle cusp rows are high-crowned and parallel, with the external row slightly longer than the middle row. The internal row is a simple high ridge on UALVP 24660, but on UALVP 24659 (posterior fragment) there are two broad, labially curving, cusp-like projections developed. This ridge is convex, lingually and straight, labially. The internal ridge terminates abruptly into the middle row at half the tooth length.

The cusps of the middle row are large and cresentic. They decrease in height and become more cresentic from the most posterior cusp to the antepenultimate cusp. The penultimate cusp of the middle row is lower in height and less cresentic (subcresentic) than the antepenultimate cusp. The ultimate cusp of this row is almost subequal with the penultimate but is not cresentic; being almost vertical in orientation. Deep troughs separate each cusp in the row.

The first three cusps in the external row are also large and cresentic, curving lingually: first toward the second; second toward the third; and third toward the fourth cusp of the middle row. Of these three, the second external cusp is highest in the row. The penultimate cusp of the external row is lower than the posterior cusps and is not cresentic, but is conical in shape, and situated directly across from the trough separating the penultimate and antepenultimate cusps of the middle row. The ultimate cusp of the external row is also conical but is directed posteriorly towards the penultimate cusp of the same row. It is subequal to the penultimate cusp and is located directly labial to the trough separating the ultimate and penultimate cusps of the middle row. The last two anterior cusps of both the external and middle rows are subequal in size.

A small ridge extends lingually from the anterior surface of the ultimate external cusp to the labial side of the ultimate cusp in the middle row. This narrow ridge forms the anterior margin of the tooth.

Discussion: The monotypic genus Pentacosmodon was described by G. L. Jepsen (1940) and is known only by P. pronus from the late Tiffanian Princeton Quarry (Polecat Bench Formation, Clark's Fork Basin) of Wyoming. The upper dentition of Pentacosmodon has never been described.

The Cochrane P4's are referred to Pentacosmodon based on their overall resemblance to the P4's of A. vossae and A. woodi. The expanded posterior regions of these teeth are consistent with the wide posterior crown characteristic of p4 in P. pronus. Further, the unique posterolingual basal cusp present on the referred P4's (UALVP 24652 and 24653) is similar in size, shape and orientation to the most anterior lingual cusp in the referred M1 of Pentacosmodon from the Cochrane locality (UALVP 24660), indicating that it may have functioned by occluding with the anterior external cusps of the m1. UALVP 24660 is considered to represent the M1 of Pentacosmodon based upon its low cusp number and occlusal fit with m1 on a Harvard dentary of P. pronus (MCZ 20066)(pers. obs.).

The presence of Pentacosmodon in the earliest Tiffanian of Alberta documents the earliest occurrence of this genus, and is the first report of the genus outside of the Clark's Fork Basin (specifically the type locality, Princeton Quarry, Polecat Bench Formation, Wyoming). The referred specimens further substantiate the primitive nature of this genus as indicated by M1, while the simple (reduced) P4's suggest specialization beyond that seen in P4 of Acheronodon.

The present sample of this taxon from Cochrane 2 only allows for comparison of m1 and m2 with P. pronus. These teeth are insufficient to determine whether the UALVP specimens belong to a new species. Such an evaluation must await the collection of referable p4's from Cochrane 2.

Subclass Theria

Infraclass Metatheria

Superorder Marsupialia

Order Marsupicarnivora Ride 1964

Family Didelphidae Gray 1821

Subfamily Didelphinae (Gray 1821)

Tribe Peradectini Crochet 1979

Genus Peradectes Matthew and Granger 1921

Peradectes sp.

(Plate18, figs. A—H; table 16)

Referred specimens: UALVP 18579, 18580 and 24684, M1's; UALVP 18609 and 24694, M2 or M3's; UALVP 18587, dp4; UALVP 18586, 24687, 24690 and 24693, m1's; UALVP 18581—18585, 18607, 18608, 18610, 24685, 24686, 24688 and 24689, m2 or m3's (total: 12); UALVP 18588, Rm4?; UALVP 18611, 24691, 24692, mX's.

Description: M1. — UALVP 18579 (L=1.5, W=1.5) and 18580 (L=1.5, W=1.7) resemble M1, P. elegans Matthew and Granger 1921, but differ in being smaller, with an anteroposteriorly compressed protocone and a slightly deeper ectoflexus. Stylar cusps A and B have been obliterated by wear and are unobservable. The remaining stylar cusps are abraded, but from their bases, D appears to have been larger than E and not as prominent as on P. elegans. Stylar cusp C appears to have been the smallest of the three preserved.

The metacone on UALVP 18579 is larger and taller than the paracone. The paracone, in turn, is higher than the protocone. The conules are relatively well-developed.

M2 or M3. — UALVP 24694 is larger (L=1.6, W=2.0) and more transverse than the referred M1's and possesses all the characters used by Krishtalka and Stucky to distinguish P. pauli Gazin 1956a from P. elegans: "...more transverse, with a narrower, anteroposteriorly compressed protocone and a deeper ectoflexus" (1983: p. 244). Stylar cusps B and D are well-developed and larger than A (parastyle) and E (metastyle). Cusp C is reduced to a small cuspule located on the posterolingual border of the ectoflexus. The relative sizes and positions of the cusps and conules are as on M1.

m1. — UALVP 18586 is virtually identical to m1 on the paratype of P. pauli (USNM 20880) from the Saddle locality of Wyoming, but differs in being slightly smaller (L=1.4, W=0.7). The Cochrane specimen has the talonid and trigonid widths subequal as on the P. pauli paratype (USNM 20880, a dentary fragment with m1).

m2 or m3. — These teeth are structurally similar to m2 and m3 in P. pauli, but are only slightly smaller than these teeth in P. elegans. The exception is UALVP 18585 (L=1.3, W=0.7), a heavily water-worn m2 or m3 missing the paraconid. The specimen is smaller than m2 and m3 of P. pauli (Krishtalka and Stucky 1983), and bears a relatively short and narrow talonid.

Discussion: The referred material, albeit meagre, appears indicative of a small species of Peradectes at Cochrane 2. These teeth are similar in size to the comparable teeth in P. pauli from the early Tiffanian of Wyoming but also display resemblance to the comparable dentition in P. elegans.

The molar dentition of P. pauli and P. elegans has recently been described in detail by Krishtalka and Stucky (1983). The Cochrane upper molars differ from the early Tiffanian (Saddle locality) material of P. pauli and the late Tiffanian type specimen of P. elegans in being shorter anteroposteriorly. The Cochrane lower molars are closer in their lengths to the values recorded for P. pauli from the Saddle locality (see Krishtalka and

Stucky 1983), and they are also closer in their relative widths of trigonid to the talonid. Structurally, the M1's from Cochrane 2 are more similar to M1, P. elegans.

Specimens similar to the Cochrane 2 teeth and identified as P. cf. P. pauli are found at the earliest Tiffanian Douglass Quarry (Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County) of Montana (D. W. Krause, pers. comm. 1986).

Infraclass Eutheria

Order Lipotyphla Haeckel 1866

Suborder Erinaceomorpha incertae sedis

Family Litocherinae Gingerich 1983

Genus Litocherus Gingerich 1983

Litocherus sp.

(Plate 19, figs. A—C)

Referred specimens: UALVP 24745, P3; UALVP 24746, P4; UALVP 24741—24743, M1 or M2 (total: 3); UALVP 24744, dp4.

Description: P3. — UALVP 24745 is similar to the P3 on the type specimen of L. notissimus (Simpson 1936), AMNH 33831, as described and illustrated by Simpson (1936, p. 25, fig. 15) and from comparison with additional specimens collected from Scarritt Quarry (pers. obs.).

P4. — UALVP 24746, a labial fragment, is similar to the P4 of L. notissimus from Scarritt Quarry, but differs in being slightly smaller (L=1.8) and in possessing a distinct metacone and relatively less inflated cusps on the crown (especially the paracone). The metacone is much smaller than the paracone and is closely appressed to it. The metacone is continuous with the metastylar salient: only faint bulges outline this cusp labially and lingually. Both cusps display apical wear. Although damaged, the lingual region of the tooth can be estimated to have been relatively narrow anteroposteriorly — considerably shorter than on P4, L. notissimus.

Upper molars. — The lingual fragments referred to this taxon are virtually identical to the comparable elements of L. notissimus from Scarritt Quarry (as described in Simpson 1936) and are only slightly smaller and, apparently, slightly higher-crowned (pers. obs.).

dp4. — UALVP 24744 (L=2.2, W=1.2) is elongate and fully molariform. The trigonid bears a large posterolingual metaconid and a smaller anterolabially positioned protoconid. The paraconid is anteriorly positioned and subequal to the protoconid, but is placed lower on the crown. The trigonid cusps are slightly bulbous. The metaconid is anteroposteriorly elongate, closing off the trigonid lingually, and distorting the postvallid. Consequently the postvallid wall is not flat, but bulges on the lingual side. The enamel is missing from the crown of UALVP 24744 and the cusps are heavily worn. As a result, a precingulid may have been present but is no longer visible.

The talonid is wide and long with a deep basin, and closely resembles the molar talonids of Litocherus. The talonid cusps are well developed and equidistantly spaced. The entoconid appears to have been slightly higher than the hypoconid, which displays more apical wear.

UALVP 24744 differs from the p4's of erinaceids in possessing a less opened, lower-crowned trigonid with a smaller protoconid and a relatively enlarged metaconid. The paraconid is oriented more posterolingually on the crown. The talonid is proportionately longer and wider with larger, more widely separated cusps and a deep talonid basin.

Discussion: These few isolated and fragmentary teeth from Cochrane 2 suggest the presence of a species of Litocherus, near L. notissimus. The specimens represent first reported occurrence of Litocherus from the earliest Tiffanian.

Litocherus cf. L. lacunatus (Gazin 1956a)

(Plate 19, fig. D)

Type of Litocherus lacunatus: USNM 21016, left dentary fragment with p4-m1.

Type locality: Titanoides Locality, Fort Union Formation, Bison Basin, Fremont County, Wyoming.

Known age and distribution for Litocherus lacunatus: Latest Torrejonian (middle Paleocene) of Wyoming (locality V-82004, Polecat Bench Formation, southern Bighorn Basin [Hartman 1986]); middle Tiffanian (late Paleocene) of Wyoming (West End locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]; Battle Mountain locality, Hoback Formation, Hoback Basin [Dorr 1958; Gingerich 1983]; Type Chappo locality, Wasatch Formation [Gingerich 1983]) and North Dakota (Brisbane and Judson localities, Tongue River Formation, Williston Basin, Grant and Morton Counties [Holtzman 1978]); late Tiffanian of Wyoming (type locality [Gazin 1956a]; localities V-77005 and V-77059, Fort Union Formation, eastern Rock Springs Uplift, Sweetwater County [Winterfeld 1982]), Saskatchewan (Roche Percée local fauna, Ravenscrag Formation [Fox, in press]), and Alberta (Swan Hills site 1, Paskapoo Formation, Swan Hills [Gingerich 1986]).

Referred specimens: UALVP 24747, M2; UALVP 24748, M3.

Description: M2. — UALVP 24747 (L=1.8, W=2.8) is missing the region of the metacone but preserves the entire ectocingulum, which clearly indicates that the posterior side of the tooth was reduced relative to the anterior. The paracone is conical and subequal in height with the protocone. The protocone is larger than the paracone due to a prominent lingual inflation giving this region a pointed appearance in occlusal view. The conules are well developed, with the paraconule closest to the protocone. Pre- and postcingula are prominently developed. The precingulum narrows anterior to the paraconule, but appears to be continuous with the parastyle and the ectocingulum, and abruptly terminates on the anterior wall of the protocone. The postcingulum is much shorter, extending from the posterior wall of the protocone (directly opposite the termination point of the precingulum) to the posterolingual corner of the metaconule. No hypocone is developed. The parastylar region is rounded with only a weak bulge on the precingulum, anterior to the paracone, to represent the parastyle. The ectocingulum extends from the parastyle to a point labial to the paracone, allowing a narrow stylar shelf to be present in this region. The trigon basin is long and relatively narrow.

M3. — The region of the paracone and parastyle is missing from UALVP 24748 (L=1.6, W=2.0), but judging from the structure of preserved parts, the paracone and parastylar lobe were well developed. The posterior side of the tooth is much reduced, with a small bulbous metacone and metaconule present. The premetacrista was short relative to the postparacrista. The paraconule is prominent and elongate (transverse), with well developed cristae. No labial or posterior cingula are developed near the metacone. A short postmetaconule crista (metacingulum) joins the metaconule to the posterolingual base of the metacone. There is no development of a premetaconule crista. The preprotocrista is short while the postprotocrista is longer. The protocone is only moderately developed and is bordered by relatively weak pre- and postcingula. The precingulum extends along the base of the anterior margin wall, from the anterior side of the protocone to the anterior side of the paraconule. The postcingulum is shorter and extends ventrolabially from the posterior base of the protocone wall to a point below the metaconule.

Discussion: In size, the Cochrane 2 specimens do not differ significantly from the comparable teeth of Litocherus lacunatus (Gazin). The referred M2 (UALVP 24747) differs from M2, L. lacunatus, in lacking a distinct hypocone on the postcingulum (see Holtzman 1978 and Gingerich 1983). The M3 (UALVP 24748) differs from the M3 of this species in being relatively wider and less transverse (Holtzman 1978).

Hartman (1986) has recently extended the temporal range of Litocherus from the Tiffanian back to the latest Torrejonian. The description of the M2 (UW 17485) referred to "Litocherus sp. cf. L. lacunatus" by Hartman (1986, p. 32) indicates that this specimen is similar to UALVP 24747 from Cochrane 2. The Cochrane specimen differs only in lacking a distinct hypocone.

Suborder Erinaceomorpha Gregory 1910

Family Erinaceidae (Fischer De Waldheim 1817)

Erinaceidae unident. gen. and sp.

(Plate 19, figs. E, F; pl. 20, figs. A—F; table 17)

Referred specimens: UALVP 24705, DP4; UALVP 24706, 24716 and 24717, P4's; UALVP 25550, M1; UALVP 18490 and 24735, M2's; UALVP 24710—24714 and 24718—24721, MX's (total: 9); UALVP 24703, dentary fragment with p2-p4; UALVP 24699, dentary fragment with p4-m1; UALVP 24701, dentary fragment with p4 and m2; UALVP 24702, dentary with m1-m3; UALVP 24695 and 24704, dentary fragments with m1-m2; UALVP 24696 and 24698, dentary fragments with m2; UALVP 24708, dp4; UALVP 24715, p4; UALVP 24722—24724 (total: 3), m1's; UALVP 24697 and 24707, m2's.

Description: P4. — The labial fragments referred here are indicative of a semimolariform P4. These specimens are structurally similar to P4, Litolestes ignotus Jepsen 1930b (to which the only known early erinaceid upper dentition is referred), but differ in the possession of a small, but distinct, metacone and a relatively smaller, more transversely compressed parastyle. The metacone is appressed to the paracone and is continuous with a prominent metastylar salient.

M1, M2. — The referred M1 (UALVP 24700) and M2's (UALVP 18490 and 24735) resemble the M1 on PU 21193, left maxillary fragment with P2-M1, of Litolestes ignotus (Gingerich 1983). The Cochrane M1 (UALVP 24700) differs in possessing a relatively lower hypocone on the postcingulum. The hypocone is more posterolingually positioned on M1 in comparison to the M2's referred here. The M2's have a relatively straight lingual margin of the crown with the hypocone situated directly posterior to the pericone. All of the upper molars display a slight concavity of the enamel at the protoconal base.

p2, p3. — These tooth positions, represented on UALVP 24703, differ from those of Litolestes ignotus Jepsen (Krishtalka 1976a) in being transversely compressed (elongate and narrow) and more gracile. The p2 on UALVP 24703 appears intermediate in structure between the canine and p2 of PU 14333, a left dentary of L. ignotus illustrated by Krishtalka (1976a, figs. 1, 2). In addition, the p2 and p3 on the referred specimen from Cochrane lack labial cingula and the p3 bears a distinct, more anteriorly directed, paraconid.

p4. — UALVP 24715 is semimolariform, low-crowned, and slightly bulbous. The trigonid is fully open with an anteriorly projecting paraconid, inflated protoconid and reduced metaconid. The paraconid is positioned low on the crown and is larger than the metaconid. The large size of the protoconid effectively separates the bases of the paraconid and metaconid. The protocristid is well developed and forms a 90 degree angle from the protoconid to the metaconid. The paracristid is also well-developed. A short lingual crest joins the paraconid to the base of the protoconid. A prominent precingulum is developed labially on the paraconid. The postvallid leans anteriorly. The talonid is shorter than the trigonid, but is wide, bearing three prominently developed talonid cusps arranged in a broad arc. The entoconid is the largest and highest talonid cusp. The hypoconulid is second in height and is subequal in size with the hypoconid. The cristid obliqua joins with the postvallid at an oblique angle and extends halfway up towards the protoconid—metaconid notch.

Lower molars. — Except for their small size, the molars of this erinaceid are similar to the molars of Litolestes Jepsen 1930b and Leipsanolestes Simpson 1928, as described by Krishtalka (1976a), but differ, additionally, in possessing less inflated cusps, greater exodaenodonty, and in an absence of labial cingulid development. In these features, as well as in size, the specimens are most similar to the molars of Eolestes (Bown 1979) from the early Graybullian (early Eocene) of Wyoming (Bown and Schankler 1982; Novacek, et al. 1985). The degree of reduction in size of m1 through m3 in Erinaceidae unident. gen. and sp. appears to be comparable to that of Leipsanolestes; however, it should be noted that the m1 and m2 of Eolestes also shows a similar reduction in molar size (see Bown and Schankler 1982).

Discussion: In size, the referred specimens are much smaller than the comparable parts of the dentition of Litolestes and Leipsanolestes, and are larger than Dartonius Novacek, et al. 1985. The dentition referred here is similar in size to teeth in both Entomolestes Matthew 1909 and Eolestes (Bown) but is most similar to the latter in p4 trigonid and molar morphology and in the relative sizes of p4 and m1. In comparison to the p4 in Eolestes, the p4's of this taxon bear a longer and wider talonid with three distinct talonid cusps.

Krishtalka (1976a) considered the Clarkforkian erinaceid Leipsanolestes seigfriedti Simpson 1928 to be more primitive than the slightly older (latest Tiffanian) Litolestes ignotus based upon "the retension of a semimolariform p4 and the less-marked reduction in size of the molars from m1-m3" (p. 30). The Cochrane taxon possesses both of these characters.

The p4 of Erinaceidae unident. gen. and sp. is also semimolariform, but differs from p4, L. seigfriedti in possessing a relatively longer, more opened trigonid, with a relatively smaller metaconid and more anteriorly directed paraconid. The metaconid is smaller than the paraconid, as in Lit. ignotus. The talonids of the Cochrane p4's differ from the p4's in both of the younger forms (and in all later erinaceids) in bearing a distinct hypoconulid.

The differences in p4 morphology noted above are interpreted as being primitive for the Erinaceidae (see Novacek 1982) and are probably enough to warrant the erection of a new genus. This action is not taken, however, pending the study of better preserved material referable to this taxon from the middle Tiffanian UADW-2 locality (Paskapoo Formation, Blindman River, Alberta [Fox, in press]) to be described elsewhere by R.C. Fox.

Suborder Soricomorpha Gregory 1910

Family Nyctitheriidae, Simpson 1928

Genus Leptacodon Matthew and Granger 1921

Leptacodon sp. 1

(Plate 21, figs. A—G; table 18)

Referred specimens: UALVP 24765, 24778 and 25560, P4's; UALVP 24767 and 24771, M1's; UALVP 24770 and 24773, M2's; UALVP 24766, 24768, 24783, 25524, 25526, 25528 and 25529, M1 or M2's (total: 7); UALVP 24775 and 24780, M3's; UALVP 24776, dp4; UALVP 24774, 24777, 24779 and 25530, p4's; UALVP 25523, m1; NMC 9098, UALVP 24772, 25525 and 25527, m2's; UALVP 24769 and 24781, m3's.

Description and discussion: Morphologically, the referred specimens are virtually identical to the comparable elements of the type species of Leptacodon, L. tener Matthew and Granger 1921, from the late Tiffanian Mason Pocket locality (Tiffany Beds, ?San Jose Formation, La Plata County [McKenna 1968]) of Colorado. As far as can be determined, the Cochrane specimens differ from the type material only in being slightly larger in linear dimensions, and, perhaps also, in having a more appressed paracone and metacone on P4. The upper dentition of L. tener has been described in detail by McKenna (1968), while the lowers were discussed by Krishtalka (1976b).

The specific assignment of this taxon to L. tener or to "cf. L. tener" is withheld until direct comparison can be made with the type material of the former.

UALVP 24770 and 24773 are virtually identical to UW 13192, an M2 referred to "Leptacodon sp. cf. L. tener" by Winterfeld (1982) from the latest Tiffanian V-77059 locality, Fort Union Formation (eastern Rock Springs Uplift, Sweetwater County) of Wyoming (pers. obs.).

L. S. Russell (1958), on his final return visit to the Cochrane 2 locality in 1955, collected an m2 (NMC 9098) which he described as "Leptacodon sp." After making comparisons with the known Leptacodon species of the day (L. tener, L. packi Jepsen 1930b, "L." munusculum Simpson 1935, and including the erinaceid Leipsanolestes siegfriedti and the erinaceomorph Mckennatherium ladae), Russell decided not to attempt a specific identification of the specimen, but suggested that it showed closest similarity to the m2 of "Leptacodon" (Mckennatherium) ladae. The conforming characters cited by Russell were "...the degree of elevation of the trigonid, the closeness of the paraconid to the metaconid, and the relative width of the talonid" (1958, p. 99).

Contrary to Russell's (1958) interpretation, I consider NMC 9098 to display much more structural similarity to the m2 of L. tener; differing from M. ladae in the possession of 1) a relatively **lower** trigonid; 2) a more cuspate paraconid, much **less** appressed to the metaconid; 3) a slightly more lingual positioning of the hypoconulid; 4) a higher entoconid than hypoconid; 5) a relatively less inflated metaconid, and 6) in possessing a higher entocristid and V-shaped talonid notch (emphasis added). In size, NMC 9098 is comparable to the lower molars of L. sp 1 from Cochrane 2 and is herein referred to this species.

<u>Leptacodon</u> sp. 2

(Plate 22, figs. A—E; pl. 23, figs. A—F; table 19)

Referred specimens: UALVP 25506, 25510 and 25517, P4's; UALVP 25507, 25508, 25509 and 25515, M1's; UALVP 24785, 24786, 25511, 25512 and 25520, M2's; UALVP 25516, 25518, 25519, 25521 and 25522, M1 or M2's; UALVP 24784, maxillary fragment with M2 and M3; UALVP 25513 and 25514, M3's; UALVP 24798, dentary fragment with p4 and alveoli for p3; UALVP 25504, p4; UALVP 25503, Lm1; UALVP 24788, 24791, 24792, 25502 and 25003, m1's; UALVP 25500, dentary fragment with m2 and alveoli for m3; UALVP 24790 and 24796, Lm2's; UALVP 24787, 24789, 24795, 24797, 24799 and 25501, m2's; UALVP 25505, m1 or m2; UALVP 24794 and 24793, m3's.

Description and discussion: The referred specimens appear to differ significantly only in size from the dentition allocated to <u>Leptacodon</u> sp. 1 (see above). The teeth of this taxon are larger than those of <u>L</u>. sp. 1 and are equivalent in size to teeth of the late Tiffanian <u>Leptacodon</u> <u>packi</u> Jepsen 1930b (see Krishtalka 1976b). Some workers (Krishtalka 1976b; Bown and Schankler 1982) have recently questioned the generic affinities of <u>L</u>. <u>packi</u>, considering it to be nearer to <u>Nyctitherium</u> Marsh 1872. The Cochrane 2 sample of <u>L</u>. sp. 2 is similar in lower molar morphology to the lowers of <u>L</u>. <u>packi</u> and differs from the lower molars of <u>L</u>. <u>tener</u> and <u>L</u>. sp. 1 in possessing a larger paraconid, more transverse (V-shaped) trigonids, a hypoconulid that is slightly closer to the entoconid than in <u>L</u>. <u>tener</u>, and the incipient development of a labial cingulid.

The p4 specimens possess short and narrow talonids, bearing three small talonid cusps (damaged on UALVP 25504). The cusps are closely spaced and equidistant from each other, on a slightly convex posterior talonid rim. The hypoconulid is considerably lower than the hypoconid and entoconid.

Gingerich, et al. (1983) have recently referred a maxillary fragment with three premolars, M1 and M2 (USNM 309874, associated with a dentary) to Leptacodon cf. L. packi from the earliest Tiffanian Bangtail locality of Montana. The M2 of this specimen is remarkably similar to the upper molars of Nyctitherium and possesses a well developed salient talon with a large "hook"-like (aquiline) hypocone (P. D. Gingerich, pers. comm. 1986). The upper molars referred to L. sp. 2 occlude tightly with the lowers referred to this taxon, but they do not closely resemble the M2 specimen referred to L. cf. L. packi by Gingerich. Instead, the Cochrane teeth are virtually identical in structure to the upper molars of L. tener and L. sp. 1.

The prominent morphological discrepancies between the upper molars associated with the L. packi-like lower dentitions at Cochrane 2 and at the Bangtail locality, respectively (Gingerich, et al. 1983), precludes confident referral of the Cochrane material to L. packi or to "cf. L. packi" until direct comparisons can be made with the type material of L. packi and the Bangtail specimens. The similarity of the upper molars from Cochrane to L. tener strongly supports the inclusion of this large-sized nyctitheriid in the genus Leptacodon.

"Leptacodon" munusculum Simpson 1935

(Plate 24, figs. A—F; table 20)

Type: USNM 9819, left dentary with m1 and m3.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality [Simpson 1937; Krishtalka 1976b]); ?latest Torrejonian of Wyoming (Rock Bench Quarry, Fort Union Formation, Polecat Bench [Rose 1981a]); earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]; Bangtail locality, Fort Union Formation, western Crazy Mountain Basin, Park County [Gingerich, et al. 1983]); middle Tiffanian of Wyoming (Cedar Point Quarry, Polecat Bench Formation, Bighorn Basin, Bighorn County [Krishtalka 1976b; Rose 1981a]) and Alberta (UADW-2 locality, Paskapoo Formation, Blindman River [pers. obs.]).

Referred specimens: UALVP 25554, P4; UALVP 25553, associated P4 and M2; UALVP 25555 and 24700, M1's; UALVP 25551 and 25558, M2's; UALVP 25552, M1 or M2; UALVP 25556, M3?; UALVP 25536, dentary fragment with i2-p1; UALVP 25546, dentary fragment with p4-m1; UALVP 25532, 25533 and 25535, dentary fragments with m1 talonid and m2; UALVP 25534, dentary fragment with m1 or m2; UALVP 25540, dentary fragment with m1; UALVP 25538 and 25539, m1 or m2; UALVP 25543, m1; UALVP 25544, m2; UALVP 25537, dentary fragment with m2 talonid and m3; UALVP 25542 and 25545, m3's; UALVP 25547, dentary fragment with m3 talonid and alveoli for m1 and m2.

Description: The upper molars of L. munusculum have not been described. Based upon size, relative abundance, and occlusal relationships, I refer a small number of upper teeth to this taxon. They are described as follows:

P4. — UALVP 25554 is shaped like an isosceles triangle in occlusal outline, with the posterior side of the crown the longest. The anterior side of the tooth is transversely shorter, giving the labial border a strongly oblique orientation. The paracone is clearly the largest and tallest cusp of the crown, followed sequentially by the protocone, metacone, and parastyle. The paracone is conical and high. The metacone is transversely compressed and confluent with a well developed metastylar salient. The metacone is slightly appressed to the paracone and has its apex oriented further linguad. The parastyle is well separated from the paracone and continuous with a weak ectocingulum. The protocone is "hooked" labially and bears prominent pre- and postprotocristae. The trigon basin is shallow and lacks conules. Faint pre- and postcingula are developed.

M1, M2. — Two M1's (UALVP 25554 and 24770) and two M2's (UALVP 25551 and 25558) are referable to this taxon. M1 is considerably longer labially than lingually. The paracone and protocone have a strong anterior lean and the paracone and metacone are slightly compressed anteroposteriorly. The postparacrista and premetacrista join together slightly labiad to a line drawn through the apices of the paracone and metacone. There is no trace of a mesostyle. A well developed stylocone is present immediately adjacent to the parastyle on the parastylar lobe. These two cusps are subequal in size and display a prominent trough-like wear facet between them that is continuous with the preparaconule crista. The ectocingulum is relatively narrow, but distinct, and the ectoflexus shallow. The stylar shelf is narrowest labial to the paracone and widest labial to the metacone. The conules are large and each is displaced anteriorly with respect to the paracone and metacone. As a consequence, the paraconule projects strongly beyond the protocone as an anterior bulge on the crown margin. The postprotocrista is confluent with the postmetaconule crista (metacingulum) and together they form a nearly straight crest to the metastylar salient. The pre- and postcingula are relatively short; the precingulum terminates lingually at a small, but distinct, pericone, directly anterior to the protocone; the postcingulum extends further linguad than the precingulum and terminates at a prominent and slightly bulbous hypocone. There is no development of a hypoconal salient.

Apical wear is broadly distributed on UALVP 25555. Wear on the cristae of the paracone and metacone of this tooth forms an incipient W-shaped pattern. Apical wear is prominent on the conules and protocone and all of their associated cristae, and is also found on the postcingulum, including the hypocone.

The M2 differs from M1 only in being slightly shorter labially and in possessing a relatively deeper ectoflexus and weaker metastylar salient.

The lower molars referred here are virtually identical to those described and illustrated by Krishtalka (1976b), and by Krause and Gingerich (1983) for L. munusculum from the type locality and Douglass Quarry, respectively.

Discussion: Krishtalka (1976b) has suggested that, on the basis of lower molar morphology, "Leptacodon" munusculum would be better placed in the genus Pontifactor West 1974; Bown and Schankler (1982) agree. Evidence for such an action would probably come from the upper dentition of "L." munusculum (Krishtalka 1976b). The upper dentition of "L." munusculum has never been described, although a specimen believed to pertain to this species (AMNH 35951, undescribed maxilla) is commented upon by Winterfeld (1982) in his description of "Leptacodon sp. cf. L. tener".

The upper molars from Cochrane referred to "L." munusculum differ from the comparable teeth of L. tener, and Leptacodon spp. from the same locality, in 1) being narrower lingually; 2) having an anteroposteriorly compressed paracone and metacone bearing incipient W-shaped crests; 3) possessing a distinct stylocone located on the parastylar lobe; 4) having the paracone strongly canted anteriorly, parallel with the protocone; 5) having the conules displaced anterior to the lingual bases of the paracone and metacone, respectively; and 6) bearing a distinct pericone and prominent bulbous hypocone, developed on relatively short pre- and postcingula. The cingula do not join lingual to the protocone and there is no hypoconal salient developed. As well, there is strong apical wear on all major crests and cusps of the crown.

In these characters, the upper molars referred here are most similar to these teeth in Pontifactor. They differ from the uppers of P. bestiola West 1974 in lacking a mesostyle and in possessing only an incipient W-shaped ectoloph. In addition, the pericone and hypocone are less well developed. The P4 (if correctly referred) differs from that of Pontifactor in possessing a distinct metacone.

Although I am confident of the association of the upper molars with the lowers and, therefore, favor the removal of "L." munusculum from the genus Leptacodon, I am uncertain as to whether the (primitive) absence of a mesostyle (and the associated W-shaped ectoloph pattern) in the Cochrane molars should still allow the inclusion of this taxon in the genus Pontifactor (which is defined to a large extent by the presence of these characters [see West 1974 and Krishtalka 1976b]). A more confident generic allocation for this taxon must await the study of more nearly complete material. Such a specimen (a complete maxilla) is preserved from the middle Tiffanian UADW-2 locality (pers. obs.) and will be described elsewhere by R. C. Fox.

Genus Nyctitherium Marsh 1872

Cf. Nyctitherium n. gen. and sp.

(Plate 25, figs. A—D)

Referred specimens: UALVP 25568, DP3; UALVP 25569, M1; UALVP 25567, m1.

Description: DP3. — UALVP 25568 (L=1.4, W=0.9) is lower-crowned, but, otherwise, virtually identical to RBN 6019, a left deciduous P3 referred to the European nyctitheriid Saturninia hartenbergeri Sigé (1976, p. 42, fig. 47). UALVP 25568 possesses a well-defined protocone and bears a broad oblique wear facet on the posterior slope of this cusp.

M1. — In comparison with its transverse width, UALVP 25569 (L=1.3, W=1.6) has the crown relatively long labially, and especially long lingually, due to the presence of a broad, low talon. Compared with the labial and lingual lengths, the mid-region is relatively narrow, giving the tooth a rough "hour-glass" shape in occlusal outline. UALVP 25569 has a tall and acute paracone and metacone, with the former cusp being slightly larger and higher than the latter. The protocone is smaller and lower than the other two cusps. The paracone and metacone are well separated. The paracone is more conical than the metacone; the latter cusp is flattened labially and is more recurved than the paracone. A prominent postmetacrista extends ventrally from the apex of the metacone and terminates on a sharp metastylar lobe (salient). Although slightly water-worn, the stylar shelf is narrow and the ectoflexus is shallow. A well-defined stylocone is present anterolabial to the paracone, and is attached to it by a short stylocrista. The parastylar region is heavily worn; nevertheless, there appears to have been a prominent parastyle. The preparaconule crista (paracingulum) is damaged. However, a strong, obliquely directed, postmetaconule crista (metacingulum) is preserved. The apex of the protocone is also damaged, but is estimated to have been lower than the paracone and metacone and has a strong anterior lean. The protocristae were short. The conules are low with the paraconule positioned much closer to the apex of the protocone than is the metaconule. Only a small portion of an originally narrow precingulum remains intact. The postprotoconal cingulum is posteriorly expanded and shelf-like (to form a talon), but low. The rim of the talon (postcingulum) is gently curved anteriorly throughout its extent. A small hypocone appears to have been developed, but is damaged on the posterolingual rim of the talon. The entire lingual portion of the tooth is slightly bent labially towards the paracone and metacone.

m1. — UALVP 25567 (L=1.3, W=0.8) bears relatively high and acute cusps. The trigonid is slightly narrower than the talonid and each has the labial cusp (protoconid and hypoconid, respectively) oriented (skewed) slightly posterior. The protoconid is taller, but less inflated, than the metaconid; both cusps are closely approximated and display strongly convex labial slopes (dorsoventrally convex lateral margins). The paraconid is much narrower (anteroposteriorly compressed) than either the protoconid or metaconid, and is medially positioned on the trigonid. The cristid obliqua is slightly concave labially and joins the postvallid at the base of the metaconid, just lingual to the protocristid notch. A prominent vertical inflation along the posterolingual height of the metaconid is continuous with the cristid obliqua. The hypoconid is damaged, but was the largest talonid cusp. The hypoconulid is closely associated with the entoconid and both cusps are bulbous with convex internal faces. The entoconid is larger than the hypoconulid and is positioned higher on the talonid rim. The entocristid extends between the metaconid and entoconid and is slightly convex lingually. The talonid basin is relatively deep, but is constricted in area by the concave cristid obliqua. The crown of UALVP 25567 is strongly exodaenodont. A narrow postcingulid extends labially from the hypoconulid to the hypoconid. A longer and wider precingulum is developed anteriorly; extending to the ventral base of the protoconid. A weak, ventrally convex, labial cingulid extends across the hypoflexid from the hypoconid to the protoconid. The labial cingulid does not join the pre- and postcingulids.

Discussion: The referred m1 and M1 (UALVP 25567 and 25569) are comparable in size to those in Leptacodon sp. 1. UALVP 25567 differs from m1, L. sp. 1, in having 1) a higher trigonid; 2) a more appressed protoconid and metaconid; 3) a taller protoconid compared to the metaconid; 4) dorsoventrally convex lateral margins on the protoconid and metaconid; 5) a more medially positioned and anteroposteriorly flattened paraconid; 6) a trigonid that has the protoconid skewed more posteriorly; 7) the incipient development of a continuous labial cingulid; 8) a slightly concave cristid obliqua; 9) bulbous (inflated) talonid cusps; 10) an entocristid that is slightly convex lingually.

UALVP 25569 differs from M1, L. sp. 1 in possessing 1) a stylocone; 2) a posteriorly expanded and shelf-like talon; 3) a shorter midline length; 4) a smaller protocone; 5) a shallower ectoflexus; 6) a taller paracone and metacone.

The m1 referred to this taxon is clearly more similar to the m1 of Nyctitherium than to the lower molars of any other known nyctitheriid. In comparison with m1, Nyctitherium velox Marsh 1872, UALVP 25567 is smaller and differs further in possessing a higher protoconid in relation to the metaconid, and a greater posterolingual inflation of the metaconid. In addition, the protoconid and metaconid are positioned closer together and the labial slopes of both cusps are more dorsoventrally convex. The labial cingulid of UALVP 25567 is poorly developed and is not continuous with the pre- and postcingulids, as in N. velox.

All of these features are virtually identical to those present on m1 of Paranyctoides Fox 1984a, the oldest and most primitive known lipotyphlan, from the late Cretaceous of Alberta (Fox 1984a). Consequently, I consider their presence on UALVP 25567 to be plesiomorphic.

In comparison with the M1 of Nyctitherium, UALVP 25569 is much shorter (anteroposteriorly) across the mid-length (or "waist") of the tooth and possessess poorer development of the talon. The talon of the Cochrane specimen is transversely and longitudinally shorter by comparison. In addition, the ectoflexus is shallower and the paracone and metacone appear less compressed anteroposteriorly. All other morphological features on UALVP 25569 are identical to those on the M1 of Nyctitherium.

An intermediate condition to that described above is seen on the upper molars referable to a primitive form of Nyctitherium from the middle Tiffanian UADW-2 locality (Paskapoo Formation, Blindman River) of Alberta, to be described elsewhere by R.C. Fox (1984; pers. obs.).

In many of the characters which differ from the M1 of Nyctitherium (eg., mid-line length, paracone and metacone shape, shallow ectoflexus), UALVP 25569 closely resembles the P4's and M1's of Saturninia Stehlin 1940 (Nyctitherinae) and the M1 of Amphidozotherium Filhol 1877 (Amphidozotherinae), nyctitheriids from the late Eocene and early Oligocene of Europe (Sigé 1976). With respect to one of these forms, Robinson (1968) has noted that: "Saturninia may be somewhat more talpiform than Nyctitherium velox, but the remarkable similarity of preserved parts, especially P4(p4)—M3(m3), argues for close relationship" (p. 136). Krishtalka (1976b) later concurred that: "Saturninia, with an expanded hypoconal shelf on P4-M2 and an absence of dilambdodonty, is more closely related to Nyctitherium" (p. 26). A primitive nyctithere with the upper and lower molar morphology represented by UALVP 25569 and 25567, respectively, could easily have been ancestral to Nyctitherium and, also, to the European nyctitheres Saturninia and Amphidozotherium (Sigé 1976).

The new nyctitheriid taxon from Cochrane may represent a structural precursor to the dentition of certain Eocene and later occurring nyctitheres (excluding Leptacodon and Pontifactor) from both North America and Europe. The paucity of referable specimens, however, makes the formal designation of this taxon premature, until such time that additional tooth positions and/or articulated material is recovered. Therefore, I leave the new genus and species unnamed.

Family Nyctitheriidae, incertae sedis

Genus Limaconyssus Gingerich 1987

Limaconyssus sp.

(Plate 25, figs. E—I; pl. 26, figs. A—D)

Referred specimens: UALVP 25572, dentary fragment with p4 and alveoli for m1; UALVP 25573, p4; UALVP 25571, m1; UALVP 25570, dentary fragment with m2, posterior alveolus for m1, and alveoli for m3.

Description and discussion: The referred specimens are closely similar in structure to the comparable parts of the dentition of Limaconyssus habrus Gingerich 1987 from the late Clarkforkian (early Eocene) Willwood Formation of Wyoming. As in L. habrus, the Cochrane species possesses tall, needle-like cusps on the cheek teeth; a large and narrow p4 trigonid, bearing an elongate anteriorly directed paraconid and similarly elongate and narrow talonid; and a gradual reduction in size of m1-3. The trigonids of the molars are strongly transverse and the talonids are labially skewed and narrower than the trigonids. Limaconyssus sp. from Cochrane differs from L. habrus in being smaller and in possessing a more exodaenodont p4 and m1.

Gingerich (1987) recently described a new genus and species of nyctitheriid lipotyphlan, Limaconyssus habrus, from the late Clarkforkian (early Eocene) of Wyoming. The lower molars of Limaconyssus superficially resemble those of palaeoryctids due to the high trigonids and narrow, labially skewed, talonids. Unlike palaeoryctids, the p4 in L. habrus is semimolariform, with a prominent hypoconid and hypoconulid, and a low, anteriorly directed, paraconid. Additionally, the molar hypoconulids project posteriorly and are closer to the entoconids than to the hypoconids; the hypoconid is distinctly higher than the entoconid; the p4 and molars (especially m1) are strongly exodaenodont and gradually decrease in size and exodaenodonty from m1 to m3; the molar trigonids close (paraconid becomes appressed to the metaconid) to a moderate degree from m1 to m3; the hypoflexid is deep and the cristid obliqua descends at a steep ventral angle to the anterior of the trigonid before sharply ascending a short distance up the wall of the postvallid; and the talonid is deeply basined.

Molars of Limaconyssus differ from those of nyctitheres as represented by Nyctitherium in possessing labially skewed talonids that are narrower than the trigonids; and differ further from those of Leptacodon in possessing a much higher hypoconid than entoconid, and a smaller, lower metaconid than protoconid.

If not for its nyctitheriid-like p4 and more lingually positioned hypoconulid, this species would probably not be considered as a member of the Nyctitheriidae. The p4 of Limaconyssus superficially resembles the p4 of Leptacodon but differs in having a relatively more elongate crown with a longer, more anteriorly directed, paraconid; a relatively smaller and lower metaconid; a better developed precingulid; a narrower labially skewed talonid with large, high, and anteroposteriorly "pinched" hypoconid; prominent posteriorly projecting hypoconulid; small entoconid; and relatively deeper talonid basin.

The presence of Limaconyssus at the Cochrane 2 locality (see above) significantly extends the temporal range of this anomalous new taxon back to the earliest Tiffanian (early late Paleocene).

Limaconyssus is also present in the middle Tiffanian of Alberta (pers. obs.), and a similar species (virtually identical to the Cochrane form) is present in the late Tiffanian Swan Hills local fauna (pers. obs.; Stonley, in prep.).

Nyctitheriidae unident. gen. and sp.

(Plate 26, figs. E—G; pl. 27, figs. A—C)

Referred specimens: UALVP 25574 and 25576, p4's; UALVP 25575, m2; UALVP 25577, m3?

Description and Discussion: These teeth resemble the comparable teeth in Limaconyssus more than in any other nyctithere. The referred specimens are larger than the specimens referred to Limaconyssus sp. from Cochrane 2 and are similar in size to the lower dentition of L. habrus (see Gingerich 1987).

The specimens differ from the comparable teeth in L. habrus from the early Eocene of Wyoming and L. sp. from Cochrane 2 in having a more exodaenodont p4 with a smaller and less transversely compressed paraconid, and more robust cusps on m2 (UALVP 25575). The significance of these differences cannot be known due to the meagre sample available. As a result, these teeth cannot be confidently identified.

Order Lipotyphla incertae sedis

Family Uncertain

Unidentified gen. and sp.

(Plate 27, figs. D—F)

Referred specimen: UALVP 25580, m2?

Description: UALVP 25580 is quadrate in occlusal outline with relatively low, but acute, cusps that are strongly canted lingually. The trigonid is transverse and anteroposteriorly compressed and is shorter and much narrower than the talonid; both are strongly exodaenodont. The paraconid is transversely long and relatively narrow, anteroposteriorly, but is cuspate and "leaf"-like in structure. The paraconid is strongly appressed toward the metaconid (but does not contact this cusp) and has its apex extending almost to the lingual margin of the crown. The protoconid and metaconid are taller than the paraconid, but the paraconid segment of the paracristid is longer than the protoconid segment. Most of the metaconid is missing; however, judging from the size of its base, the metaconid was probably slightly larger and taller than the protoconid. The metaconid segment of the protocristid appears to have been longer than the protoconid segment. The entire talonid is strongly canted posteriorly toward the talonid, overhanging it to a degree. The talonid is wide (transverse) and has a deep V-shaped basin formed by relatively flat entoconid and hypoconid walls. The hypoconid is the largest talonid cusp and is subequal or slightly lower in height than the entoconid. The hypoconulid is smaller and lower than the other talonid cusps, but is well-defined and medially positioned on the talonid; sharing the same wall as the entoconid. The talonid cusps are all approximately equidistant from each other on the talonid rim. The talonid notch is deep; the entocristid is slightly convex, labially and higher than the cristid obliqua. The cristid obliqua is [illegible] and terminates at the base of the protoconid, labial to the protocristid [illegible]. A second postvallid crest extends posteriorly a short distance from the metaconid to join with the lingual side of the cristid obliqua. A short labial cingulid is developed at the base of its relatively shallow hypoflexid. A prominent precingulid is developed; two separate postcingulid segments are present; one lingual, the other labial, to the hypoconulid.

Discussion: UALVP 25580 is anomolous in its possession of an erinaceoid-like trigonid with a "leaf"-like (slightly crestiform) paraconid, appressed toward the metaconid; moderately low trigonid, elevated anteriorly and leaning posteriorly over the talonid; and in possessing a broad and deep talonid, with prominent talonid cusps, located equidistantly from each other.

Apart from the distinctive posterior cant of the trigonid over the talonid, UALVP 25580 compares most favorably with members of the Lipotyphla.

In comparison with the m1 and m2 in the primitive erinaceomorph Mckennatherium Van Valen 1965b, UALVP 25580 bears a more cuspate paraconid coupled with a less inflated metaconid; a relatively wider talonid with a V-shaped basin; a closed entocristid with a sharp and deep talonid notch; a higher entoconid (and entocristid); a more medially positioned hypoconulid; a more convex cristid obliqua, joining labially with the trigonid (shallower hypoflexid); a well developed labial cingulid and greater exodaenodonty.

Compared with the m2's in erinaceids such as Litolestes, Leipsanolestes and Eolestes, UALVP 25580 is relatively more transverse and higher-crowned, with sharper cusps, a wider talonid with a more convex cristid obliqua and doubled postcristid, a transversely longer paraconid, and a relatively greater appression of the paraconid with the metaconid.

UALVP 25580 also resembles early dormaaliids, such as Macrocranion Weitzel 1949 and Scenopagus McKenna and Simpson 1959, but differs in possessing a less crestiform and more cuspate paraconid, a more convex cristid obliqua, a V-shaped talonid basin, a more medially positioned hypoconulid, and greater exodaenodonty.

In comparison with primitive nyctitheres, UALVP 25580 differs significantly in most of its talonid morphology, but is most similar in its trigonid cusp structure to primitive members of the family.

UALVP 25580 possesses a mozaic of structural characteristics used to define the major groupings of early Tertiary lipotyphlans: As in primitive erinaceomorphs (such as Mckennatherium), the specimen is high-crowned with a transverse orientation of the paraconid; a relatively strong appression of the paraconid with the metaconid (moderately closed trigonid [Krishtalka 1976a; Novacek 1982]); a wider talonid than trigonid; and possesses virtually identical postcingulid structure.

As in erinaceids, the talonid basin is formed as a V-shaped valley with flat internal hypoconid and entoconid walls, and there is an appreciable degree of exodaenodonty of the crown (Krishtalka 1976a; Novacek 1982; although see Rose and Gingerich 1987). In comparison with the m2's in erinaceids, such a Litolestes, Leipsanolestes, and Eolestes, UALVP 25580 is relatively more transverse and higher-crowned, bearing sharper cusps; a wider talonid with a more convex cristid obliqua and doubled postcristid; a transversely longer paraconid; and a relatively greater appression of the paraconid with the metaconid.

Consistent with dormaaliids (Macrocranion and Scenopagus), UALVP 25580 bears a transversely oriented, slightly crestiform, paraconid which is closely appressed against the metaconid; a transversely wide talonid; and a low, labial connection of the cristid obliqua to the postvallid wall.

As in primitive nyctitheriids (soricomorphs), such as Leptacodon, "Leptacodon" munusculum and Pontifactor, the metaconid is slightly larger and (probably) higher than the protoconid; the metaconid possesses a triangular outline in horizontal section, with a convex lingual face, a less convex posterolabial face, and a flat anterolabial face; the paraconid has a "leaf"-like (slightly crestiform) structure; all cusps of the crown are acute (sectorial); and the entoconid is slightly higher than the hypoconid (Rose and Gingerich 1987). This latter character is primitive for lipotyphlans in general (Rose and Gingerich 1987) and indicates an increase in the entoconid—protocone contact during occlusion (Butler 1980).

UALVP 25580 is distinctive in the anteroposterior compression of the crown; the canting of the trigonid; the relative width (strongly transverse) and slight curvature of the talonid; and in the medial positioning of a prominent hypoconulid.

The only other group of early Tertiary mammals possessing a strong posterior canting of the trigonid are the Apatemyidae. The morphological dissimilarity between UALVP 25580 and the molars of primitive apatemyids rules out any close affinity between these two taxa and supports the convergent development of this feature.

From the available information, UALVP 25580 appears to represent a highly specialized lipotyphlan, retaining several primitive features characteristic of the early lipotyphlan groups (erinaceomorphs, soricomorphs) or, perhaps, converging upon them, secondarily.

Order Dermoptera Illiger 1811

Family Plagiomenidae Matthew 1918

Genus Elpidophorus Simpson 1927

Elpidophorus cf. E. elegans Simpson 1927

(Plate 28, figs. A—F)

Type of Elpidophorus elegans: AMNH 15541, right dentary fragment with m1-m2.

Type locality: Erickson's Landing, Paskapoo Formation, Red Deer River, Alberta.

Known age and distribution for Elpidophorus elegans: Earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.; D. W. Krause, pers. comm. 1986]); early Tiffanian of Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Szalay 1969]); middle Tiffanian of Alberta (type locality [Simpson 1927]; localities UADW-1 and UADW-2, Paskapoo Formation, Blindman River [Fox, in press]; Joffre Bridge Road Cut, lower level, and Joffre Bridge Mammal Site No. 1 localities, Paskapoo Formation, Red Deer River [Fox, in press]; Hand Hills West locality, upper level, Paskapoo Formation, Hand Hills [Fox, in press]) and Wyoming (Cedar Point Quarry, Fort Union Formation, northern Bighorn Basin, Bighorn County [Rose and Simons 1977]); late Tiffanian of Alberta (Police Point locality, Ravenscrag Formation, Cypress Hills [Krishtalka 1973]).

Referred specimens: UALVP 18612, M2; UALVP 25582, dentary with p3-m3 and alveoli for i3-p2; UALVP 25581, p4; UALVP 25583, m1.

Description: M2. — UALVP 18612 is quadrangular in occlusal outline with nearly parallel anterior and posterior sides. The specimen is slightly smaller than M2's of E. elegans from the younger localities (L=4.0, AW=5.3, PW=5.1). The pre- and postcingula are prominent and extend lingually to almost encircle the protocone. The precingulum fades and becomes cuspidate after reaching the lingual face of the protocone. The hypocone is well-developed and continuous with the postcingulum. The base of the hypocone is distinctly swollen.

p3. — The p3 on UALVP 25582 is premolariform. The paraconid is incipiently developed and positioned just above the anterior base of the crown. The labial base of the crown is straight and lacks exodaenodonty.

p4. — UALVP 25581 (L=3.5, AW=2.0, PW=2.5) and the p4 of UALVP 25582 (L=3.7) are both smaller than the p4 in E. elegans from Scarritt Quarry and E. elegans from the middle Tiffanian of Alberta (pers. obs.). The paraconid is loph-like and labially oriented with a rounded apex; much lower than the protoconid. The protoconid is posteriorly displaced and appressed to the metaconid. As a result, the trigonid is open and transversely narrow; giving the talonid an enlarged appearance. The talonid is shallow with a high cristid obliqua and two well-developed talonid cusps: the entoconid is higher than the hypoconid. There is no trace of a hypoconulid. The labial cingulid is poorly developed, but extends to the base of the hypoflexid. The labial base of the hypoconid is rounded and shows no sign of exodaenodonty.

A faint crest curves posteroventrally from the apex of the paraconid terminating at the lingual base of the metaconid. Two tiny cuspules are developed on this crest. The enamel is weakly wrinkled on all sides of the tooth.

Lower molars. — The molars on UALVP 25582 have low trigonids and talonids and the labial bases of their hypoconids only poorly exodaenodont. In addition, p4 is smaller than m1 and the m3 appears relatively smaller and lower-crowned with respect to m2, than in E. elegans.

Discussion: The M2 of Elpidophorus cf. E. elegans from Cochrane 2 (UALVP 18612) differs from M2, E. elegans, of the early Tiffanian Scarritt Quarry in being more quadrate occlusally, having a relatively better developed hypocone, and ~~in~~ possessing more extensive and prominent pre- and postcingula that almost completely surround the tooth. Similarly, the lower molars on UALVP 25582 differ from the molars in later E. elegans in being slightly smaller, and in possessing relatively lower metaconids and less exodaenodont hypoconids. In comparison with the type of E. elegans (AMNH 15541), the molars are smaller and less canted lingually.

The p4's of the Cochrane form are smaller than all of the known p4's of E. elegans. Morphologically the Cochrane specimens are, by comparison, less molariform than p4, E. elegans, from Scarritt Quarry and from the Blindman localities of Alberta (pers. obs.).

The p4 of Elpidophorus minor Simpson 1937 (on PU 14201, right dentary fragment with p3-m2) from the late Torrejonian Silberling Quarry (upper Lebo Formation, Crazy Mountain Field) of Montana (Simpson 1937) appears to be slightly more advanced than the Cochrane p4's in the possession of a hypoconulid and a more lingually oriented paraconid (more closed trigonid). In addition, E. minor has a straighter lingual margin and a less arcuate entocristid on p4. Primitively (as in the Cochrane p4's), the p4 in E. minor is smaller than the m1 and has a larger and higher protoconid than metaconid. In contrast, the p4's of later occurring E. elegans from the middle Tiffanian of Alberta (Blindman and Joffre Bridge localities [Fox, in press]) are more equal in size to m1 and display relatively smaller and lower protoconids (pers. obs.).

The apparently primitive (less molariform) structure of p4, E. cf. E. elegans, in comparison with the molariform p4 of the temporally older E. minor may indicate that the two species represent separately evolving lineages, and that an ancestor—descendant relationship between the two is less plausible. Simpson (1937) expressed reservations about the generic status of E. minor based upon its differences from E. ("patratus") elegans. Szalay (1969) found less difficulty in accepting E. minor as a "slightly more primitive" Elpidophorus species but held reservations about its propinquity to later E. elegans. Szalay (1969) in his description of p4, E. minor, acknowledged the presence of two "cuspules" (one large, the other small) on the postcristid between the entoconid and hypoconid. The large "cuspule" is certainly the hypoconulid. On the cast of the type specimen, I cannot distinguish a second smaller cuspule from the fold in the postcristid and therefore assume that both "cuspules" represent the hypoconulid, as Simpson interpreted and as depicted in his original figure of the specimen (1937: p.134; fig. 27a.). In the presence of a distinct hypoconulid on p4, E. minor, this tooth resembles the molariform p3 of the Eocene dermopteran genus Plagiomene Matthew, 1918 more so than the p4 of later occurring Elpidophorus.

Order Primates Linnaeus 1758

Suborder Plesiadapiformes Simons and Tattersall in Simons 1972

Superfamily Paromomyoidea Simpson 1940

Family Paromomyidae (Simpson 1940)

Genus Palaechthon Gidley 1923

?Palaechthon sp.

(Plate 29, fig. A)

Referred specimens: UALVP 25587, M1 or M2; UALVP 18364, 25588 and 25589; M3's; UALVP 11748, m3.

Description and discussion: UALVP 18364 represents the only complete specimen referable to this taxon. In size (L=1.7, W=2.8) and morphology UALVP 18364 is virtually identical to the M3 of Palaechthon nacimienti Wilson and Szalay 1972 from the middle Torrejonian University of Kansas locality 14 ("Angels Peak"), Nacimiento Formation (Kutz Canyon, San Juan Basin) of New Mexico. In comparison with M3 of the late Torrejonian Palaechthon alticuspis Gidley 1923 (USNM 9550, maxillary fragment with M1-M3) from Gidley Quarry of Montana (Simpson 1937), UALVP 18364 and the other referred M3's are larger and slightly more transverse, although closely similar in crown structure. Unlike the M3's of Plesiolestes problematicus Jepsen 1930b, the Cochrane specimens are smaller, less transverse, and more oval-shaped (rounded) in occlusal outline.

UALVP 18364 is also virtually identical to an isolated, uncatalogued, M3 referred to "Palaechthon sp." from the earliest Tiffanian Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation (Wind River Basin, Fremont County) of Wyoming (pers. obs.).

D. W. Krause (1978) questionably referred an m3, UALVP 11748, with heavy postmortem abrasion of the crown, to the hypodigm of the carpolestid Elphidotarsius russelli Krause 1978 from Cochrane 2 (see below). This specimen is much too large (L=2.5, W=1.5) to be the m3 of E. russelli. In addition, the trigonid is proportionately larger with respect to the talonid than the condition on the m3's of carpolestids. In size and preserved morphology, UALVP 11748 is most comparable with the m3 of Palaechthon nacimienti (see Wilson and Szalay 1972) and, on this basis, is hereby referred to ?Palaechthon sp. from Cochrane 2.

Genus Plesiolestes Jepsen1930b

Plesiolestes cf. P. sirokyi Szalay 1973

(Plate 29, figs. B—E)

Type of Plesiolestes sirokyi**:** AMNH 92135, right dentary fragment with m2-m3.

Type locality: Saddle locality, Bison Basin, Fort Union Formation, Fremont Co., Wyoming.

Known age and distribution for Plesiolestes sirokyi**:** Early Tiffanian (late Paleocene) of Wyoming (type locality [Szalay 1973; Szalay and Delson 1979]).

Referred specimens: UALVP 25590, M2; UALVP 25591, dp4; UALVP 25592, m1; UALVP 25593, m3.

Description and discussion: UALVP 25590 differs from the M2 of P. sirokyi, as figured by Szalay (1973) from the Saddle locality, in being slightly more transverse in occlusal view with a narrower midlength (L=3.4, AW=5.2, PW=4.5). In addition, a sinusoidal (rather than straight) postprotocrista is present on UALVP 25590, and the nannopithex fold or postprotocingulum ["distal cingulum" of Szalay (1973)] appears to connect with the apex of the protocone as in P. problematicus, the generotype, from the late Torrejonian of Wyoming and Montana (Jepsen 1930b; Szalay 1973).

In postprotocingulum morphology and in the possession of a slightly more transverse occlusal outline, UALVP 25590 resembles the conditions in P. problematicus and thus appears to represent a slightly more primitive member of the P. sirokyi lineage.

UALVP 25592 is structurally almost identical to the m1 trigonid of Torrejonia wilsoni Gazin 1968, which is considered to be the junior synonym of Plesiolestes (Wilson and Szalay [1972], Szalay [1973] and Szalay and Delson [1979]), and differs only in being considerably larger (AW=2.8). In size, UALVP 25592 is similar to a molar trigonid (USNM 25722) identified by Gazin (1969, p. 6, Pl. 2, fig. 7) as "cf. Torrejonia wilsoni" from the earliest Tiffanian Little Muddy Creek locality (Evanston Formation, Lincoln County), Wyoming. This m1 trigonid is also similar to the trigonids of a number of lower molars referred to "cf. T. wilsoni" by Gazin (1971), from the earliest Tiffanian Keefer Hill locality ("Shotgun local fauna"), Fort Union Formation (Wind River Basin, Fremont County), Wyoming. As in Gazin's description of "T. wilsoni" (1968) and "cf. T. wilsoni" (1969, 1971), the Cochrane 2 trigonid possesses "three parallel transverse crests" in occlusal view.

UALVP 25593 is virtually identical to the trigonid on the m3 of "cf. T. wilsoni" from Keefer Hill (Gazin 1971, p. 29, fig. 4c). UALVP 25593 closely resembles the m1 referred here (UALVP 25592) but differs in being relatively more transverse with a greater appression of the paraconid to the metaconid. Both of the molar trigonids from Cochrane 2 differ substantially from the comparable elements of "T. wilsoni" in being larger in all linear dimensions and in possessing more prominent labial cingulids.

The referred deciduous p4 (UALVP 25591) is also a trigonid and is structurally similar to the m1 trigonid (UALVP 25592) but is more elongate anteroposteriorly and transversely narrow, with greater separation of the cusps.

The occurrence of P. cf. P. sirokyi at Cochrane 2 is the first recognition of this lineage outside of the Bison Basin, Wyoming and represents a range extension — both temporally and geographically for the species, and geographically for the genus. The teeth described here are referable to the largest primate presently identified from the Cochrane 2 locality.

Genus Ignacius Matthew and Granger 1921

Ignacius fremontensis (Gazin 1971)

(Plate 30, figs. A—C; pl. 31, figs. A—I; table 21)

Type: AMNH 88309, right dentary fragment with p4-m2.

Type locality: Keefer Hill locality ("Shotgun local fauna"), Fort Union Formation, Wind River Basin, Fremont County, Wyoming.

Known age and distribution: Late Torrejonian (middle Paleocene) of Wyoming (Rock Bench Quarry, Fort Union Formation, Bighorn Basin [Rose 1981a; pers. obs.]); earliest Tiffanian (late Paleocene) of Wyoming (type locality [Gazin 1971]).

Referred specimens: UALVP 24819, I1; UALVP 24820, DP4; UALVP 11744, 24811, 24818 and 24824, P4's; UALVP 24802, M1; UALVP 18464, 24804, 24805 and 24812, M2's; UALVP 24808, 24821, 24822, 24852 and 24855, M1 or M2's; UALVP 18368, 24800, 24823, 24850 and 24851, M3's; UALVP 11752, 24809, 24810 and 24813, p4's; UALVP 18366, 24803 and 24806, m1's; UALVP 24807 and 24853, m2's; UALVP 24815 and 24854, mX's; UALVP 24801, 24814, 24816 and 24817, m3's.

Description and discussion: The specimens from Cochrane 2 are slightly larger (see Table 21) than the type sample from Keefer Hill, but are nonetheless virtually identical morphologically. Gazin (1971) provides an adequate description for the majority of the dentition of I. fremontensis. Szalay and Delson (1979, fig. 19C, D, E; fig. 20) illustrate the complete lower dentition and the first and second upper molars of this taxon.

The P4 of I. fremontensis was described by Krause (1978 [as "Paromomys cf. depressidens", see below]). The M3 of this species has never before been described and is represented by three specimens in the sample from Cochrane 2.

The M3's referred to I. fremontensis (UALVP 18368, 24800, and 24823) are roughly pyriform in occlusal outline with strongly oblique labial and rounded lingual regions. The parastylar lobe is poorly developed and rounded anterolabially. The hypocone shelf is moderately well developed. These teeth are low-crowned with a prominent paracone and reduced, but distinct, metacone; the paracone is the highest cusp on the crown. Both the paracone and metacone are transversely compressed and crest-like. The protocone is low and bulbous, and is continuous with the postcingulum. The postprotocrista is faintly developed, and a short precingulum is prominent.

In comparison with the M3's of I. frugivorus (Roche Percée local fauna [Krause 1978]), the referred specimens are more transverse and less rhomboidal (more pyriform) in occlusal outline, with shorter anteroposterior midwidth lengths. The posterolingual region is also more rounded than on M3, I. frugivorus, and the hypocone shelves are less posteriorly expanded. In addition, the paracone and parastylar lobe are more obliquely oriented, and the metacone appears to be relatively more reduced on the M3's referred to I. fremontensis.

Krause (1978) described three teeth from Cochrane 2 that he referred to "Paromomys cf. depressidens Gidley". Collections made subsequent to Krause's study indicate that the p4 (UALVP 11752) and P4 (UALVP 11744) described by him are better referred to Ignacius fremontensis.

The occurrence of I. fremontensis at Cochrane 2 is the first reported for this taxon outside of Wyoming. However, this species may also be present in the Douglass Quarry fauna (Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County) of Montana (D. W. Krause, pers. comm. 1986).

Ignacius cf. *I. frugivorus* Matthew and Granger 1921

(Plate 32, figs. A—H; pl. 33, figs. A—L; table 22)

Type of *Ignacius frugivorus*: AMNH 17368, left maxillary fragment with P2, P4-M2.

Type locality: Mason Pocket, "Tiffany" beds, San Jose Formation, San Juan Basin, Colorado.

Known age and distribution for *Ignacius frugivorus*: Earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [Gazin 1971]); early Tiffanian of Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Simpson 1936]); middle Tiffanian of Alberta (UADW-2 locality, Paskapoo Formation, Blindman River [Fox 1984b; Fox, in press]; Joffre Bridge Road Cut locality, lower level, Paskapoo Formation, Red Deer River [Fox, in press]; Hand Hills West locality, upper level, Paskapoo Formation, Hand Hills [Fox, in press]), North Dakota (Brisbane and Judson localities, Tongue River Formation, Williston Basin, Grant and Morton Counties [Holtzman 1978]), and Wyoming (Cedar Point Quarry, Fort Union Formation, northern Bighorn Basin, Bighorn County [Rose 1981a]); late Tiffanian of Alberta (Swan Hills site 1, Paskapoo Formation, Swan Hills [G. J. Stonely, pers. comm. 1985]; Police Point locality, Ravenscrag Formation, Cypress Hills [Krishtalka 1973; Krause 1978]; Canyon Ski Quarry, Paskapoo Formation, Red Deer [Krause 1978; Fox, in press]), Saskatchewan (Roch Percée local fauna, Ravenscrag Formation [Krause 1978]), Wyoming (Locality V-77005, Fort Union Formation, eastern Rock Springs Uplift, Sweetwater County

[Winterfeld 1982]), Colorado (type locality [Simpson 1935]), and Texas (Joe's Bone Bed, Black Peaks Formation, Big Bend National Park [Schiebout 1974]).

Referred specimens: UALVP 24825 and 24843, I1's; UALVP 24829 and 24837, P4's; UALVP 24844, M1; UALVP 24834 and 24840, M1 or M2's; UALVP 24828, 24839 and 24848, M3's; UALVP 24826, dp4; UALVP 24827, p4; UALVP 24830, 24831, 24833, 24845 and 24847, m1's; UALVP 11750, 24835, 24836 24838, 24842 and 24849, m2's; UALVP 24832, 24841 and 24846, m3's.

Description and discussion: The upper molars of I. cf. I. frugivorus from Cochrane are more transverse and possess less expanded hypocone regions than these teeth in I. frugivorus from the late Tiffanian Roche Percée local fauna of Saskatchewan (Krause 1978). The M3's lack the hypocone lobe developed posteriorly on the M3's of I. frugivorus. The labial margin of the M3's are also more rounded and less straight than in I. frugivorus.

The lower molars referred to I. cf. I. frugivorus differ from the comparable teeth of I. frugivorus from Roche Percée (Krause 1978) in being slightly smaller and in having more anteroposteriorly compressed trigonids with less inflated paraconids and metaconids.

Comparison of the Cochrane 2 specimens with the molars referred to "Phenacolemur cf. frugivorus" by Gazin (1971) from the Keefer Hill locality of Wyoming reveals few structural differences between the two samples.

Krause (1978, p. 1266, fig. 9H) identified an m2 talonid from Cochrane 2 as belonging to "Paromomys cf. depressidens". This specimen compares well with the talonids of m2's of I. cf. I. frugivorus from this locality and is herein referred to this species.

Superfamily Plesiadapoidea Trouessart 1897

Family Plesiadapidae Trouessart 1897

Genus Pronothodectes Gidley 1923

?Pronothodectes sp.

(Plate 34, figs. A—E)

Referred specimens: UALVP 24910, I1; UALVP 24911, p4; UALVP 24912, m3.

Description and discussion: Despite being water-worn, UALVP 24911 and 24912 are much smaller than the p4 and m3, respectively, of Nannodectes intermedius (Gazin 1971) from Cochrane 2 (and elsewhere [Gingerich 1976]). UALVP 24911 is a double-rooted plesiadapid premolar comparable in morphology to the p4 of Pronothodectes matthewi Gidley 1923 (the smallest plesiadapid to be described [Gingerich 1976]) from the late Torrejonian of Montana, but much smaller (L=1.6, W=1.4). In size UALVP 24911 is more similar to the p3 of P. matthewi (see Gingerich 1976).

UALVP 24912 lacks enamel, exposing a heavily worn crown of dentine that superficially conforms to the m3 structure of plesiadapids. In cusp morphology and occlusal outline, this specimen is most similar to m3, P. matthewi, but was probably slightly smaller and less transverse in the unworn condition.

UALVP 24910, although fragmentary, is much smaller (W=1.8) than the I1 referred to Plesiadapis praecursor from Cochrane 2 (UALVP 24883) and appears to be significantly smaller than the I1's described by Gingerich (1976) for Nannodectes intermedius. The crown of UALVP 24910 preserves a poorly developed mediocone that is shelf-like and continuous (confluent) with the anterocrista. In size and morphology, UALVP 24910 is virtually identical to the I1's described by Gingerich (1976) and illustrated by Gidley (1923, Pl. 3, figs. 11, 12) for Pronothodectes matthewi from Gidley Quarry, upper Lebo Formation (Crazy Mountain Field, Sweetgrass County), Montana.

UALVP 24910 was collected by L. S. Russell in 1929 and was given a tentative identification 48 years later, by D. W. Krause, as possibly belonging to Pronothodectes (D. W. Krause, unpubl. note 1977). Krause did not describe this specimen in his 1978 paper on Paleocene primates (presumably because of its fragmentary nature) and it remained uncatalogued until the present study.

The small size and distinctive morphology of the aforementioned specimens presently preclude their referral to Nannodectes intermedius, and strongly suggests the presence of a small plesiadapid taxon at Cochrane 2, with dental morphology not unlike that of Pronothodectes matthewi.

Genus Nannodectes Gingerich 1975

Nannodectes intermedius (Gazin 1971)

(Plate 34, figs. F, G; pl. 35, figs. A—C; table 23)

Type: UW 3223, left dentary fragment with p4-m3.

Type locality: Keefer Hill ("Shotgun local fauna"), Fort Union Formation, Wind River Basin, Fremont County, Wyoming.

Known age and distribution: Earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin [Gingerich 1976; Krause and Gingerich 1983]; Bangtail locality, Fort Union Formation, western Crazy Mountain Basin [Gingerich, et al. 1983]) and Wyoming (type locality [Gazin 1971; Gingerich 1976]; ?Little Muddy Creek locality, Evanston Formation [Gazin 1969]).

Referred specimens: UALVP 24860, 24861 and 24872, P3's; UALVP 24878, DP4; UALVP 24873 and 24881, P4's; UALVP 24870, 24871 and 24880, M1's; UALVP 18356, maxillary fragment with M2; UALVP 24856 and 24857, M2's; UALVP 24864 and 24882, M1 or M2's; UALVP 24869, M3; UALVP 11739 18435 and 24879, dp4's; UALVP 24866, 24862 24875 and 24876, p4's; UALVP 18488, 24865 and 24874, m1's; UALVP 11738, dentary fragment with m2; UALVP 11749, 24867, 24868, 24877 and 24882, m2's; UALVP 18383, 24858, 24859 and 24863, m3's.

Description and discussion: The dentition of N. intermedius has been adequately described by Gazin (1971), Gingerich (1976), and by Gingerich, et al. (1983).

The Cochrane material is virtually identical to the samples of N. intermedius from the type locality of Wyoming, and from Douglass Quarry and the Bangtail locality of Montana (pers. obs.)

The deciduous P4 of this taxon has not been previously described. A single tooth (UALVP 24878), of the correct size and morphology to be the DP4 of N. intermedius, is referred here. In occlusal outline UALVP 24878 is roughly triangular with a greater labial, than lingual, length. The anterior margin is slightly convex and the posterior margin is strongly concave. The ectoflexus is shallow, with a discontinuous ectocingulum. The paracone is slightly larger than the metacone, but both cusps are conical and subequal in height. The conules are distinct, subequal, and conical. A well-defined postprotocingulum (nannopithex fold) is continuous with the postcingulum. The postprotocingulum is weakest near the apex of the protocone. The postmetaconule crista is not connected to the metaconule, but is confluent with the postcingulum. Apical wear is present on all cusps of the crown. The enamel of the basolingual slope of the protocone is continuous with the lingual root.

Krause (1978) tentatively referred three poorly preserved plesiadapid specimens (UALVP 11738, 11739 and 11749) from the Cochrane 2 locality to "Pronothodectes? sp." Direct comparison of these specimens with the larger sample of N. intermedius collected subsequently from Cochrane 2 and with the type material (and an even larger sample from Douglass Quarry), indicates that they are best referred to this taxon. This conclusion confirms Gingerich's (1982b) suggested identification for these specimens.

In 1983, Krause and Gingerich, and Gingerich, et al., extended the geographic range of N. intermedius from the type locality in central Wyoming, northward to south-central Montana. The recognition of this temporally restricted taxon from Cochrane 2 extends the known range of N. intermedius further north to include southwestern Alberta.

Genus Plesiadapis Gervais 1877

Plesiadapis praecursor Gingerich 1975

(Plate 36, figs. A—F; pl. 37, figs. A—D; table 24)

Type PU 14512, left dentary fragment with p4-m2.

Type locality: Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County, Montana.

Known age and distribution Earliest Tiffanian (late Paleocene) of Montana (type locality [Gingerich 1976; Krause and Gingerich 1983]) and Wyoming (Keefer Hill [Shotgun] locality, Fort Union Formation, Wind River Basin [Gazin 1971; Gingerich 1976]).

Referred specimens: UALVP 24883, I1; UALVP 24884, DP4; UALVP 24889, P4; UALVP 24888, 24891, 24892 and 24897, M1 or M2's; UALVP 24900, dentary fragment with p4-m3 and alveoli for i1-p3; UALVP 24885, 24887 and 24890, dp4's; UALVP 24898, p4; UALVP 24893 and 24896, m1's; UALVP 24886 and 24895, m2's; UALVP 18375, 24892 and 24899, m3's.

Description and discussion: The referred specimens do not significantly differ from the material described for P. praecursor from Wyoming and Montana by Gazin (1971 [as "Plesiadapis sp."]), Gingerich (1976), and Krause and Gingerich (1983), and nothing further can be added with respect to the described dentition.

The referred DP4 (UALVP 24884) differs from the deciduous premolar described for Nannodectes intermedius (Gazin) from Cochrane 2 (see above) in having a larger and more robust crown, less conical cusps, relatively smaller conules, and in possessing a less strongly concave posterior margin.

The presence of P. praecursor at Cochrane 2 represents the same northerly range extension as for Nannodectes intermedius (see above). These temporally restricted taxa are found together at three of six known earliest Tiffanian localities — Keefer Hill, Douglass Quarry, and Cochrane 2 — but are, as yet, represented singly at the Bangtail and Little Muddy Creek localities (by N. intermedius [Gingerich, et al. 1983]) and at the Cub Creek [cc-4, Clark's Fork Basin, Wyoming] locality (by P. praecursor [P. D. Gingerich, pers. comm. 1985]).

Plesiadapis cf. P. anceps Simpson 1936

(Plate 37; fig. E; pl. 38, figs. A—G)

Type of Plesiadapis anceps**:** AMNH 33822, left dentary with i1, m1-m3, associated p4 and maxillae with P4, M1-M2.

Type locality: Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County, Montana.

Known age and distribution for Plesiadapis anceps**:** Early Tiffanian (late Paleocene) of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a; Gingerich 1975, 1976]; Highway Blowout locality, Polecat Bench Formation, Big Horn Basin [Gingerich 1975, 1976]) and Montana (type locality [Simpson 1936; Gingerich 1975, 1976]); middle Tiffanian of Alberta (UADW-2 locality, Paskapoo Formation, Blindman River [R. C. Fox, pers. comm. 1987]).

Referred specimens: UALVP 18361, DP4; UALVP 24905, M1 or M2; UALVP 24901, dp4; UALVP 24902, p4; UALVP 24904. m1; UALVP 24903, m2.

Description: DP4. — UALVP 18361 resembles the M1 of Nannodectes intermedius (UALVP 24880) in size (L=2.6*, W=3.9) and general morphology, but differs in being more anteroposteriorly elongate labially, and more acute lingually. The tooth is missing the anterolabial corner, including all of the paracone, but was no doubt triangular in occlusal outline, possessing anterior and posterior margins that converged lingually to elongate the lingual base of the protocone. The lingual face of the protocone is strongly sloped.

As is characteristic of many deciduous teeth, UALVP 18361 is missing all of the roots and the covering of enamel is thin.

dp4. — UALVP 24901 differs from the deciduous p4's referred to Plesiadapis praecursor and Nannodectes intermedius in having a larger crown (L=2.7, W=2.0), with a relatively lower trigonid, and in bearing a paraconid that is more appressed toward the metaconid, and less anteriorly directed.

p4. — UALVP 24902 is significantly larger (L=2.4, W=2.3) than the p4 of P. praecursor and is virtually identical in size and morphology to the comparable tooth in P. anceps as described by Gingerich (1976).

m1. — UALVP 24904, referred here to Plesiadapis cf. P. anceps, differs from the m1 of P. praecursor from Cochrane 2 in being larger and more inflated in all dental dimensions (L=3.0, W=2.7). In addition, UALVP 24904 bears more wrinkled enamel on the crown and possesses two vertical grooves on the postvallid wall. The most significant differences are in the greater crown height and talonid width of UALVP 24904.

In comparison with the m1 of P. anceps on casts of AMNH 33978 and PU 18738, right and left dentaries from Scarritt Quarry and the Highway Blowout locality, respectively, the Cochrane specimen differs only in possessing a slightly smaller talonid. Comparison of UALVP 24904 with the m1 of P. anceps from the UADW-2 locality of Alberta reveals no significant differences.

m2. — UALVP 24903 preserves only the trigonid of the largest plesiadapid molar so far discovered at Cochrane 2. This tooth differs from the m1 referred to P. praecursor from Cochrane 2 (UALVP 24904) in having the base of the crown more inflated and, thus, being transversely wider (AW=2.7), and in possessing a higher crown. UALVP 24903 differs from the casts of P. anceps from Scarritt Quarry and the Highway Blowout locality, and from the m2 of P. anceps from UADW-2 in a slightly closer positioning of the trigonid cusps with respect to the trigonid basin — thereby reducing the size of the basin and giving the remainder of the trigonid a more inflated appearance. Apart from this, the specimens are virtually identical.

Discussion: The specimens referred here document the presence of a second species of Plesiadapis at the Cochrane 2 locality. Gingerich (1975, 1976) considered P. anceps to be stratigraphically and temporally restricted to localities younger than Keefer Hill and Douglass Quarry (where P. praecursor has been found) and older than Cedar Point Quarry and Battle Mountain, to name but a few (where P. rex is present); he subsequently erected the Ti2 biochronological zone to accommodate the presence of P. anceps at the early Tiffanian Saddle and Scarritt Quarry localities. This interpretation has since become convention (see Krause 1978, 1982; Krause and Gingerich 1983; Winterfeld 1982; Sloan 1987). The contemporaneous occurrence of P. cf. P. anceps with P. praecursor in deposits of earliest Tiffanian age disrupts the biostratigraphic inclusiveness of this scheme and lends additional support to recent opinion based on morphological evidence (see Watters and Krause 1986) suggesting that P. praecursor and P. anceps may not represent an ancestor—descendant pair, but rather, ecologically distinct consanguineous species. The evidence from Cochrane clearly indicates that these species were both temporally and regionally coexistent (at least in the earliest Tiffanian of western Canada).

Family Carpolestidae Simpson 1935

Genus Elphidotarsius Gidley 1923

Elphidotarsius russelli Krause 1978

(Plate 39, figs. A—J; table 25)

Type: UALVP 11742, left p4.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta (type locality and Hand Hills West locality, lower level, Paskapoo Formation, Hand Hills [Fox, in press]) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [D. W. Krause, pers. comm. 1985]).

Original hypodigm (Krause 1978): Type specimen and UALVP 11743, right m2, only. Not including UALVP 11748, a tentatively referred Lm3.

Referred specimens: UALVP 18619, I1; UALVP 18613 and 18617, P3's; UALVP 18614, P4; UALVP 18367 and 24909, p4; UALVP 18616, m1; UALVP 24906, m2.

Revised diagnosis: p4 larger than in any other known species of Elphidotarsius. Apical cusps of p4 aligned in nearly straight anteroposterior row, the third apical cusp (protoconid) being the highest and the metaconid not being offset far lingually as in E. florencae Gidley 1923, nor even slightly lingually as in E. shotgunensis Gazin 1971, and E. wightoni Fox 1984c. Talonid of p4 less distinct than in E. florencae, E. shotgunensis, and E. wightoni. P3 subquadrate, closer in size and shape to P4 than in all other Elphidotarsius, except E. wightoni; P3 differing from E. wightoni in possessing a small posterolabial cusp developed along the postmetacrista, a small incipiently developed hypocone on the postprotocingulum, a relatively much longer and more prominent precingulum, and lacking a discrete cuspule on the postcingulum and a "preprotocrista". P4 differing from E. wightoni in possessing incipiently developed hypocone and pericone, stronger postprotocingulum, longer and sinuous precingulum, and lacking a "preprotocrista". Differs from all species of Carpodaptes Matthew and Granger 1921 in the presence of four apical cusps on p4; in possessing a non-linear arrangement of the trigonid cusps (lingual paraconid) on m1; in having an incipient hypocone and a smaller anterolabial (preparaconal) cusp, better separated from the paracone, on P3; and in bearing four labial ridge cusps, an incipient hypocone and pericone, and lacking a distinct metastylar cusp (developed posterior to the metacone on the postmetacrista) on P4.

Description: I1. — In describing this tooth, I use the occlusal cusp terminology for plesiadapid I1's developed by Gingerich (1976). UALVP 18619 is similar in crown shape to the I1 described and illustrated by Krause (1978, fig. 2F, G) for Carpodaptes cygneus (Russell 1967) from the late Tiffanian Roche Percée local fauna, and exhibits a well-developed (but damaged) anterocone and a larger, but heavily worn, laterocone. Basally, a small, but well-defined, posterocone is present. A posterocrista extends posteromedially from the posterocone to a smaller, incipiently developed, basomesial cusp. This latter cusp is absent from an isolated, uncatalogued, I1 referable to E. wightoni Fox from the UADW-2 locality (Paskapoo Formation, Blindman River) of Alberta (pers. obs.), but is distinctly developed on the I1 questionably referred to Carpodaptes hazelae (UALVP 21003) by Fox (1984c), and on the I1's referred to Carpodaptes cygneus from the Roche

Percée local fauna (Krause 1978; D. W. Krause, pers. comm. 1985) and the Swan Hills locality (Paskapoo Formation) of Alberta (G. J. Stonley, pers. comm. 1985). Prominent mesial and distal cingula border the margins of the crown on UALVP 18619, occlusally.

P3. — UALVP 18613 is roughly subquadrate but more triangular (like P4) in occlusal outline than is the P3 of E. wightoni (Fox 1984c). The crown of the tooth is slightly longer labially than lingually and wider posteriorly than anteriorly. Four labial cusps are developed. Of these cusps a large paracone is closely appressed with a smaller metacone, and an even smaller, lower, preparaconal cusp is developed anterior to the paracone. The fourth labial cusp is a tiny posterolabial (metastylar) cusp developed posterior to the metacone along the postmetacrista. The preparaconal cusp is separated from the paracone (and labial ridge) by a prominent notch on UALVP 18613; a narrow ridge connects the two cusps on UALVP 18617. The ectocingulum is weakly developed and extends to the terminal cusps of the labial row. The labial cusps all show considerable apical wear on UALVP 18613 and 18617. A large median cusp is developed lingually between the preparaconal cusp and the paracone. A long lingually convex median crest descends posteriorly from the apex of the median cusp. The median cusp is not joined with the anterolabial (preparaconal) cusp by crest development. The median crest is not cuspidate but bears a small cuspule posterior to the median cusp. The protocone is slightly smaller than the median cusp and is joined to it, basally, by a narrow, weakly developed crest (postprotocrista?). This crest separates the lingual basin into anterior (trigon) and posterior (talon) sections. The protoconal (talon) basin is wide and relatively deep, and is bordered posteriorly by a short postprotocingulum and a long postcingulum. The postprotocingulum extends to a small, incipiently developed, hypocone. This cusp is obscured to a great degree by a chipping of the enamel, but is distinguishable, internally, as a slight swelling of the basin wall. The postcingulum is sinuous, becoming convex and then concave, posteriorly, and terminating at the posterolingual base of the median crest. The postcingulum lacks cuspule development. The precingulum is similarly sinusoidal, but extends further labially than the postcingulum to the anterolabial (preparaconal) cusp. The trigon basin is smaller and is shallower than the talon basin. No other cusps or crests are developed.

P4. — UALVP 18614 is roughly triangular in occlusal outline. The anterior side of the crown is longer than the posterior side and the lingual corners are smoothly rounded. Four cusps are developed on a prominent labial ridge. The paracone is centrally located and (although its apex is missing) was the largest and highest labial cusp. The metacone is second in size and height, followed by the preparaconal cusp. The fourth labial cusp (parastyle) is the smallest and lowest of the crown and is situated anterior to the preparaconal cusp. The ectocingulum is narrow but well-defined and spans the entire basolabial length of the crown, from the parastylar cusp to the metastylar region. The ectocingulum joins sharply with the postmetacrista, but no distinct metastylar cusp is developed. The median crest extends anteriorly and posteriorly to the parastylar and metastylar regions, respectively, from a tall, centrally positioned median cusp. The base of this cusp is broad and encompasses the central region of the crown. The median ridge is not excessively cuspidate, but bears a small anterior cuspule. The protocone is subequal with the median crest and their bases are joined by a poorly developed crest (postprotocrista?). The protocone, median cusp, and paracone are aligned directly along the midwidth of the crown. A short postprotocingulum extends from the apex of the protocone to a damaged section of the postcingulum, which may have possessed an incipient hypocone, owing to a minute inflation of the lingual wall. (This region of the crown is preserved on the P4 of UM 83940, a maxillary fragment of E. russelli from the Douglass Quarry of Montana and clearly displays an incipient hypocone [D. W. Krause, pers. comm. 1985].) The pericone and hypocone are defined lingually by slight grooves in the enamel on the lingual slope of the protocone. Anteriorly, the precingulum descends from the side of the protocone and forms a sharp angle, where an incipient pericone is developed as a slight swelling of this crest. The precingulum is higher than the postcingulum, but both crests are subequal in length and strongly sinusoidal (more so than on P3). There is no development of a "preprotocrista".

p4. — The p4 of *E. russelli* has been described in detail by Krause (1978).

m1. — UALVP 18616 is strongly exodaenodont and equal in length and width (L=1.4, AW=1.4, PW=1.4). The arrangement of the trigonid cusps is similar to that on m1 of *Elphidotarsius florencae*, *E.* sp. cf. *E. florencae* Rose 1975, *E. shotgunensis* and *E. wightoni*. The paraconid is the smallest trigonid cusp and is positioned lingually on the trigonid, but slightly more medial than the metaconid. The metaconid is posteriorly positioned on UALVP 18616, resulting in a more open trigonid. A well-defined paracristid is present. The pre- and postcingulids are poorly developed. UALVP 18616 is larger than m1's of the aforementioned species of *Elphidotarsius* and approaches the m1 of *Carpodaptes hazelae* Simpson 1936 in size. UALVP 18616 differs from m1, *C. hazelae*, in being lower-crowned and in possessing a V-shaped, rather than a more linear, arrangement of the trigonid cusps.

m2. — This tooth has been adequately described by Krause (1978). The subequal size and height of the paraconid and metaconid on UALVP 11743 (Krause 1978) is not observed on UALVP 24906 or UM 83943 (an m2 of *E. russelli* from the Douglass Quarry of Montana) and appears to be an individual variant. The structure of the trigonid cusps in these latter two specimens is similar to that in other *Elphidotarsius* and in *Carpodaptes hazelae*, with the metaconid larger and taller than the paraconid.

Discussion: The new dental sample of *E. russelli* from Cochrane 2 provides information for four previously unknown tooth positions (m1, I1, P3, and P4), as well as increasing the sample size of p4 for this species.

As previously noted by Krause (1978) and Fox (1984c), the p4 of *E. russelli* (as demonstrated by the type specimen) is more derived than in any other species of *Elphidotarsius*. The two additional p4's (UALVP 18367 and 24909) collected from

Cochrane are virtually identical in size and structure to the holotype, revealing less variability than would be expected for this tooth position (see Rose 1975).

The m1 of E. russelli (UALVP 18616) is larger than in any other Elphidotarsius, possesses a better developed paracristid with respect to E. florencae, E. cf. E. florencae, and E. shotgunensis, and further differs from m1, E. shotgunensis, in possessing more compressed and trenchant trigonid cusps and a more anteroposteriorly compressed talonid.

I1 of E. russelli (UALVP 18619) is intermediate in morphology between the possible I1's of E. wightoni (pers. obs.) and that of Carpodaptes hazelae (Fox 1984c) in possessing an incipient basomesial cusp on the crown. The I1 of E. russelli is also known from a badly fractured specimen, UM 83941, from the Douglass Quarry of Montana (D. W. Krause, pers. comm. 1985) and by an isolated, uncatalogued, I1 from the Hand Hills West locality, lower level, of Alberta (Fox, in press). Both specimens are virtually identical to UALVP 18616 (pers. obs.).

P3 in E. russelli is more derived than in all other known Elphidotarsius, including E. wightoni. Characters that are derived with respect to P3, E. wightoni, include 1) the presence of four labial ridge cusps in E. russelli (the labial ridge of P3, E. wightoni bears only three cusps, with no cusp development on the postmetacrista); 2) a distinct separation of the large medial cusp from the anteriolabial preparaconal cusp (the medial cusp is joined to the preparaconal cusp by a crest in E. wightoni); 3) the possession of a better developed hypocone (E. wightoni has a nannopithex fold but no hypocone); 4) the presence of a long, sinuous (S-shaped), precingulum and the absence of a "preprotocrista" (E. wightoni either lacks a precingulum [UALVP 21002] or has only a short precingulum [UALVP 21007] and bears a prominent "preprotocrista"); and 5) the absence of a distinct cuspule developed on the medially indented portion of the postcingulum (E. wightoni bears a discrete cuspule on the postcingulum).

Like E. wightoni, P4 of E. russelli has a labial ridge with four prominent cusps and a cresentic median ridge with a large central cusp and a more anterior cuspule. The relative size and overall shapes of the occlusal profiles are also similar. E. russelli differs from E. wightoni in the absence of a "preprotocrista", in the presence of a long S-shaped precingulum, and in the greater development of a hypocone and pericone, all of which appear to be more derived carpolestid character states (Fox 1984c).

According to Krause (1978) (and reiterated by Fox [1984c]), C. hazelae appears to be the most primitive known species of Carpodaptes. The P3 of E. russelli is exceedingly similar to P3 of C. hazelae. As in Carpodaptes, P3 has a squared occlusal outline and is approximately equal in size to P4. In C. hazelae, P3 is slightly larger than in E. russelli but is morphologically very similar. The labial ridge of P3 of both species bears four cusps, and the most anterior cusp is separate from the posterior three cusps. Both possess a cresentic median ridge, terminating anteriorly in a single large cusp, and both have two lingual cusps — a protocone and hypocone. The hypocone is better developed in C. hazelae than in E. russelli. Finally, the pre- and postcingula are prominent and strongly sinuous in both taxa.

A second isolated, but fragmentary, P3 of E. russelli (uncatalogued and virtually identical in preserved morphology to UALVP 18613) is known from the Hand Hills West locality, lower level, of Alberta (Fox, in press).

The P4 of Carpodaptes is characterized by the presence of five to six labial cusps (Rose 1975). In comparison, the P4 of E. russelli possesses only four labial ridge cusps, as in E. cf. E. florencae (Rose 1975) and E. wightoni (Fox 1984c) (the cusp number on P4 of E. florencae and E. shotgunensis is unknown). The arrangement of the labial ridge cusps on P4, E. russelli, is virtually identical to the condition in C. hazelae. The pericone and hypocone are inflated and well developed on P4, C. hazelae, with an intermediate condition (between E. russelli and C. hazelae) present on a specimen (UALVP 18615) from Cochrane 2 referred to C. cf. C. hazelae (see below).

The larger sample described here confirms Krause's (1978) suggestion that E. russelli is more Carpodaptes-like than any other species of Elphidotarsius, and similarly confirms Fox's (1984c) conclusion that p4 of E. russelli is more derived than that of E. wightoni and that, in general, E. russelli is more Carpodaptes-like than the stratigraphically younger E. wightoni.

Krause (1978) tentatively referred an isolated and heavily abraded m3 (UALVP 11748) to E. russelli. The tooth is removed from the hypodigm based upon its large size and structural differences from the m3's of E. russelli and other carpolestids. This specimen may, instead, be referable to Palaechthon sp. from Cochrane (see above).

The m3 tooth position of E. russelli is known by isolated specimens from the Hand Hills West locality, lower level, of Alberta (Fox, in press) and from Douglass Quarry of Montana (by UM 83944 [D. W. Krause, pers. comm. 1985]). The upper molars of E. russelli are represented on UM 83940 and by UM 83947, also from Douglass Quarry. All of these tooth positions will be described elsewhere (Krause, et al., MS).

Gazin (1971), in his description of the primates from the Keefer Hill locality ("Shotgun local fauna"), Wyoming, questionably referred an upper premolar (MCZ 18774), which he identified as P4, to E. shotgunensis. Rose (1975) argued that the tooth was a water-worn premolar of Carpodaptes, referable to the species described by Gazin (1971) from the same locality. At the time of Rose's analysis, upper premolars of Elphidotarsius were known only for E. cf. E. florencae. Comparisons of MCZ 18774 with the sample of upper premolars now known for E. wightoni and E. russelli support Gazin's referral of the tooth to E. shotgunensis (D. W. Krause, pers. comm. 1985), although MCZ 18774 is most probably a right P3, and not a P4 as suggested by Gazin (1971).

MCZ 18774 is transversely (labiolingually) narrower than UALVP 18613, but is otherwise nearly identical, differing in virtually the same characters from P3, E. wightoni, as does E. russelli. The morphology of the Keefer Hill specimen will be described and discussed in detail elsewhere (Krause, et al., MS).

The P3 of E. shotgunensis clearly reveals closest affinity to E. russelli and the comparable dentition (sparse as it is) differentiates E. russelli from E. shotgunensis in its slightly larger size and in the more derived morphology of p4 (Krause 1978; Fox 1984c; D. W. Krause, pers. comm. 1986).

Close comparison of the dental samples of E. russelli from the Cochrane 2 and Douglass Quarry localities reveals certain differences. The p4's from Cochrane (N=3) are slightly smaller and lower-crowned in comparison with UM 83942, a single p4 from Douglass Quarry. Similarly, an m2 from Douglass Quarry (UM 83943) is anteroposteriorly longer and higher-crowned than the Cochrane specimens (UALVP 11743 and 24906). On the best preserved P4 from Douglass Quarry (on UM 83940) the stylar regions appear better defined than on UALVP 18614, and there is the incipient development of a fifth labial ridge cusp on the postmetacrista.

Although the sample sizes from both localities is still small, these (more Carpodaptes-like) differences in p4, m2 size and P4 development can be interpreted as derived (with respect to the Cochrane 2 specimens) and, therefore, suggestive of a slightly younger age for the Douglass Quarry fauna.

Genus Carpodaptes Matthew and Granger 1921

Carpodaptes cf. C. hazelae Simpson 1936

(Plate 40, figs. A—E)

Type of Carpodaptes hazelae: AMNH 33854, right dentary fragment with p4-m3.

Type locality: Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County, Montana.

Known age and distribution for Carpodaptes hazelae: Earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [Gazin 1971]); early Tiffanian of Montana (type locality [Simpson 1936; Rose 1975]); middle Tiffanian of Wyoming (Cedar Point Quarry, Polecat Bench Formation, Bighorn Basin, Bighorn County [Rose 1975, 1981]) and Alberta (Localities UADW-1, UADW-2, UADW-3, and Mel's Place, Paskapoo Formation, Blindman River [Fox 1984c; Fox, in press]; Joffre Bridge Road Cut locality, lower level, Paskapoo Formation, Red Deer River [Fox, in press]; Hand Hills West locality, upper level, Paskapoo Formation, Hand Hills [Fox, in press]).

Referred specimens: UALVP 18618, P4; UALVP 18615, M1; UALVP 24915, p4; UALVP 24913 and 24914, m2's.

Description: P4. — UALVP 18618 is subquadrate, but is also roughly triangular (and slightly T-shaped) in occlusal outline. This specimen is slightly larger (L=1.9, W=2.3) than P4, E. russelli, with the posterior side of the crown only slightly longer than the anterior side. The labial ridge bears five well developed cusps. The paracone is closer in size to the metacone and preparaconal cusp than in E. russelli. A prominent, but low, parastylar cusp is developed anterior to the preparaconal cusp. The most posterior (fifth) labial cusp of the ridge is small, but distinct, and is developed on the postmetacrista. A distinct metastyle is absent. The three most posterior labial cusps (paracone, metacone, and postmetaconal cusp) are more closely appressed to each other than are the first two (parastyle and preparaconal cusp). The central median cusp is subequal in size and height with the protocone. The median ridge is incipiently cuspidate and bears a distinct cuspule (paraconule?) on the anterior segment. A small but distinct pericone and hypocone are developed. These cusps are subequal in size and height and much lower than the protocone. The pre- and postcingula are moderately sinusoidal and similar in length and height.

M1. — UALVP 18615 is virtually identical in size (L=1.4, W=2.1) and morphology to the M1's of Carpodaptes hazelae from the type locality (Scarritt Quarry) of Montana (pers. obs.). The M1 of C. hazelae has been adequately described by Simpson (1937a). In comparison with the M1 of E. russelli from Douglass Quarry (preserved on UM 83940), this specimen is larger and bears a more prominent hypocone and postprotocingulum (nannopithex fold).

p4. — UALVP 24915 consists of the talonid and only the most posterior portion of the root of this tooth. The talonid cusp is relatively more reduced and the width of the talonid and the posterior root are greater (PW=1.6) than in E. russelli.

m2. — UALVP 24913 (L=1.4, AW=1.5, PW=1.6) and 24914 (L=1.6, W=1.6) are proportionately larger, transversely much wider, and relatively more anteroposteriorly compressed than the m2's referred to E. russelli. These specimens also bear well developed ectocingulids (especially UALVP 24913).

Discussion: The enlarged upper fourth premolar is generally regarded as one of the most diagnostic tooth positions in carpolestids (Rose 1975; Fox 1984c). UALVP 18618 differs from the P4's of the type material of C. hazelae from the early Tiffanian Scarritt Quarry, in 1) having a more triangular shape, with a greater relative disparity between the labial (long) and lingual (much shorter) lengths of the crown; 2) lacking the development of a distinct metastylar cusp adjacent to the postmetaconal cusp on the labial ridge; 3) possessing a relatively smaller and lower pericone and hypocone; and 4) in being much less inflated lingually. In addition, UALVP 18618 appears to be more subequal in size with the M1 (UALVP 18615) referred to this taxon. In these features UALVP 18618 is similar to the P4 of E. russelli, and is, thus, more primitive than P4 in of C. hazelae.

Gazin (1971) described two taxa of carpolestids, Elphidotarsius shotgunensis and Carpodaptes sp. (Carpodaptes cf. C. hazelae of Rose [1975: p. 9]), from the earliest Tiffanian Keefer Hill locality ("Shotgun local fauna") of Wyoming. The latter species is primitive in morphology, but, otherwise, exceedingly similar to C. hazelae from Scarrit Quarry (as noted in Rose 1975). The P4 in the Cochrane taxon is similarly plesiomorphic in comparison with the Scarritt material. Although there are no adequately comparable dental elements from the Cochrane 2 and Keefer Hill samples (pers. obs.), the P3 (MCZ 18774) that Gazin (1971) referred to Carpodaptes appears to possess similar plesiomorphic traits to that demonstrated by UALVP 18618, including small size and, generally, more triangular occlusal outline.

The association of Carpodaptes with Elphidotarsius at Cochrane 2 and at Keefer Hill (Gazin 1971) occurs elsewhere only in the middle Tiffanian of Alberta (Fox 1984c; Fox, in press). The coexistence of these two genera in earliest and middle Tiffanian deposits provides support for Fox's (1984c) falsification of Rose's (1977) theory of stratigraphic succession in carpolestids and suggests a more complex phylogenetic history for the Carpolestidae.

Family Picrodontidae Simpson 1937

Genus Picrodus Douglass 1908

Picrodus silberlingi Douglass 1908

(Plate 41, figs. A—D; table 26)

Type: CM 1670, right dentary fragment with p4-m1; CM 1675, left dentary fragment with m2 and talonid of m1.

Type locality: Silberling Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality and Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County [Douglass 1908; Simpson 1937]) and Wyoming (Rock Bench Quarry, Fort Union Formation, Polecat Bench [Rose 1981a]; Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Szalay 1968a; Rigby 1980]; Locality V-82004, Polecat Bench Formation, southern Bighorn Basin [Hartman 1986]); earliest Tiffanian (late Paleocene) of Alberta (Cochrane 2 locality, Porcupine Hills Formation [Krause 1978]), Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [D. W. Krause, pers. comm. 1986]; Bangtail locality, Fort Union Formation, western Crazy Mountain Basin, Park County [Gingerich, et al. 1983]) and Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [McGrew and Patterson 1962; Szalay 1968a]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [McGrew and Patterson 1962; Szalay 1968a]) and Alberta (Hand Hills West locality, lower level, Paskapoo Formation, Hand Hills [Fox, in press]); middle Tiffanian of Wyoming (Cedar Point Quarry, Polecat Bench Formation, Bighorn Basin, Bighorn County [Rose 1981a]).

Referred specimens: UALVP 24918, maxillary fragment with P4-M1 and alveoli for M2; UALVP 11753, P4; UALVP 11740 and 24917, M1's; UALVP 24916 and 24922, M3's; UALVP 24921, m1; UALVP 11741, m2 [not m3, as published in Krause 1978]; UALVP 24919, m3.

Description: Except for the upper fourth premolar and upper third molar (contra Krause [1978] and Gingerich, Houde and Krause [1983]), the dentition of Picrodus silberlingi has been adequately described by Simpson (1937), Szalay (1968a), and Gingerich, et al. (1983). In light of new information from recent collections at the Cochrane 2 locality, these teeth are described here in detail.

P4. — This tooth was initially described from UALVP 11753, a specimen from Cochrane 2 that Krause (1978) considered to be a possible M3 of P. silberlingi. The collection of UALVP 24918, a maxillary fragment preserving P4 in articulation with M1, confirms the identity of UALVP 11753 as a terminal premolar and provides evidence for a radical reinterpretation of the cusp homologies of this tooth.

In Krause's (1978) description of UALVP 11753, he considered the smaller cusp, adjacent to the large conical paracone, to be a metacone, and, therefore, assumed the margin nearest these cusps to represent the labial side of the crown.

UALVP 24918 reveals the P4 of P. silberlingi to be oriented much differently in the maxilla. The side considered to be labial by Krause (on UALVP 11753) is actually anterior, with the small conical cusp being the protocone, not the metacone. Consequently, the possible right M3 (UALVP 11753) of Krause (1978) is a three-rooted, premolariform, left P4. These cusp homologies are in complete conformity with the structure of M1 and are appropriate for occlusion with p4. Although Krause (1978) did not acknowledge it, a linear crest extends posteriorly from the apex of the paracone to the posterolabial corner of the crown on UALVP 11753. On UALVP 24918, the maxillary fragment containing P4-M1, this crest appears to be homologous to the centrocrista of the molars. A distinct metacone is clearly absent on UALVP 11753 and on the P4 of UALVP 24918. The entire posterolabial corner of the crown on these P4's is greatly expanded, and on UALVP 24918 this region abuts against the anterobasal margin of the M1. The crown of M1 on this specimen overlaps a substantial portion of the posterior margin on P4 (a small interdental facet on the posterior margin of UALVP 11753 confirms a similar contact). This overlap results in a slight elevation of the anterior side of the tooth (and its cusps) over the posterior side of the crown. The anterior side of P4 is smooth: no crests or cingula are developed there. The posterior half of P4 lacks cusps, is low-crowned, and is bordered by a broad, low crest (postprotocingulum?) extending from the apex of the protocone to the posterolabial corner of the crown. The basin is shallow and faintly papillate.

During occlusion, the protocone on P4 appears to have contacted the shallow talonid basin of p4, while the expanded trigon basin made contact with the paraconid of m1.

M3. — In occlusal outline, UALVP 24916 (the undamaged specimen) is shaped like a quadrilateral polygon with four unequal sides. The anterior border is longer than the posterior and the labial margin is obliquely oriented with respect to a longer lingual margin. The paracone is higher and less crestiform than the metacone, and both cusps are joined at their apices by a long centrocrista, which gently bends lingually and then posteriorly as a long postparacrista and a shorter premetacrista, respectively. The ectocingulum is well developed along that portion of the labial margin anterior to the metacone. A small labial projection of the ectocingulum is developed at the paracone (as on M2 of this species). A second, shorter, cingulum (preparaconule crista? or paracingulum?) is developed anterior to the paracone, and is continuous with the labial cingulum, disappearing lingually half-way down the anterior border of the tooth. A short, but distinct, preparacrista is present, separating the labial and anterior cingula. Another weaker crest (postparaconule crista?) extends lingually from the paracone to the lingual end of the anterior cingulum. The protocone is positioned almost directly lingual to the paracone and is subequal to it. The trigon basin is wide and deep, with papillated enamel on its surface. There are no pre- or postcingula.

All other features are similar to that seen on M3, Zanycteris paleocena Matthew 1917.

Discussion: Krause (1978), in his description of the primates from the Cochrane 2 locality, tentatively identified UALVP 11753 as the M3 of Picrodus silberlingi, based upon its superficial resemblance to M3, of the late Tiffanian picrodontid, Zanycteris paleocena. This identification was later corroborated by Gingerich, et al. (1983) by the referral to P. silberlingi of a similar specimen (USNM 309870) from the earliest Tiffanian Bangtail locality of Montana. Gingerich, et al. described the tooth as being "...about the same size and shape as M3 in Zanycteris paleocena ... [but differing] ... in having a sharper paracone and more reduced metacone, and in lacking a labial cingulum" (1983: p. 966).

The collection of UALVP 24916 and 24922 from Cochrane 2 during this study, and their noticeably greater resemblance to the M3 of Zanycteris paleocena and M2, P. silberlingi, than any of these to UALVP 11753 (the tooth tentatively referred as M3 by Krause [1978]), cast doubt upon the identification of this latter specimen (and the Bangtail tooth) as M3. The pointed conical cusps of UALVP 11753, along with its attenuated lingual construction and lack of protocone, crest and cingula development, made it highly probable that this specimen, instead, represented the right upper fourth premolar of P. silberlingi. To further support this interpretation, I noted that the root orientation of

UALVP 11753 resembles the three-rooted alveoli pattern of the P4 tooth position in UW 1780, a left maxilla from the Bison Basin Saddle locality (illustrated in Szalay and Delson 1979, fig. 29).

The subsequent collection in 1987 of an articulated P4 and M1 of P. silberlingi (UALVP 24918) provides indisputable evidence for the above interpretation and supports UALVP 24916 and 24922 as the first recognized M3's of P. silberlingi. The occlusal relationship between these specimens and UALVP 24919, the referred left m3, also supports this view.

The discovery of UALVP 24918 confirmed the identity of UALVP 11753 (and probably USNM 309870) as a P4, but, suprisingly, also indicates that the tooth represents a left, rather than a right, tooth, and that the cusps of the crown consist of a large paracone and a smaller protocone, with the centrocrista reduced and the metacone absent (see description above) — a structure that is occlusally correspondent with the premolariform p4 and high m1 trigonid of P. silberlingi.

UALVP 24918 provides the first documented occurrence of the P4 tooth position in articulation for P. silberlingi and for picrodontids, in general.

The referred M3's from Cochrane (UALVP 24916 and 24922) are less quadrate in occlusal outline than the M2 of P. silberlingi and are similar in shape, but much larger, than the comparable teeth in Zanycteris. UALVP 24916 and 24922 further differ from M3, Zanycteris paleocena (on the type specimen, AMNH 17180), in 1) possessing a labially protruding (salient) ectocingulum at the paracone (as on M2, P. silberlingi); 2) bearing a distinct preparacrista and anterior cingulum (paracingulum?); 3) possessing a more reduced metacone; and 4) bearing sharper (less rounded), right-angled corners, lingually, on the crown.

Order ?Rodentia Bowdich 1821

Family ?Mimotonidae Li 1977

Unidentified gen. and sp.

(Plate 41, figs. E—G)

Referred specimen: UALVP 25127, m1 or m2.

Description: UALVP 25127 is quadrate in occlusal outline (L=2.0, AW=1.9, PW=2.0), relatively high-crowned, and bears a slight amount of anterior and posterolabial crushing. Strong apical wear is distributed evenly over the cusps and crests of the entire crown. The lingual side of the tooth is longer than the labial side, and the posterior margin of the crown is virtually straight, transversely. The trigonid is strongly transverse, and roughly triangular in occlusal outline. Structural features of the trigonid are obliterated by the apical wear, which has created a broad, flat occlusal surface. The talonid is equally as transverse as the trigonid, but much shorter anteroposteriorly. Three talonid cusps are arranged linearly on the posterior margin. The hypoconid is crushed but appears to have been larger than the entoconid, which in turn is larger than the hypoconulid. The hypoconulid is situated closer to the entoconid than to the hypoconid. All three talonid cusps are interconnected by high transverse crests. The talonid is divided, internally, by a short, but prominent, central crest (cristid obliqua?) extending from the hypoconid and hypoconulid to the middle of the postvallid (just labial to its center). The hypoflexid is exceedingly narrow and constricted, forming a slit-like gap between the hypconid and the protoconid (labial corner of the trigonid). The talonid basin is restricted to a shallow depression on the lingual side of the talonid. The talonid is narrowly open lingually, and the basin is bordered by the metaconid, the central crest, and the entoconid. The entoconid is discrete and inflated at its base, setting it apart from the hypoconulid. There is no sign of pre- or postcingulid development. The roots of UALVP 25127 are relatively stout, and a fragment of the dentary is preserved on the lingual side of the tooth. The dentary bone is relatively thick and increases in thickness near the base of the posterior root.

Discussion: UALVP 25127 is morphologically unlike the lower molar of any recognized eutherian mammal of the North American Paleocene, but is similar in several respects to the lower molars of the earliest Asian eurymyloids (Butler 1985). Of these UALVP 25127 shows greatest resemblance ~~to~~ m1 and m2 of the mimotonid Mimotona wana Li 1977 from the late Paleocene (Dou-mu Formation), Anhui, Eastern China (Li and Ting 1985). UALVP 25127 shares with m1 and m2, M. wana, a prominent trigonid, clearly differentiated from the talonid and a strong connection of the protoconid and metaconid. In addition, the talonid of these teeth display a large, tall hypoconid and the development of a strong oblique crest joining the hypoconid with the middle of the trigonid (postvallid) wall. The talonid basin is similarly small and lingually situated in these teeth. The Cochrane 2 molar and the lower molars of M. wana also possess a large hypoconulid, which is confluent with a high transverse crest joining the hypoconid to the entoconid.

Unlike the lower molars of M. wana and other eurymyloids, UALVP 25127 has the trigonid occupying over half of the crown area (see Li and Ting 1985, fig. 8; Bulter 1985).

Until a gliriform incisor possessing the morphological features characteristic of eurymyloids (or diagnostic of the Rodentia or Lagomorpha) is found from Cochrane 2, the resemblance of UALVP 25127 to eurymyloid lower molars can only be interpreted as suggestive of special relationship, and certainly inconclusive as to propinquity. A thorough study of the enamel ultrastructure of UALVP 25127 in comparison with the teeth in early rodents and lagomorphs may also prove to elucidate the relationships of this anomalous tooth.

Order Creodonta Cope 1875

Unidentified. gen. and sp.

(Plate 42, figs. A—D)

Referred specimen: UALVP 24974, P3.

Description: UALVP 24974 is T-shaped in occlusal outline and appears to be a large, highly carnassiform P3 (L=5.4, W=4.9). The parastylar lobe, metastylar blade, and protoconal lobe form the T-shape of the crown, radiating out from a large, centrally located paracone. The paracone is highly sectorial and strongly curved posteriorly, with a sharp, high apex (crown height=5.0) that is further canted posterolabially. The paracone is three-sided, not conical: the anterior side is transversely flat, forming a broad shearing surface, that extends far lingually, almost to the protocone. The posterolingual side is concave, from base to apex. The labial side is slightly convex anterolabially and slightly concave, posterolabially, at the metastylar blade. The parastylar lobe extends anterolingually, terminating at a small "hook"-shaped parastyle. A short labial cingulum extends from the apex of the parastyle to the anterolabial corner of the paracone. A similarly short, but faint, preparacrista extends across the center of the parastylar lobe and up the lower parts of the anterior surface of the paracone. The preparacrista, short of contacting the parastyle, terminates near the center of the parastylar lobe. The postparacrista is wide and long, descending almost vertically to a pit-like remnant of a carnassial notch, and forming a long curving trenchant crest with the metastylar blade. The postparacrista is longer than the metastylar blade. The crests, from the apex of the parcone and postparacrista to the metastylar blade and metastyle, are heavy worn. The ectocingulum extends from the metastyle to a point on the base of the paracone, directly below the paracone apex. A deep ectoflexus, separating the anterior and posterior segments of the labial cingulum, is developed at this point. A prominent postcingulum extends almost in a straight line from the metastyle to the posterior side of the protocone; it disappears in ascending the protocone, well before reaching the apex. The postcingulum shows heavy wear from the metastyle to anterolabial to the protocone. The protocone leans posterolabially; it is only one-fourth the height of the paracone, but is larger than either the parastyle or metastyle. A short precingulum runs from the apex of the protocone to the anterolingual corner of the paracone; this crest is considerably higher than the postcingulum. A short but prominent medial crest connects the apex of the protocone to the base of the paracone. A second segment of the precingulum appears to have extended from the apex of the parastyle to the anterior wall of the paracone, however, most of this cingulum is obliterated by a deep wear facet on the lingual margin of the parastylar lobe.

The majority of the precingulum between the parastyle and paracone is removed by this facet (see Van Valen 1966 for description of similar wear pattern on P4 of Dipsalodon). This wear pattern suggests contact with a sharp blade-like, transversely wide, protoconid on p3. The enlarged metastylar blade on UALVP 24974 suggests that p4 had a relatively well-developed paraconid and paracristid (prevallid). In addition, UALVP 24974 has a broad vertical shear facet with obliquely oriented striations on a flat anterior surface of the paracone, presumably formed by occlusion with p3.

The roots on UALVP 24974 are long and stout. The anterior root is anteroposteriorly elongate and arises directly below the parastylar lobe. The posterior root appears to be anterolingually—posterolabially elongate, in conformation with the metastylar blade. In contrast, the lingual root is transversely elongate, as is the protoconal lobe. All three roots appear to meet beneath the paracone at the center of the crown.

Discussion: Lillegraven (1969) considered the Late Cretaceous palaeoryctid Cimolestes magnus Clemens and Russell 1965 to be the most probable ancestor for the

Creodonta (Hyaenodontidae and Oxyaenidae). The complete crown for P3 of C. magnus is unknown (Lillegraven 1969; pers. obs.). Therefore, comparison was made with P3 in the related form Cimolestes cerberoides (Lillegraven 1969). In occlusal outline and general morphology, UALVP 24974 closely resembles the P3 of C. cerberoides and differs from it in the following:

1. UALVP 24974 possesses a larger and lingually broader paracone with three sides — having a flat anterior surface (wall) and a concave posterolingual surface.
2. The paracone on UALVP 24974 curves posteriorly to a greater degree.
3. A prominent shear facet is present on the anterior face of the paracone of UALVP 24974.
4. UALVP 24974 possesses a better developed metastylar blade with a prominent metastylar lobe.
5. It has the metastylar region elevated relative to the parastylar region, and the metastylar blade is more labially oriented and inflated, resulting in a deeper ectoflexus.
6. UALVP 24974 possesses a better developed and less curved (concave) posterior cingulum, with a more nearly straight extent between the protocone and metastyle.
7. The precingulum much higher than the postcingulum on UALVP 24974.

In comparison with P4, C. magnus, the P3 from Cochrane 2 is similar in length and in the sizes of the cusps and crests. The morphology of the paracone differs only in being flat anteriorly and in having a more concave posterolingual surface (enhancing the shearing crest). The metastylar blade on the P3 also differs in being more labially extensive.

After comparison with known therian P3's, I find UALVP 24974 to be a large Cimolestes-like P3, structually similar to the sectorial P4 in C. magnus UALVP 24974 is, however, larger and more carnassiform than P3 in any known form of Cimolestes.

In comparison with the P4 in the most primitive, described, oxyaenid — Tytthaena parrisi Gingerich 1980, from the middle Tiffanian Cedar Point Quarry of Wyoming — UALVP 24974 reveals certain structural similarities. The P3 resembles P4 of T. parrisi (PU 21454) in the orientation of the metastylar blade and protoconal lobe with respect to the paracone and parastylar lobe; in the straight and prominent postcingulum; in the low, basal position of the postcingulum on the crown; in the elevation of the metastyle and metastylar blade with respect to the parastyle; and in the weak development of the preparacrista. UALVP 24974 differs in being much smaller.

A key character distinguishing oxyaenid creodonts from primitive hyaenodontids is the better developed metastylar blade on P4 of the former (Van Valen 1966, p. 76). A well developed metastylar blade should also be expected on P3, for the P3's in early oxyaenids such as Oxyaena Cope 1874, Dipsalidictides Denison 1938, and Palaeonictis Blainville 1842 all possess a carnassiform shearing structure (Denison 1938). In contrast, P3 in primitive hyaenodontid creodonts, such as Arfia ("Sinopa") Van Valen 1965 and Prolimnocyon Matthew 1915a, has little or no metastylar blade development (Denison 1938).

According to Gingerich, P3 in Tytthaena parrisi "...was three rooted and similar to P4 in conformation but somewhat smaller" (1980, p. 573). Such a description could be easily applied to UALVP 24974 which (although primitive) is structurally not unlike P4, T. parrisi. Therefore, UALVP 24974 is identified as the P3 of an oxyaenid creodont on the basis of the following features:

1. Its advanced carnassiform morphology (including wear patterns) — hyaenodontids have a primitive non-sectorial P3 morphology in the early Wasatchian (Denison 1938).

2. In the close structural resemblance to the P4 and expected shape for P3 in Tytthaena parrisi, the previously oldest known oxyaenid.
3. In the lack of reduction of the protocone and protoconal lobe — the most primitive hyaenodontids lack a protocone on P3 (see Denison 1938).
4. In its large size relative to the known carnivorous mammals of the day.

The presence of an oxyaenid from the earliest Tiffanian Douglass Quarry of Montana (pers. obs.), considered by D. W. Krause to represent a new genus and species (pers. comm. 1987), lends further evidence to the above interpretation. This identification indicates the distinctiveness of [illegible] from, at least, the latest Torrejonian land-mammal age. Whether or not UALV[illegible] referable to the same new genus and species of oxyaenid found at Douglass Quarry must await the collection of additional material from both localities.

Order Carnivora Bowdich 1821

Family Viverravidae Wortman and Matthew 1899

Pristinictis n. gen.

Etymology: Pristinus, L. original, primitive, and iktis, Gr., martin or weasel (a common suffix for viverravid genera), in reference to the primitive, Cimolestes-like; upper molar morphology in this genus.

Type: Pristinictis connatus n. sp.

Included species: "Protictis" agastor Gingerich and Winkler 1985; "Protictis" dellensis Gingerich and Winkler 1985.

Age and distribution: Earliest Tiffanian to latest Tiffanian (late Paleocene) of western North America including Cochrane 2 locality, Porcupine Hills Formation, Alberta; Douglass Quarry, Melville Formation, Montana; Cedar Point Quarry, Fort Union Formation, Wyoming; Roche Percée local fauna, Ravenscrag Formation, Saskatchewan; Dell Creek Quarry, Hoback Formation, Wyoming; Divide Quarry, Polecat Bench Formation, Wyoming; Princeton Quarry, Fort Union Formation, Wyoming; Fossil Hollow, Polecat Bench Formation, Wyoming.

Diagnosis: Differs from all other viverravid genera in having transverse upper molars with paracone and metacone joined at their bases; reduced metastylar lobe; shallow ectoflexus; prominent stylocone, postprotocrista, and metaconule; and an unreduced premetaconule crista. Further differs in having the talonid on m2 equal in length to the trigonid.

Discussion: Pristinictis is distinctive in comparison with Protictis Matthew 1937, Simpsonictis MacIntyre 1962, Raphictis Gingerich and Winkler 1985, and Viverravus Marsh 1872, in the retention of more primitive characters in the upper dentition. The genus shares a primitively strong metaconule and premetaconule crista on M1 with Bryanictis MacIntyre 1966, but differs in the remaining characters of the diagnosis, and further differs from this genus in possessing upper molars that lack lingual cingulum development, and in bearing a greater reduction of the M2. Intyrictis Gingerich and Winkler 1985 is reportedly close to Bryanictis in upper molar morphology (see Rigby's [1980] description for "Bryanictis" vanvaleni). Ictidopappus Simpson 1935 is unique in its highly specialized postcanine dentition (see MacIntyre [1966] and Gingerich and Winkler [1985]).

Pristinictis connatus n. sp.

(Plate 42, figs. E, F; pl. 43, figs. A, B)

Etymology: connatus, L. joined, united with, born together, in reference to the condition of the paracone and metacone, which are joined at their bases to a greater degree than in the other species of the genus.

Holotype: UALVP 24949, left maxillary fragment with P4-M2.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Hypodigm: Type specimen and UALVP 24948, DP2; UALVP 24951, DP3; UALVP 24947, P3; UALVP 24945, M1; UALVP 24946, M2; UALVP 24950, dp4; UALVP 24944, m1.

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta (type locality) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]).

Diagnosis: Differs from "P." agastor and "P." dellensis in being substantially smaller (P4 is 45% smaller and the upper molars are approximately 30% smaller than in "P." agastor and "P." dellensis). Further differs in having M1 with slightly more connate paracone and metacone; shorter precingulum; and in lacking a connection of postcingulum with metacingulum and metacingulum with ectocingulum.

Description: The dentition of the holotype will be described and compared in detail followed by a brief account of the additional specimens.

P4. — This tooth (represented only on the type specimen, UALVP 24949) is similar to the P4's of other species of Viverravidae except for a relatively shorter metastylar blade (L=5.0, W=3.6), a robust paracone blade, and a poorly developed parastylar cingulum. The labial and lingual cingulum are also relatively faint. The protocone is bulbous and is distinctly larger than the parastyle. The parastyle is similarly bulbous and bears a faint crest that connects with a well-developed preparacrista on the paracone. Apical wear is seen on both the parastyle and the protocone. A broad wear facet, having several obliquely oriented striations, is developed on the anterolingual face of the tooth; in evident association with the facet is an excavated pit anterolingual to the paracone, on the anterolabial corner of the protocone lobe.

M1. — In occlusal outline the M1 of UALVP 24949 (L=4.0, AW=5.6, PW=5.1) is transverse with a moderately shallow ectoflexus extending lingually almost to the base of the paracone. The parastylar lobe is sharply "hooked" and curves around the posterior end of the metastylar blade of the P4. The stylar shelf is narrow at its midlength due to the presence of a robust paracone. The shelf widens posteriorly in the metastylar region. The ectocingulum is wide anteriorly at the parastylar lobe, narrows at the ectoflexus, and widens again at the metastylar lobe. The paracone and metacone are connate at their bases and are oriented with their apices pointed at an angle of approximately 57 degrees from each other. The paracone is inflated and more than twice the size of the metacone. The metac[illegible]d and has its apex directed posteriorly. The prominent parastylar lobe possesses a large parastyle and, posterior to it, an even larger stylocone. Both parastyle and stylocone are pyramidal in shape with the stylocone slightly taller. The anterior surface of the parastyle is slightly concave to accommodate the labial end of the metastylar blade from the P4. A well-developed preparacrista runs downward from the apex of the paracone to its base to join with the stylocrista of the stylocone. A weak carnassial notch is developed at the anterolabial base of the paracone, where these two crests meet. The postmetacrista is not continuous with the labial cingulum, but is interrupted at the posterolabial base of the metacone by a well-developed carnassial notch. No distinct metastyle is developed. The rim of the ectocingulum is cuspidate from the stylocone to the postmetacrista. The preparaconule crista extends almost in a straight line from the paraconule to the parastyle. The resulting paracingulum is wide and is enhanced by the centrally located position of the paracone. A small accessory stylar cuspule is located between, and slightly labial to, the parastyle and the stylocone and is joined to both by two small crests.

The protocone is prominent and bulbous, and only slightly lower in height than the paracone. The protocone is relatively narrow anteroposteriorly, with steep anterior and posterior walls that are slightly concave. The preprotocrista is broad and high (approximately twice the height of the postprotocrista); consequently, the paraconule is positioned on the crown almost twice as high as the metaconule. A small carnassial notch is formed between the paraconule and the protocone. The metaconule is well developed with a prominent premetaconule crista. The postmetaconule crista disappears posterolabial to the metacone, well below the postmetacrista. The resulting metacingulum is relatively wide and is further enhanced by the medial positioning of the metacone. The precingulum and postcingulum are well-developed and do not converge lingual to the protocone. Both extend from the midpoint or "waist" of the tooth down to points just anterolingual and posterolingual from the protocone. The pre- and postcingulum terminate well below the paracingulum and metaconule, respectively. The edges of both cingula are slightly cuspidate. A slight bulge or swelling is present at the base of the protocone between the lingual ends of these two cingula; this may be a remnant of a once continuous (or perhaps an incipient) lingual cingulum (a similar bulge is present on the upper molars of both Cimolestes magnus and, to a lesser degree, on C. cerberoides). The edges of the pre- and postcingulum are slightly cuspidate.

A wear facet is developed on the anterolingual surface of the upper one-half of the paracone, lingual to the preparacrista, and on the upper anterior surface of the preparaconule crista. preprotocrista. A larger facet is present on the anterolingual face of the metacone, directly below the premetacrista. Apical wear occurs on the paraconule, preprotocrista, and on the metaconule.

M2. — The M2 on UALVP 24949 is narrow and transversely elongate in occlusal outline (L=2.0, W=3.9). It is approximately one-half as long and one-third as wide as the M1. The parastylar lobe is well developed but lacks a parastyle. The stylocone is present and prominently developed, almost as high as the metacone. The preparacrista forms a right angle in its extent from the paracone to the stylocone. The preparaconule crista merges just below the stylocone. The relative dimensions of the main cusps on the crown are the same as in M1. Wear facets are developed in the same locations as on the M1.

DP2.— UALVP 24948 (L=3.2, W=2.1) preserves a crown morphology virtually identical to UALVP 24947, isolated P3 (see description below), referred to Pristinictis [illegible]natus. UALVP 24948 is considered to be deciduous based upon the thin enamel and [illegible]llowed-out base of the crown. The specimen further differs from UALVP 24947 in bearing an incipient carnassial notch between the paracone and metacone, and in being slightly smaller in all linear dimensions. The apex of the paracone is worn away to nearly one-half of its estimated original height. The [illegible] is obliquely oriented, with the lowest point on the lingual face. The apex of the much smaller metacone is worn away in similar fashion. A small amount of occlusal wear is also present on the lingual cingulum of the protoconal lobe (but no protocone is developed). The parastyle is the only portion of the crown that is damaged. Only a minor portion of a transversely wide posterior root is preserved.

P3. — The crown on UALVP 24947 (L=3.5, W=2.4) is shaped like a scalene triangle in occlusal outline, with the labial side longest and the posterolingual side shortest. The paracone is located in the center of the tooth and a small spur-shaped parastyle is developed in the anterolabial corner of the crown. Labial and lingual cingula border the posterior sides of the tooth. The metastyle is a tiny cuspule formed at the intersection of the labial cingulum with the lingual cingulum. The paracone is large and conical in anterior view, with a rounded anterior face, but with a sharply keeled posterior. The paracone is posteriorly canted and bears a long, steep anterior slope. At a point slightly lower than half-way down the posterior slope of the paracone is the development of a distinct metacone. This cusp is transversely flattened and much smaller than the paracone, but larger than either the parastyle or metastyle. The metacone is not blade-like and there is no distinct carnassial notch developed between the short, almost horizontal, premetacrista and the much longer postparacrista. A longer, keel-like postmetacrista descends steeply to join the metastyle. The labial cingulum is incomplete, extending only from the metastyle to a point labial to the paracone apex before disappearing. The lingual cingulum is similarly incomplete, becoming cuspidate and disappearing well before reaching the parastyle. The remnant of the protoconal lobe is well developed and shelf-like, extending posterolingually as the third corner of the crown. The lingual root of the protoconal lobe has fused with the posterior root forming a single transversely wide posterior root. A similar fusion is observed in the P3's of the Torrejonian viverravids described by MacIntyre (1966) and is also indicated by the transversely wide posterior P3 alveoli in the maxillaries of the Tiffanian viverravids "Protictis" agastor (PU 21242) and Protictis schaffi (PU 16495) (pers. obs., and illustrated in Gingerich and Winkler 1985). The lingual cingulum borders the entire length of the protoconal lobe — from directly lingual to the paracone to the metastyle. The lingual cingulum is best developed on the posterior side of the lobe. The lingual tip of the protoconal lobe is damaged due to chipping of the enamel; nevertheless, a slight crenulation on the lingual cingulum in this region appears indicative of a cuspule-like protocone; the presence of which cannot be confidently confirmed. A short, faint, medial crest extends up the lingual face of the paracone from this point. A similar weak and short preparacrista is developed from the parastyle.

In general morphology UALVP 24947 is similar to P3 in the Torrejonian viverravids Protictis haydenianus Cope and Bryanictis microlestes MacIntyre (MacIntyre 1966; Flynn and Galiano 1982). MacIntyre (1966) reported a substantial amount of intraspecific variability in P3 structure for both Protictis and Bryanictis. Nevertheless, the Cochrane 2 specimen clearly differs from the P3's described for P. haydenianus (MacIntyre 1966) in lacking the development of a metastylar shearing blade and in possessing a distinct metacone. The development of a metacone is described in some specimens of B. microlestes (MacIntyre 1966, p. 182); however, UALVP 24947 differs from these P3's in lacking a carnassial notch between the paracone and metacone and in bearing a much smaller parastyle and protocone (if present). In the reduction of the parastyle and position of the metacone, UALVP 24947 also reveals close similarity to the P3 of Didymictis (as preserved on USGS 1197, maxillary fragment with P3-M2). The major differences with P3 in this form are found in the better developed metacone and carnassial notch in Didymictis, as well as in the reduction of the protoconal lobe.

dp4. — UALVP 24950 preserves only the paraconid and part of the protoconid of a deciduous viverravid p4 of the size expected for P. connatus. The specimen is similar in comparable features to the dp4 of Didymictis Cope 1875 (USGS 1452), but differs in possessing a short crest on the lingual side of the paraconid joining to the metaconid.

m1. — UALVP 24944 is the protoconid and a minor portion of the metaconid of an m1 of appropriate size (AW=3.0*, TH=5.0) for P. connatus. UALVP 24944 exhibits a more extensive precingulid than m1, Protictis haydenianus Cope 1882, and a more smoothly curved labial outline of the protoconid. In these features the fragment most closely resembles the m1 in "P." agastor. The paracristid is well worn on this specimen and numerous obliquely oriented striations (as a result of vertical shear) completely cover the postvallid and prevallid. A deep groove is worn into the protoconid segment of the protocristid.

Discussion: Comparison of M1, Pristinictis connatus with the upper molars of the primitive Late Cretaceous palaeoryctids Cimolestes cerberoides and C. magnus reveals the following symplesiomorphies:

1. Paracone and metacone are connate to the same degree with virtually identical crest morphology — especially with respect to M2, C. magnus.
2. Parastyle and stylocone are developed in the same positions on the ectocingulum.
3. Ectocingulum is cuspidate.

4. Relative sizes, shapes, and positions of conules same as on M1, C. magnus and C. cerberoides.
5. Postmetaconule crista (metacingulum) identically shaped as on M1 of C. magnus and C. cerberoides.
6. Precingulum and postcingulum are similar in position and extent to those on M1 of C. magnus.
7. Protocone narrow as on M2 of C. magnus.
8. Occlusal outline, including paracingulum and metacingulum (but excluding pre- and postcingulum), as transverse as on M1 and M2 of C. magnus and C. cerberoides.

The M1 of P. connatus differs from M1 in C. cerberoides and C. magnus in the following features:

1. The paracone and metacone are slightly lower in height.
2. The parastyle and stylocone are relatively larger.
3. The preparaconule crista (paracingulum) is relatively wider and less curved.
4. The postmetaconule crista (metacingulum) is relatively wider and extends labial to the metacone.
5. The precingulum and postcingulum are wider.
6. The protocone apex is rounded and more bulbous.
7. The trigon basin is relatively smaller.
8. Occlusal wear centers on the preparaconule crista and preprotocrista.

The majority of the aforementioned characters are synapomorphies of viverravids in general, with the exception of numbers 2., 6., and 7. which appear to be uniquely derived. In comparison with the known Paleocene viverravids UALVP 24949 is most similar to "Protictis" agastor from the middle Tiffanian Cedar Point Quarry of Wyoming (Gingerich and Winkler 1985). Characters 2., 6., and 7. are shared with "P." agastor on PU 21242, a left maxillary preserving P1, P4-M2. The two specimens also share the following additional synapomorphies:

1. A stylocone that is larger than the parastyle and pyramidally-shaped.
2. A relatively shallow ectoflexus and reduced metastylar lobe.
3. Prominent precingulum and postcingulum that do not join lingual to the protocone.
4. Cuspidate rims on the precingulum and postcingulum.
5. A similar-shaped M2 that is reduced to the same degree.

A number of symplesiomorphies are also shared between UALVP 24949, Prist. connatus and PU 21242, "P." agastor, and they are as follows:

1. P4 with poorly developed labial and lingual cingulum.
2. M1 and M2 with connate paracone and metacone.
3. M1 possessing a prominent (singular) metaconule and a well-developed premetaconule crista.
4. M1 possessing a well-developed postprotocrista.
5. M1 and M2 having a transverse occlusal outline.

"P." agastor differs from Prist. connatus:

1. In possessing a slightly less connate paracone and metacone.
2. In possessing a connection of the postcingulum with the metacingulum.
3. In lacking a distinct crest connection of the metaconule with the metacingulum.
4. In having the metacingulum join with the ectocingulum at the metastyle.
5. In bearing a better developed stylocrista.
6. In possessing a longer precingulum that extends further labially and lingually.
7. In the development of an incipient carnassial notch between the parastyle and preparacrista on P4.
8. In the more lingual positioning of the M2 with respect to the M1.
9. In being larger in size.

All of the above differences appear to apply equally well to the presumed descendant species of "P." agastor: "P." dellensis from the late Tiffanian of Wyoming (Gingerich and Winkler 1985) and Saskatchewan (Roche Percée local fauna [pers. obs.]). These characters, in fact, may be interpreted as morphological trends in a single evolutionary lineage, for they also appear to represent synapomorphies with early forms of Didymictis from the Clarkforkian and Wasatchian of Wyoming and elsewhere. All four taxa (P. connatus, "P." agastor, "P." dellensis and Didymictis) can be united under characters already mentioned for Prist. connatus and "P." agastor and these include:

1. A well-developed parastyle and better-developed stylocone on M1.
2. A reduced metastylar lobe on M1.
3. The presence of a prominent (singluar) metaconule and well-developed premetaconule crista on M1.
4. A well-developed postprotocrista on M1.
5. A relatively small parastyle on P4.

In their description of the upper molars of "P." agastor Gingerich and Winkler (1985, p. 116) considered M1 and M2 to be "similar in form to these teeth in P. schaffi." Detailed comparison of PU 21242, "P." agastor, with the teeth on PU 14165, 14441 (maxillaries) and PU 16495 (skull) of Protictis schaffi reveal several differences not mentioned by Gingerich and Winkler. The differences of "P." agastor from P. schaffi include:

1. A connate paracone and metacone on the upper molars.
2. A shallower ectoflexus and more reduced metastylar lobe on M1.
3. A prominent parastyle and stylocone on M1, with stylocone, pyramidally-shaped and larger and the parastyle.
4. The presence of a prominent, unreduced, metaconule with well-developed premetaconule crista on M1.
5. A strong unreduced postprotocrista on M1.

6. A relatively smaller talonid basin on M1.

7. A much longer postcingulum on M1.

8. The presence of carnassial notch development on the preparacrista.

9. A more transverse occlusal outline on M1.

These additional differences (along with those mentioned by Gingerich and Winkler 1985) indicate greater similarity between "P." agastor and Pristinictis, while the upper molars of P. schaffi appear to have greatest resemblance to those of Viverravus and Raphictis (pers. obs., based upon undescribed specimens of Raphictis from the Roche Percée local fauna, Ravenscrag Formation, Saskatchewan).

The genus Protictis as diagnosed by Gingerich and Winkler (1985, p. 103) has the metaconule on the upper molars reduced, as a synapomorphy uniting the several Tiffanian species. The metaconule on M1 and M2 of "P." agastor is clearly unreduced by comparison with P. haydenianus. I assume that the metaconule in "P." dellensis would also be unreduced, based upon the reportedly close similarity between this form and "P." agastor in upper molar morphology (Gingerich and Winkler 1985). Thus, an important synapomorphy for the upper molars of Protictis, namely a reduced or absent metaconule, does not apply to one-third of the included members of the genus, specifically to "P." agastor and "P." dellensis, which retain prominent metaconules on M1. The discovery of Pristinictis connatus from the earliest Tiffanian of Alberta provides a structurally ideal ancestor (at least in the known parts of the upper dentition) for the "P." agastor — "P." dellensis lineage. The primitive structure of the upper molars in Prist. connatus — which includes a connate paracone and metacone, strong postprotocrista, and prominent metaconule — and its retention in later species, provides substantial evidence for the generic separation of these forms from the more derived morphology (separate paracone and metacone, weak postprotocrista, and reduced and twinned metaconule) present in the older P. haydenianus. Protictis haydenianus, in fact, appears to be unique in comparison with all other Tiffanian viverravids in possessing an m1 with the talonid equal in length to the trigonid. The talonid of the m2 is similarly elongate, having a talonid length greater than the trigonid length. In addition, the parastyle on P4 is large relative to the protocone and the parastylar lobe is elongate and oval in occlusal outline (previously noted in Flynn and Galiano 1982).

The presence of the above characters in P. haydenianus should certainly have an effect on the systematics of Tiffanian species lacking those characters and referred to Protictis. However, any formal taxonomic action should await a more complete study of both the upper and lower dentitions in these viverravids. Such an analysis is outside of the scope for this paper.

The apparent synapomorphies and symplesiomorphies of Pristinictis connatus, "Protictis" agastor and "P." dellensis with Clarkforkian Didymictis only serve to strengthen the already recognized affinity between "P." dellensis and Didymictis as hypothesized by Gingerich and Winkler (1985) (and as recognized initially by Dorr [1952] and Rose [1981]) and, at the same time, weakens the alternative hypothesis — close relationship with Bryanictis microlestes — which was also postulated by Gingerich and Winkler (1985, pp. 125 [fig. 15], 126; and reiterated by Sloan [1987]).

An isolated viverravid P4 (PU 14642) from the earliest Tiffanian Douglass Quarry of Montana identified by Krause and Gingerich (1983) as "Protictis sp." is identical to the P4 on the holotype of Prist. connatus (pers. obs.). A second specimen from Douglass Quarry is also referable to this taxon. This specimen is an isolated, uncatalogued Lm2 (SUNY field no. 84466) which is referable based upon its size and close occlusal fit with M2 of the holotype (pers. obs.). The uncatalogued specimen resembles m2 in "P." agastor in having a large, low-crowned trigonid coupled with a relatively narrow and short talonid, approximately equal in length to the trigonid.

Pristinictis connatus is primitive in upper molar morphology with respect to all Tiffanian and Torrejonian taxa of Viverravidae. In M1 structure, Simpsonictis, Protictis paralus, P. schaffi, and Raphictis are more derived: sharing the reduction in size of the parastyle and stylocone; a greater separation of the paracone from the metacone; the reduction and elimination of the metaconule and premetaconule crista; reduction in the length of the postcingulum; and an increase in size of the trigon basin.

Placement of "P." agastor and "P." dellensis in the genus Pristinictis reveals a single primitive lineage apparently evolving through the Tiffanian to a point of close resemblance, and perhaps direct ancestry, to that of Clarkforkian Didymictis.

Genus Simpsonictis MacIntyre 1962

Simpsonictis cf. S. tenuis (Simpson 1935)

(Plate 43, figs. C—F)

Referred specimens: UALVP 24961 and 24962, m1's.

Description: UALVP 24962 and 24961 are the trigonid and talonid (from different individuals) of a viverravid significantly smaller than S. tenuis. UALVP 24962 is a high and narrow trigonid (AW=1.4, TL=1.4, TH=2.3). The paraconid is positioned low on the crown and is much lower in height than the metaconid. The metaconid, in turn, is intermediate in height between the paraconid and protoconid. The metaconid is closely appressed with the protoconid for most of its height and is separated by a deep carnassial notch. A second carnassial notch, usually developed between the protoconid and paraconid, is absent in this specimen. The cusps of the trigonid are relatively higher and narrower than the cusps of Simpsonictis tenuis, but they still maintain the same relations and orientations on the crown as on the m1 of that species. The postvallid, however, is significantly narrower by comparison.

The talonid from Cochrane (UALVP 24961) is mophologically identical to the m1 talonids of S. tenuis from Gidley and Rock Bench quarries, and differs only in its significantly smaller size (PW=1.0).

Discussion: MacIntyre (1966) described a slightly larger, more robust, form of Simpsonictis from the early Tiffanian Saddle locality, Bison Basin (Fort Union Formation), of Wyoming which he identified as "Protictis (Simpsonictis) cf. tenuis". Teeth of this form are certainly distinct from the specimens described here and may possibly represent an enlarged descendant of the S. tenuis — S. jaynanneae Rigby 1980 lineage.

The referred trigonid and talonid from Cochrane 2 appear to belong to a very small and gracile species of Simpsonictis — much more diminutive than S. tenuis and representative of the smallest known viverravid. The tall, needle-like trigonid cusps of this tiny carnivoran were probably related to an exclusively insectivorous diet. Although UALVP 24962 is almost certainly indicative of a new species, I feel that a diagnosis based upon the fragmentary material of a single tooth position would be premature. Such actions should await the discovery of additional referable specimens.

Simpsonictis pegus Gingerich and Winkler 1985

(Plate 44, figs. A—I; table 27)

Type: PU 17511, left dentary fragment with p2, p4-m2.

Type locality: Rock Bench Quarry, Fort Union Formation, northern Bighorn BasinWyoming.

Known age and distribution: Late Torrejonian (middle Paleocene) of Wyoming (type locality [Gingerich and Winkler 1985]) and earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [MacIntyre 1966; pers. obs.]) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]).

Referred specimens: UALVP 24955 and 24956, P4's; UALVP 24959 and 25636, M1's; UALVP 24960, dp4; UALVP 24957 and 24958, p4's; UALVP 18535, 24952 and 24953, m1's.

Description: The referred lower dental elements (p4's and m1's) are essentially identical to their homologs on the type dentary of S. pegus (PU 17511) and provide no additional descriptive information. The p4 and m1 of S. pegus have already been adequately described by Gingerich and Winkler (1985). The upper dentition of S. pegus was not known to Gingerich and Winkler (1985) and the following description will concentrate upon the referable elements of upper dentition from Cochrane 2, as well as a single isolated deciduous tooth.

P4. — UALVP 24955 and 24956 represent small viverravid P4's that are virtually identical in morphology to the P4 identified by MacIntyre (1966) as "Cf. Protictis (Simpsonictis)" from the Keefer Hill ("Shotgun") locality of Wyoming. Only the paracone and metastylar blade remain on the crown of UALVP 24956, while UALVP 24955 (L=3.7*, W=2.6) is missing only the parastyle. UALVP 24955 is relatively unworn; however, UALVP 24956 is well worn along the metastylar blade and paracone, in the same manner as is the uncatalogued specimen from Keefer Hill (MacIntyre 1966). The detailed description of this tooth by MacIntyre (1966) applies equally well to the Cochrane specimens referred to S. pegus, and nothing further can be added from the Cochrane material. MacIntyre's (1966) description is further substantiated by the comparison of UALVP 24955 and 24956 with another isolated, uncatalogued, P4 in the Keefer Hill collection at the University of Wyoming (pers. obs. 1986).

M1. — UALVP 24959 and 25636 are incomplete M1's. UALVP 24959 (L=3.0) is well worn and missing the paracone, while UALVP 25636 is less worn, but missing the parastylar lobe. The specimens are the appropriate size for occlusion with the m1's of S. pegus and differ morphologically from the M1 of Pristinictis connatus in possessing a less connate paracone and metacone, weakly developed stylocone and parastyle, and a better developed metastylar lobe (deeper ectoflexus) with no evidence of a carnassial notch on the postmetacrista. In general, these teeth compare well with the M1's described by Rigby (1980) for Simpsonictis jaynanneae from Swain Quarry, but differ in having a deeper ectoflexus and a paracone that is larger and taller than the metacone. Wear on UALVP 25636 is limited to the preparacrista, premetacrista, and on the posterolingual face of the paracone. A prominent prevallum shear facet with vertical striations is developed on the anterior surface of the fragment, nearly obliterating the parastylar "hook", preparacrista, and paracingulum.

dp4. — UALVP 24960 represents the high-crowned trigonid of a viverravid deciduous p4, equal in size (AW=1.7, TL=1.9, TH=3.5) to the p4 in S. pegus. The enamel on the crown of this tooth is thin and cracked. The trigonid cusps have the same relationships to each other as in m1, S. pegus, with the exception of a lower, more anterolabially directed paraconid and a narrower postvallid. The postvallid in this deciduous tooth was oriented obliquely to the plane of the dentary. The prevallid extends more anteriorly than in m1, S. pegus. Comparison of UALVP 24960 with the deciduous p4 of Didymictis (USGS 1452) and the dp4 of an extant Vulpes kit (UA 9106) reveals a similar positioning of the cusps and orientation for the pre- and postvallid. As in these teeth, the paracristid of the Cochrane 2 trigonid is prominent and keel-like along the anterior edge of the protoconid. The carnassial notch on the protocristid is well-developed, but that on the paracristid is only incipient. A broad precingulum follows the basal contour of the trigonid from the base of the paraconid to the base of the protoconid. The cristid obliqua joins with the postvallid below the protocristid notch. The anterior root of UALVP 24960 is broken at the base of the crown, but appears to have been limited in posterior extent to beneath the paraconid (as in USGS 1452).

Discussion: Simpsonictis pegus is also present in the SUNY collection from Douglass Quarry (pers. obs.), where it is represented by an uncatalogued, complete, Lm1 (field no. 85735) that is virtually identical to the Cochrane specimens.

The presence of S. pegus at Cochrane 2, Keefer Hill, and Douglass Quarry extends the temporal range of this species into the earliest Tiffanian (late Paleocene) and extends its known geographic range northward to include Montana and Alberta.

Order Condylarthra Cope 1881

Family Arctocyonidae (Giebel 1855) Murray 1866

Subfamily Oxyclaeninae (Scott 1892) Matthew 1937

?Oxyclaeninae n. gen. and sp.

(Plate 45, fig. A).

Referred specimens: UALVP 24975—24977 (total: 3), M1's

Description: UALVP 24976 (L=3.4, W=4.6) and 24977 (L=3.3, W=4.6*) resemble an isosceles triangle in occlusal outline, with long lateral walls bordering prominent, lingually expanded protocones. The protocone dominates the crown of these specimens and is much larger and higher than either the paracone or metacone. The paracone is conical, while the metacone is more transversely compressed; both are well-separated and slightly canted away from each other. The paracone exhibits strong apical wear that has removed roughly half of its height (on UALVP 24977 and 24975 [L=3.2]). The metacone was only slightly lower than the paracone originally and is worn on both the apex and premetacrista, forming a continuous oblique facet on UALVP 24977. The stylar shelf is wide owing to the small size of the paracone and metacone. The postmetacrista is prominent and continuous with the ectocingulum, but a preparacrista is absent or only incipiently developed. The parastyle is weak, a metastyle is absent, and the ectocingulum is relatively low and cuspidate. The paraconule is absent and a wear facet occurs on the segment of the preparaconule crista that was adjacent to the paraconule (and now continuous with the preprotocrista). The enamel posterior to this wear facet is inflated as a remnant of the paraconule. Apical wear continues labially on this crest, anterior to the paracone. No postparaconule crista is developed. In contrast, the metaconule is better developed, with a strong postmetaconule crista and incipient premetaconule crista. Apical wear is developed on the metaconule but is absent from the postmetaconule crista. The postmetaconule crista does not join with the postmetacrista and ectocingulum, but fades posterolingual to the metacone. The protocone shows evidence of strong apical wear. Extremely faint pre- and postcingula are present, with the former slightly more extensive than the latter. The incipient postcingulum disappears directly below the apex of the protocone. The precingulum extended further lingually, by comparison, past the protocone apex.

Discussion: These teeth resemble the M1 of Protungulatum donnae Sloan and Van Valen 1965 and Mimatuta morgoth Van Valen 1978 more than the molars of any other condylarths. They differ in possessing only faint, incipiently developed, lingual cingula; a reduced ectocingulum; relatively smaller paracone and metacone, and in lacking both a paraconule and a connection of the postmetaconule crista with the postmetacrista and ectocingulum. UALVP 24976 and 24977 are similar to M1 of Protungulatum in being relatively transverse lingually with similar overall crest lengths. They also resemble M1 in the most primitive Mimatuta species in orientation, relative sizes, and wear patterns on the paracone and metacone and in reduction of the preparacrista. In addition, the protocone is enlarged and oriented in similar fashion to the M1 protocone of M. morgoth, with the angle formed by the lingual surface (slope) of the protocone greater than 45 degrees with respect to the lateral base of the crown. Further, the postcingulum is reduced on M2 of M. morgoth (M1 on the type specimen, AMNH 35982, preserves only the most labial portion of this tooth position) and the precingulum (also reduced) extends more lingually than in Protungulatum — resembling the conditions present on the Cochrane specimens.

These teeth appear to represent primitive condylarth M1's that may have been secondarily simplified through crest, cingulum, and conule reduction. In their specialization UALVP 24976 and 24977 appear to converge towards the upper molar morphology of palaeoryctid insectivores, and display a curious mixture of primitive and specialized characters for a condylarth.

Genus Chriacus Cope 1883

Chriacus pelvidens (Cope 1881)

(Plate 45, figs. B—D; table 28)

Type: AMNH 3097, left dentary fragment with p4-m3.

Type locality: Torrejon locality, Nacimiento Formation, San Juan Basin, New Mexico.

Known age and distribution: Late Torrejonian (middle Paleocene) of New Mexico (type locality [Matthew 1937]) and Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980]); latest Torrejonian of Wyoming (Rock Springs locality V-77014, Fort Union Formation, eastern Rock Springs Uplift, Sweetwater County [Winterfeld 1982]) and Montana (Medicine Rocks I locality and Mehling site, Tongue River Formation, Carter County [pers. obs.]); earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]; Little Muddy Creek locality, Evanston Formation, Lincoln County [Gazin 1969]; Cub Creek locality [CC-1], Clark's Fork Basin [P. D. Gingerich, pers. comm. 1986]) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]) and Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [D. W. Krause, pers. comm. 1986; pers. obs.]).

Referred specimens: UALVP 24779, M1; UALVP 24980, M2; UALVP 24978, m1; UALVP 24981, m2.

Description and discussion: These specimens differ from the type material (and other Torrejonian specimens) only in being slightly larger and more robust (see Table 28). Specimens referred to C. pelvidens from Cochrane 2, Keefer Hill, Douglass Quarry, Cub Creek, and the Saddle locality are all virtually identical in comparable molar structure.

Although the material referred to this species from the Tiffanian of North America averages slightly larger than the Torrejonian samples, the total sample of teeth, nevertheless, appear indicative of a single species.

<u>Chriacus</u> cf. <u>C</u>. <u>baldwini</u> (Cope 1882)

(Plate 45, fig. E; pl. 46, fig. A; table 29)

Type of <u>Chriacus</u> <u>baldwini</u>: AMNH 3114, right dentary fragment with p3-m1.

Type locality: Torrejon locality, Nacimiento Formation, San Juan Basin, New Mexico.

Known age and distribution for <u>Chriacus</u> <u>baldwini</u>: Late Torrejonian (middle Paleocene) of New Mexico (type locality [Matthew 1937]) and Montana (Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County [Simpson 1937; Van Valen 1978]); earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a; pers. obs.]).

Referred specimens: UALVP 24982, maxillary fragment with M1-M2; UALVP 24987 maxillary fragment with M1; UALVP 24985 and 24986, M1's; UALVP 24984, dentary fragment with m1 or m2; UALVP 24983, m1 or m2.

Description and discussion: The upper molars referred here are smaller, lower-crowned, and more nearly quadrate in occlusal outline than are M1 and M2 of <u>C</u>. <u>pelvidens</u>. In addition, the M1 of <u>C</u>. cf. <u>C</u>. <u>baldwini</u> possesses a "hook" or "spur"-like parastylar lobe. These teeth are most similar to upper molars of "<u>Metachriacus</u> <u>provocator</u>"

(Simpson 1935, 1937) and differ mainly in being larger (see Table 29). Van Valen (1978, p. 54) synonymized "M. provocator" with C. baldwini (Cope), which is followed here.

Gazin (1956a, p. 27) described (Pl. 5, figs. 2, 3) two isolated upper molars — one (USNM 21003, a left M2) identified as "Chriacus, near C. pelvidens" and the other (USNM 21019, a left M1 [described as M2]) as "Chriacus sp." — from the Saddle locality of Wyoming. Both upper molars compare well with M1 and M2, respectively, of C. cf. C. baldwini from Cochrane and differ only in minor detail. These specimens are clearly smaller and lower-crowned in comparison with molars of C. pelvidens from the same locality (pers. obs.) and are hereby referred to C. cf. C. baldwini. Several uncatalogued specimens from the Douglass Quarry of Montana probably also pertain to the Cochrane form (pers. obs.).

Genus Thryptacodon Matthew 1915a

Thryptacodon orthogonius n. comb. (Russell 1929a)

(Plate 46, figs. B—E; table 30)

Holotype: UALVP 124, left M2.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta (type locality [Russell 1929a]) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]); middle Tiffanian of Wyoming (Ledge locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]); late Tiffanian of Wyoming (Rock Springs localities V-77006, V-77007, and V-78052, Fort Union Formation, eastern Rock Springs Uplift, Sweetwater County [Winterfeld 1982]).

Referred specimens: UALVP 24996, p4; UALVP 24998 and 24999, m1's; UALVP 24997, m2; UALVP 24995, m3.

Revised diagnosis: Smaller than T. australis and T. antiquus; upper molars relatively more transverse and more nearly quadrate in occlusal outline, with weaker hypocones; paracone subequal in size with metacone. Additional features are provided by Gazin (1956a).

Description and discussion: The lower molars referred here from the type locality are virtually identical to those of Thryptacodon "demari" and T. "belli" from the Ledge locality and Saddle locality, respectively, of the Bison Basin, Wyoming (Gazin 1956a). Importantly, UALVP 24997 (m2) occludes well with the type specimen of "Chriacus" orthogonius (Russell 1929a) from Cochrane 2. Van Valen (1978) has synonymized T. "belli" with T. "demari" and considers "C." orthogonius to be the senior synonym of "Metachriacus" punitor Simpson.

The taxon "Chriacus" orthogonius is based upon a single specimen from Cochrane 2, UALVP 124, an isolated LM2 described by L. S. Russell (1929a). "C." orthogonius is presumed to have been derived from Chriacus baldwini (Sloan 1987, fig. 3). However, according to Van Valen (1978), both "Metachriacus provocator" and "Chriacus truncatus" are junior synonyms of C. baldwini. Neither of these latter forms closely resemble "C." orthogonius in upper molar morphology. The type specimen of "C." orthogonius (UALVP 124) differs from M2, C. baldwini (and C. cf. C. baldwini from Cochrane 2): 1) in being more symmetrically quadrangular and rounded in occlusal outline, with slightly convex anterior and posterior walls; 2) in possessing a shallow (reduced) ectoflexus; 3) in possessing a relatively larger and more internally situated (more anterolabially positioned) hypocone; 4) in having a slightly concave postprotocrista that bends labially at the metaconule; and 5) in being slightly smaller. These differences are derived with respect to C. baldwini (including "C. truncatus" and "Metachriacus provocator") and also apply to Metachriacus punitor Simpson (with the exception of No. 5), which Van Valen (1978) considered a junior synonym of "C." orthogonius — and which probably represents a distinct taxon in Chriacus (but see Rose 1981a, pp. 146, 147).

The above characters, more broadly, appear to be unique to the genus Thryptacodon and clearly distinguish UALVP 124 from molars of Chriacus, which possess the following features: 1) strong spur-like hypocone projecting posterolingually; 2) sharply quadrate occlusal outline with concave anterior and posterior sides; and 3) slightly convex postprotocrista that is continuous with a straight, posterolabially directed postmetacrista (P. A. Johnston, unpubl. notes).

Prior to the present study, the holotype was the only specimen from Cochrane 2 referable to "C." orthogonius, and its affinities have remained in question (see Krause and Gingerich 1983). Direct comparison of UALVP 124 with M2's referred to Thryptacodon "demari" from the Ledge locality and T. "belli" from the Saddle locality reveals these teeth to be virtually identical and supports the conspecificity of the Cochrane 2 molar in the genus Thryptacodon. T. "demari" (including T. "belli") is herein considered a junior synonym of T. orthogonius. Additional material, collected for this study, from Cochrane 2 is of the correct size to be referred with the type specimen and is clearly of T. "demari" morphology, providing further support for the above interpretation.

Winterfeld (1982) recently described a lower molar (UW 13226) from the latest Torrejonian (Rock Springs locality V-77010, Fort Union Formation) of Wyoming which he considered to be the m1 of "Chriacus orthogonius" based upon its close resemblance to m1, "Metachriacus punitor" (Van Valen 1978). The measurements given by Winterfeld (1982) for this tooth are exceedingly small compared with the m1 of T. orthogonius in this study (see Table 30) and m1, T. "demari" (Gazin 1956a). Nevertheless, since I do not consider "M." punitor to be synonymous with "C." orthogonius, I feel that Winterfeld's specimen probably pertains to Chriacus punitor.

Subfamily Arctocyoninae Giebel 1855

Genus Colpoclaenus Patterson and McGrew 1962

Colpoclaenus cf. C. keeferi Patterson and McGrew 1962

(Plate 47, figs. A, B)

Type of Colpoclaenus keeferi: MCZ 8355, left m3.

Type locality: Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County, Wyoming.

Known age and distribution for Colpoclaenus keeferi: Earliest Tiffanian (late Paleocene) of Wyoming (type locality [Patterson and McGrew 1962]) and Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.; D. W. Krause, pers. comm. 1986]); middle Tiffanian of Alberta (UADW-1 and UADW-2 localities, Paskapoo Formation, Blindman River [Fox, in press]).

Referred specimens: UALVP 25020, P4; UALVP 25019, M1 or M2; UALVP 25018, m1.

Description and discussion: The molar dentition of C. keeferi was described in detail by Patterson and McGrew (1962); however, the hypodigm did not include m1's. UALVP 25018 (L=8.2, Aw=5.5, PW=6.1) differs from m2's (UW 1935 and MCZ 8358) referred to C. keeferi (Patterson and McGrew, 1962) in being shorter and slightly narrower with the talonid much wider than the trigonid. As a consequence, the tooth is roughly pyriform in occlusal outline and displays flat anterior (trigonid) and posterior (talonid) ends. The paraconid is distinct, positioned relatively low, and is displaced anteriorly along with the paracristid, being less appressed to the metaconid than on the m2's of this species. All other features of the crown are as described for m2 by Patterson and McGrew (1962).

The referred specimens are slightly smaller (UALVP 25019: W=10.1; UALVP 25020: L=6.0*, W=6.0*) but, nevertheless, compare well with better preserved and more abundant material from the middle Tiffanian Paskapoo Formation of Alberta (Fox, in press). C. keeferi is also present in the earliest Tiffanian Douglass Quarry fauna from Montana (pers. obs.).

Genus Claenodon Scott 1892

Claenodon cf. C. montanensis (Gidley 1919)

(Plate 47, fig. C)

Type of Claenodon montanensis: USNM 8362, large portion of the skull and mandibles including most of the dentition, parts of fore and hind limbs, and other fragments.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution for Claenodon montanensis: Late Torrejonian (middle Paleocene) of Montana (type locality [Gidley 1919; Simpson 1937]) and Wyoming? (?Rock Bench Quarry, Fort Union Formation, Bighorn Basin, Park County [Van Valen 1978; Rose 1981a]; ?Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980]); earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a]) and Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [D. W. Krause, pers. comm. 1986]).

Referred specimens: UALVP 25023, C1; UALVP 25022, P3; UALVP 25021, M3.

Description: C1. — UALVP 25023 is the crown of an upper canine (W=7.0) that is referred to Claenodon cf. C. montanensis on the basis of its size and the presence of a serrated posterior edge, which are both consistent with C. montanensis (see Krause and Gingerich 1983, p. 185).

P3. — UALVP 25022 is similar to P3, C. montanensis, as illustrated by Simpson (1937, figs. 37, 38) and is roughly triangular in occlusal outline (L=8.1, W=6.0), bearing, in its center, a robust and sharp paracone. The paracone is strongly canted posteriorly and possesses three prominent crests on its sides. The preparacrista is much longer than the postparacrista, and the metastyle is much larger than the parastyle. A third crest is incompletely developed on the anterolingual face of the paracone. This crest ascends the paracone wall from the lingual cingulum, but narrows vertically and does not reach the apex. The lingual cingulum joins lingually to a weak protocone, formed on a relatively small protoconal lobe. An incipiently developed ectocingulum is also present. All the crests and cingula of the crown are cuspidate and the enamel is weakly wrinkled throughout. UALVP 25022 is three-rooted and the roots correspond with the parastylar, metastylar, and protoconal lobes, respectively.

M3. — UALVP 25021 is virtually identical to the M3's described and illustrated for this tooth position by Simpson (1937, pp. 175-183) for both C. montanensis and C. ferox. The Cochrane M3 is slightly larger (L=6.8, W=10.2) than M3 in the type specimen (USNM 8362) from Gidley Quarry (Simpson 1937), and is similar in size to the material described as C. cf. C. montanensis from Douglass Quarry (Krause and Gingerich 1983).

Discussion: Van Valen (1978) has suggested a transfer of C. montanensis to the European genus Arctocyonides, but without documentation, and I therefore concur with Rose (1981), Winterfeld (1982 p. 98), and Krause and Gingerich (1983 p. 184) in retaining the traditional nomenclature.

These teeth are slightly larger than the corresponding parts of the dentition of C. montanensis (Gidley) but are smaller than the teeth of C. ferox. In size, they closely resemble the material collected from the Douglass Quarry of Montana (Krause and Gingerich 1983).

?Claenodon sp.

Referred specimens: UALVP 25025, C1; UALVP 25024, m1 or m2.

Description and discussion.—UALVP 25024 consists of only the posterolabial corner of what appears to have been the largest lower molar in the collection from Cochrane 2. This tooth, when complete, would have been much larger than the molars of C. cf. C. montanensis from Cochrane 2. The exceedingly high labial cingulid and low hypoconid with deeply wrinkled sides, coupled with the shape of this talonid fragment, make its allocation to the genus Claenodon the most plausible interpretation.

UALVP 25025 is an upper canine that has the apex and most of the posterior portion of the crown worn away. This specimen is much larger (maximum W=10.0) than the isolated C1 referred to C. cf. C. montanensis (UALVP 25023) from Cochrane 2 and is comparable in size to the C1 described as Claenodon? sp. (UM 80825) by Krause and Gingerich (1983, p. 185, figs. 19C, D) from the Douglass Quarry, Montana.

Genus *Mimotricentes* Simpson 1937

?*Mimotricentes* sp.

Referred specimens: UALVP 25017, M1 or M2; UALVP 25016, m1 or m2.

Description and discussion: UALVP 25016 is slightly larger (PW=4.0*), but, nevertheless, closely similar to the m2 talonid of *Mimotricentes fremontensis* Gazin 1956a (PU 23590) from the Douglass Quarry of Montana (Krause and Gingerich 1983). Both specimens display heavily wrinkled enamel and high, subequal, and closely appressed entoconid and hypoconulid.

To my knowledge, the upper molars of *Mimotricentes* have not been described. As a consequence, UALVP 25017 is referred here on the basis of size, general structural similarity, and its good occlusal relationships with PU 23590 (Lm2) from Douglass Quarry. UALVP 25017 is unique among arctocyonid upper molars from Cochrane 2 in possessing prominent conical conules, with the paraconule the smaller and closer to the protocone; a postprotocrista that does not contact the metaconule, but instead attaches directly to the cingulum posterolingual to it; and in possessing a cuspidate lingual cingulum that lacks a distinct hypocone. The crown of UALVP 25017 is rounded lingually and possesses a high lingual cingulum (as in *Claenodon*), but also exhibits a high and sharp protocone and conules (as in *Chriacus*). The enamel of the crown is heavily wrinkled and displays numerous accessory cuspules, the two largest of which are situated in the position of a hypocone on the lingual cingulum.

Family ?Hyopsodontidae Trouessart 1879

Subfamily ?Hyopsodontinae Trouessart 1879

Genus Oxyprimus Van Valen 1978

?Oxyprimus sp.

(Plate 47, figs.D, E; pl. 48, fig. A)

Referred specimens: UALVP 25030, M1; UALVP 25026, m1; UALVP 25027 and 25029, ?m2's; UALVP 25028 and 25031, m3's.

Description: M1. — UALVP 25030 is relatively transverse in occlusal outline (L=3.4, W=4.5) with well-developed paracone and metacone. The protocone, conules, and their associated cristae have been removed as a consequence of heavy apical wear. Judging from the area of wear, these cusps were originally prominently developed.

m1. — UALVP 25026 has an "hour-glass" shape in occlusal outline (L=3.1) with a rounded trigonid and talonid. The talonid is larger than the trigonid (AW=2.1, PW=2.5) and extends further labially than lingually with respect to the trigonid width. The trigonid and talonid are both canted lingually with the protoconid and hypoconid taller than the metaconid and entoconid, respectively. The metaconid is subequal in size with the protoconid and slightly more extensive posteriorly. Both cusps are conical. The paraconid is much lower than either the metaconid or protoconid and is transversely oriented on the crown, closely appressed to the metaconid. The apex of the paraconid is only slightly labial to a line drawn through the apices of the metaconid and entoconid. The paracristid and protocristid are distinct. A well-developed precingulid extends from the anterior base of the paraconid to the anterolingual base of the protoconid before fading. The hypoconid and entoconid are prominent and externally inflated. The talonid cristids are relatively high and sharp. The postcingulid is poorly developed and extends to a basal swelling of the hypoconid. The swelling appears indicative of an incipient labial cingulid.

m2. — UALVP 25029, a heavily worn molar (L=3.3, AW=2.3, PW=2.5*), and UALVP 25027, a talonid (PW=2.7), are tentatively identified as m2's of this species based upon their similarity to UALVP 25026.

m3. — UALVP 25031 is the trigonid on m3. The trigonid is larger and more transverse (AW=2.2) than on the m1 (UALVP 25026) and has the paraconid more closely appressed to the metaconid.

Discussion: The youngest record of the genus Oxyprimus is of O. albertensis (Fox 1968) from the Puercan (early Paleocene [P2 zone]) of Montana and Saskatchewan (Van Valen 1978; Johnston and Fox 1984; Sloan 1987: fig. 3). By comparison, the lower and upper first molars of O. albertensis are significantly larger and more derived than in UALVP 25026 and 25030, respectively.

UALVP 25026, instead, is virtually identical to the m1 on UCM 34175, a left dentary fragment with m1-m2 identified as "Oxyprimus cf. galadrielae" (M. Middleton, unpubl. data 1980) from the Mantuan (earliest Paleocene) Alexander locality of Colorado (Sloan 1987). Both of these specimens differ from the m1 of O. galadrielae (represented on PU 16712 from the earliest Mantuan type locality of Wyoming [Van Valen 1978; Sloan 1987]) in possessing paraconids that are slightly more appressed to the metaconids. UALVP 25026 further differs from both of the older forms in possessing a more inflated hypoconid and relatively higher talonid cusps.

In comparison with the m3 trigonid of O. galadrielae (PU 16712), UALVP 25031 has a relatively shorter metaconid with the paraconid more closely appressed. The m3 is not preserved on UCM 34175 of O. cf. O. galadrielae; however, the m2 trigonid on this specimen has the paraconid similarly appressed to the metaconid as on UALVP 25031 and 25028 (m3 trigonids).

UALVP 25030 differs from M1, O. galadrielae (preserved on PU 16703 and 16866), in having the paracone and metacone further separated on the crown. As a consequence of the wider separation of paracone and metacone, the trigon basin is relatively more extensive in the Cochrane 2 specimen. The area of the postcingulum is displaced from the remainder of the crown and is slightly crushed. The size of the hypocone, therefore, cannot be determined. Nevertheless, the rest of the crown is essentially identical to that of O. galadrielae.

Should the referred specimens from Cochrane 2 prove to represent an extremely conservative species of the genus Oxyprimus, then they would appear to be most similar to a species that is previous known only from the earliest Paleocene of Colorado (Middleton, unpubl. data 1980).

Family Hyopsodontidae Trouessart 1879

Subfamily Hyopsodontinae Trouessart 1879

Genus Litomylus Simpson 1935

Litomylus dissentaneus Simpson 1935

(Plate 48, fig. B; table 31)

Type: USNM 9425, left dentary fragment with p3-m3.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality [Simpson 1937]) and Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980]; V-77009, V-77012, and V-77014 "Rock Springs" localities, Fort Union Formation, eastern Rock Springs Uplift [Winterfeld 1982]; Rock Bench Quarry, Fort Union Formation, Polecat Bench [Rose 1981a]); earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]) and Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]); early Tiffanian of Wyoming (Ledge locality, Fort Union Formation, Bison Basin [Gazin 1956a; Rigby 1980]).

Referred specimens: UALVP 25039, P4; UALVP 25034 and 25037, M1's; UALVP 25033 and 25038, M2's; UALVP 25032 and 25036, M3's; UALVP 25035, p4; UALVP 25042, m1; UALVP 25044, m2; UALVP 25041, 25043 and 25045, m3's.

Description: Most of the molar dentition of L. dissentaneus has already been adequately described by Simpson (1937), Rigby (1980), and Winterfeld (1982) and the specimens from Cochrane 2 do not substantially differ in morphology from the samples represented at other Paleocene localities. Nevertheless, a brief account is provided for the P4 and M3 tooth positions, which have remained inadequately described in the literature.

P4. — P4, L. dissentaneus, has never been described or illustrated and UALVP 25039 is referred to this species from its size and its resemblance to P4 of other hyopsodontines, such as Haplaletes disceptatrix (as illustrated by Simpson [1937, p. 244, fig. 69]), Dorraletes diminutivus (Gingerich 1983) and Hyopsodus (pers. obs., UALVP specimens). The shape of UALVP 25039 approximates a scalene triangle in occlusal outline with a relatively straight posterior side (the longest) and labial side (the shortest). The labial side of the tooth is oriented at a strongly oblique angle with respect to the posterior side. The parastylar lobe is well-developed and anterolingually projecting and bears a prominent, but heavily worn, parastyle. The metastylar region is posterolabially directed, with a comparatively small metastyle. A moderately well-developed ectocingulum extends from the parastyle to the labial base of the metastyle, where it is strongly developed. The protocone and paracone are large and bulbous. The paracone is posteriorly canted and taller than the protocone. A small metacone is incipiently developed half-way down the posterior slope of the paracone. A short postmetacrista curves posterolabially from the metacone to the apex of the metastyle. A prominent but blunt preparacrista is formed on the anterior face of the paracone. The protoconal lobe is relatively narrow (anteroposteriorly) compared to the labial length of the crown. The apex of the protocone is sharply recurved labially, with prominent pre- and postprotocristae extending to the mid-width of the crown. The cristae join with relatively well-developed pre- and postcingula, respectively. The precingulum is short, but the postcingulum extends from the posterior side of the protocone to the metastyle. Conules are not developed, although a short, faint, medial crest extends from the protocone to the lingual base of the paracone on the anterior side of the trigon basin. Apical wear occurs on all cusps of the crown and on the postprotocrista. A small interdental facet is seen on the anterolingual corner of the parastyle and a second interdental facet on the posterior margin of the metastyle. A broad shear facet is developed on the anterior surface of the protocone.

M3. — M3, L. dissentaneus, was only illustrated by a line-drawing and given a cursory description by Simpson (1937, p. 242, fig. 67). The Cochrane 2 specimens (UALVP 25032 and 25036) resemble a scalene triangle in occlusal outline, with the anterior side, longest, and labial side, shortest. The conules are well-separated and possess sharply defined cristae. The conules are nearer to the paracone and metacone, respectively, than to the protocone, which is low and lingually-centered. The protocone is not inflated, as on M1 and M2. The precingulum and postcingulum are both prominent, with the latter shorter than the former. No hypocone is developed.

Discussion: Rigby (1980) has suggested that the genera Litomylus and Haplaletes are better referred to the lipotyphlan family Adapisoricidae, based, primarily, on features of the lower fourth premolar. Comment upon this action is outside of the scope for this paper. I follow the traditional classification of Van Valen (1978), Rose (1981a), Winterfeld (1982), Krause and Gingerich (1983), Gingerich (1983), and Johnston and Fox (1984).

Litomylus grandaletes n. sp.

(Plate 48, figs. C, D; pl. 49, figs. A—I; table 32)

Etymology: grandis, L. large, great: grandparent, aletes, Gr. (masc.) grinder: allusion to its size, primitive dental morphology, and its possible ancestry to Aletodon.

Holotype: UALVP 25000, right maxillary fragment with M2 and alveoli for M1 and M3.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Hypodigm: Type specimen and UALVP 18405, P4; UALVP 340, 25003 and 25005, M1's; UALVP 25001 and 25002, M2's; UALVP 25004, 25006 and 25007, M3's; UALVP 25010 and 25015, m1's; UALVP 25008, 25009, 25012 and 25013, m2's; UALVP 25014, m3.

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta — known only from the type locality.

Diagnosis: Differs from all other species of Litomylus, except L? ishami Gazin 1956b, in being larger (molars approximately 13% larger than in L. osceolae Van Valen 1978 and 25% larger than in L. orthronepius Johnston and Fox 1984, L. perissum [Gazin 1941], L. aequidens [Matthew 1937]) and L. dissentaneus. Differs from L? ishami in bearing better developed crests and higher, less inflated cusps on upper and lower molars and in possessing more prominent paraconids and well-developed cingulids on the lower molars (Winterfeld 1982; pers. obs.).

Description: P4. — UALVP 18405 resembles the P4 of Litomylus dissentaneus in general morphology, but is more bulbous and simplified. The crown is rounded in occlusal outline having a relatively large, inflated paracone and protocone and reduced parastyle, metastyle and ectocingulum. The apex of the paracone and the region immediately posterior to it is heavily worn and posteriorly directed. A distinct metacone does not appear to have been developed. The paracone narrows posteriorly to form a blunt crest. The posterior crest of the paracone joins with a tiny metastyle at a point less posterolabial and more posterior than in L. dissentaneus. A parastyle is only incipiently developed on an anterolingually directed parastylar lobe. An ectocingulum is absent on the anterolabial side of the tooth. The ectocingulum is incipiently developed labial to the paracone and is most strongly developed labial to the metacone and at the metastyle. The postprotocrista is well-developed and extends directly to the metastyle. The preprotocrista is incipiently developed. A short weakly-developed crest extends between the bases of the paracone and protocone. There is no development of a pre- or postcingulum.

M1. — This tooth is transverse and rectangular in occlusal outline, with a large bulbous protocone and hypocone. The conules are inflated, with a reduction of the postparaconule and premetaconule cristae. The paracone and metacone are conical and acute. The parastylar region is rounded, but the metastylar lobe is flattened posteriorly and more pointed; extending further labially. The postmetacrista curves sharply to join labially with the ectocingulum to form the point of the metastylar lobe. The postmetaconule crista also curves labiad in similar fashion to join with the postmetacrista at a point posterolabial to the metacone. The ectocingulum is prominently developed and the ectoflexus is moderately deep. The precingulum and postcingulum are well-developed. An additional accessory cingulum is incipiently developed posterobasal to the postcingulum on UALVP 25005.

UALVP 340 is a tooth described by L. S. Russell (1932, p. 53, fig. 11) as "oxyclaenid?, gen. and sp. indet." The specimen has a slightly more prominent hypocone than the other M2's of the hypodigm but is referred to this species with some confidence based upon the labial morphology of the crown.

M2. — The M2 is considerably wider than M1 (see Table 32) and bears more massive cusps. The parastylar lobe is better developed and is anterolabially directed. The metastylar region is flattened labially and is generally more reduced. The postmetaconule crista disappears slightly below the postmetacrista, directly anterior to the metacone. The paraconule appears to be closer to the protocone apex than on M1. In addition, the bases of the hypocone and protocone are more bulbous and lingually display a distinctly bilobate separation. A well-developed crest (extension of the postcingulum) extends anterolingually from the apex of the hypocone. This accessory crest forms a deep notch in its connection with the posterolingual base of the protocone. This notch is especially prominent on UALVP 340, where a second crest-like cuspule is formed on the posterolingual side of the protocone, further narrowing the gap between the accessory crest and the hypocone wall.

M3. — These teeth are more transverse than, but otherwise similar in shape to, M3, L. dissentaneus. UALVP 25004 is an unworn crown, but lacks the hypocone, internal conule cristae, and shows poor conule development. The precingulum and postcingulum are still well-developed. On UALVP 25004 and 25006 a posterior crest connects the postprotocrista with the postcingulum, just lingual to the metaconule. On UALVP 25007 this crest is poorly developed.

m1. — UALVP 25015 is the only complete specimen representing this tooth position in L. grandaletes. The tooth is "hourglass"-shaped in occlusal outline, with large and acute trigonid and talonid cusps. The trigonid is subequal in width to the talonid. The paraconid is crestiform and not greatly reduced. The apex of the paraconid is well-defined and anteriorly directed. The paracristid is not fully lophid but remains slightly angular. The protoconid and metaconid are inflated at their bases but still maintain relatively acute apices. The talonid cusps are similarly inflated and are high and sharp, as well, with well-developed cristids. A small eoconulid is developed on the cristid obliqua of both UALVP 25015 and 25010. The talonid notch and basin are both deep, with the basin reaching its lowest level at the base of the notch. Prominent pre- and postcingulids are present. A faint labial cingulid is also developed. The labial cingulid is strongest at the hypoflexid and becomes wrinkled on the labial surfaces of the protoconid and hypoconid.

m2. — UALVP 25012 and 25013 (complete specimens) are markedly wider (transversely) than is m1 (see Table 32). Both specimens have the apices of their cusps heavily worn. The paraconid is medially positioned and more closely appressed to the metaconid than on m1. On the only specimen with an unworn trigonid (UALVP 25008), a crest extends from the apex of the metaconid to the posterolingual corner of the paraconid, completely closing the trigonid basin. The trigonid basin is triangular in occlusal view. The precingulid and postcingulid are joined by a broad, high labial cingulid. The labial cingulid dominates the labial side of the crown. An additional cingulid is variably developed extending lingually from the anterolingual side of the paraconid. This accessory cingulid is best developed on UALVP 25013 and 25009, where it incompletely extends from the paraconid, lingually around the metaconid, to the talonid notch. The talonid is as in m1, except for the development of a prominent eoconulid on the cristid obliqua in specimens where this region is well-preserved (ie. UALVP 25012 and 25009).

m3. — UALVP 25014 has a high trigonid and relatively short but broad talonid. The paraconid is similarly appressed to the metaconid as on m2 and forms a crest-like ridge that terminates at the anteromedial surface of the metaconid. The precingulid is prominent and extends labially around the protoconid to the hypoflexid before disappearing. The hypoconulid is well-developed but slightly smaller than the entoconid. A short postcingulid is present between the hypoconid and hypoconulid. There is no labial cingulid development on the hypoconid.

Discussion: Comparison of Litomylus grandaletes n. sp. with the contemporary and type species, L. dissentaneus, reveals a generally similar gross morphology in the dentition with some interesting differences. On the lower molars of L. grandaletes, the trigonid is higher; the paraconid is more cusp-like and less lophid (also less medially positioned on m1); the remaining cusps are higher and more acute; and a prominent labial cingulid is developed (especially on m2). In these characters L. grandaletes appears to more closely resemble the primitive L. orthronepius from the Puercan Rav W-1 locality of southwestern Saskatchewan (Johnston and Fox 1984). On the upper molars, L. grandaletes also resembles L. orthronepius (more than it does L. dissentaneus) in the more transverse occlusal outline of the molars; the better developed ectocingulum; slightly wider stylar shelf; and in the prominent anterolabially projecting parastylar lobe on M2. Similarly, as in L. orthronepius, the postmetaconule crista terminates labially beneath the postmetacrista, and a short postcingulum accessory crest extends from the apex of the hypocone to the anterolingual base of the protocone.

The molars of L. grandaletes also appear derived with respect to those of both L. orthronepius and L. dissentaneus: the lower molars possess more inflated cusps and extensive cingulids, relatively larger entoconid than hypoconulid on m3, and m2 wider than m1. The upper molars have a more inflated protocone, hypocone and conules; a metaconule that is relatively higher and closer to the protocone; weakly developed postparaconule and premetaconule cristae; and M2 transversely wider than M1. In the above characters, as well as in occlusal molar outline, L. grandaletes is suggestive of the genus Aletodon Gingerich 1977 from the middle Tiffanian to late Clarkforkian of Colorado, Wyoming, and North Dakota (Gingerich 1977; Rose 1981a; Gingerich 1983).

Based upon molar comparison of L. grandaletes with Aletodon quadravus and A. gunnelli (pers. obs.), it is highly probable that this species is near the ancestry of the later forms, if not directly ancestral to them. The changes required in order to give rise to an A. quadravus descendant would involve a further inflation of the molar cusps, coupled with a reduction in crest (crista and cristid) development, and a slight reduction of the paraconid, as well as a general lowering in crown-height.

In size, the teeth of L. grandaletes are most similar to the comparable teeth in the middle Tiffanian L? ishami: a taxon which is considered a valid species of Litomylus by Winterfeld (1982), but which is recognized with query by Gingerich (1983) (as it was by Gazin [1956b]). L. grandaletes differs from L? ishami in possessing sharper crests on taller, less bulbous cusps on all molars, and better developed paraconids and cingulids on the lower molars (pers. obs.). L. grandaletes could have conceivably given rise to L.? ishami, as well, but such a transition would have required a marked inflation of the molar cusps. L? ishami differs from Aletodon in retaining narrower lower molars with higher trigonids and sharper cusps (Gingerich 1983), as they do in L. grandaletes. The upper molars of L? ishami further differ from Aletodon, in: "(1) lacking continuous bordering cingula; (2) having a much larger metacone, less bulbous protocone, and stronger paracingulum; and (3) lacking a crest connection between the hypocone and protocone on M1" (Winterfeld 1982: p. 102). The possible ancestry of Aletodon and L? ishami through the large and less bulbous-cusped L. grandaletes (which precedes them in time and specialization) provides a more parsimonious hypothesis of relationship than the possible derivation of these later forms from the gracile and low-crowned, L. dissentaneus, as suggested by Sloan (1987, fig. 3).

If the P4 (UALVP 18405) described for L. grandaletes is correctly referred, then the hypothesis of relationship between this form and Aletodon is even further enhanced, for the inflated crown of UALVP 18405 is very similar to the P4 originally described and illustrated by Holtzman (1978, p. 60; Pl. 11, fig. 19) as "Condylarth, genus and species "indeterminate (1)" (SMM P77.8.202) and later identified by Gingerich (1983) as the P4 of A. quadravus — the youngest and presumably most primitive species of the genus.

L. grandaletes appears to represent a primitive, but specialized, species of Litomylus that coexisted at Cochrane 2 with the more derived L. dissentaneus. Based upon the large size of its teeth and their morphological similarity to the primitive L. orthronepius, L. grandaletes is a plausible ancestor for both Aletodon and L? ishami of the middle Tiffanian.

Subfamily Apheliscinae (Matthew 1918)

Apheliscinae n. gen. and sp.

(Plate 50, figs. A—F; table 33)

Referred specimens: UALVP 25060 and 25069, P4's; UALVP 25050, 25052, 25054, 25058, 25059 and 25063, M1's or M2's (total: 6); UALVP 25070, M3 (tentatively referred); UALVP 25053, 25061, 25062 and 25065, p4's; UALVP 25066, m1; UALVP 25068, dentary fragment with m2 and alveoli for p4, m1, and m3; UALVP 25057, m2; UALVP 25067 and 25071, m3's.

Description and discussion: The teeth from Cochrane 2 referred here are virtually identical to uncatalogued teeth from the Douglass Quarry (Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County) of Montana (pers. obs.) that D. W. Krause considers to represent a new genus and species of apheliscine (D. W. Krause, pers. comm. 1986). These teeth are most similar to the comparable parts of the dentition of <u>Phenacodaptes</u> <u>sabulosus</u> Jepsen 1930b from the latest Tiffanian Princeton Quarry of Wyoming (pers. obs.; Gazin 1959).

The lower molars of this taxon are quadrate in occlusal outline, with rounded anterior margins and medially positioned paraconids. The paraconids are much reduced, and the protoconids and metaconids are subequal. The paraconid on m1 and m2 is relatively less reduced, and more cuspate, than in <u>Phenacodaptes</u>.

The p4's of this species have a relatively higher and more posteriorly recurved protoconid and a simple, unicuspid talonid in comparison with p4 in <u>Phenacodaptes</u>. The upper molars are <u>Haplaletes</u>-like, with acute cusps. In comparison with the upper molars of <u>Phenacodaptes</u>, the Cochrane 2 specimens are more transverse and have less inflated cusps. The referred P4's differ in the same ways from P4, Phenacodaptes, as do the molars. This new taxon appears to represent the oldest known apheliscine and will be described in detail elsewhere by Krause and Maas (in prep; D. W. Krause, pers. comm. 1985).

Family ?Periptychidae Cope 1882

?Periptychidae unident. gen. and sp.

Referred specimens: UALVP 25076, ?MX; UALVP 25075, m1 or m2.

Description and discussion: UALVP 25076 is an anteroposteriorly narrow upper molar lingual fragment preserving the protocone, cingula, and metaconule (?). The base of the fragment is incomplete, but the lingual face of the protocone is steep and extends lingually from the base of this cusp. The anterior and posterior sides of the protocone are tall and the lingual edge of the protocone is rounded. The metaconule (?) appears to have been positioned near the protocone. The protocone and the cristae flaring from it are heavily worn. The labial face of the protocone appears to have been relatively flat. A short, narrow and slightly cuspidate precingulum is present. The postcingulum is also short but is wider and much higher, and extends from the base of the crown below the metaconule (?) to the anterolabial side of the protocone. The postcingulum does not join with the precingulum. Two heavily worn cuspules (hypocone and pericone?) appear to have been developed on the postcingulum, anterolingual and posterolingual to the protocone. The posterior side of the protocone is slightly concave, while the external wall of the postcingulum is slightly convex over its entire extent.

In its limited morphology UALVP 25076 shows greatest resemblance to the upper molars of primitive periptychids and, in particular, displays similarity to M1 and M2 of Tinuviel eurydice Van Valen 1978. UALVP 25076 resembles Tinuviel in possessing a weakly transverse lingual region, with a subequal pericone (?) and hypocone (?) located anterolingual and posterolingual, respectively, to the protocone. In addition, the protocone wears from its apex rather than from its labial surface.

UALVP 25076 differs from Tinuviel and other primitive periptychids in possessing reduced cingula and smaller pericone (?) and hypocone (?). In addition, the postcingulum extends anteriorly around the lingual side of the protocone.

UALVP 25075 is an incomplete talonid. The cusps of this specimen are high and acute, and strong crests connect them. The hypoconid is the largest cusp, and the entoconid is larger than the hypoconulid, which is displaced towards the entoconid and abuts against it posterolabially. All of the talonid cusps curve inward toward the talonid basin. A weak postcingulid extends from the hypoconulid down to the labial base of the hypoconid. The entocristid and cristid obliqua converge anteriorly in joining with the postvallid. The cristid obliqua is short and strongly convex labially. The entocristid is slightly shorter and is less convex lingually.

With the exception of its more gracile appearance this talonid is most similar to talonids characteristic of primitive periptychids.

Family Phenacodontidae Cope 1881

Genus Desmatoclaenus Gazin 1941

Desmatoclaenus cf. D. mearae Van Valen 1978

(Plate 51, figs. A—C)

Type of Desmatoclaenus mearae: UCMP 114308, right maxillary fragment with M1-M2.

Type locality: Saddle locality, Fort Union Formation, Bison Basin, Fremont County, Wyoming.

Known age and distribution for Desmatoclaenus mearae: Early Tiffanian (late Paleocene) of Wyoming (type locality [Van Valen 1978]) and ?Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Simpson 1936; Van Valen 1978]).

Referred specimens: UALVP 25078, dp3; UALVP 25080, p2; UALVP 25077, p3?; UALVP 25079, m1; UALVP 25103, m1 or m2.

Description: p2, p3? — The anterior premolars referred here (UALVP 25080 [L=4.5, W=2.7] and 25077 [L=5.1, W=3.4]) resemble the comparable teeth of Ectocion Cope 1882a, but are slightly lower-crowned and more inflated at their bases than in that genus. Both specimens have simple crowns with triangular lateral outlines and well developed anterior and posterior protoconid crests. The posterior crest on the referred p3 divides near the talonid cusp (hypoconid), forming a branching pattern reminiscent of the postvallid crest pattern on dp3 of E. collinus Russell 1929a (see below), but much smaller. This specimen lacks a distinct paraconid.

dp3. — UALVP 25078 is a posterior fragment of a premolar that is closely similar to dp3 (UALVP 25096 and 25104) in E. collinus (see below), but smaller (W=2.5). The specimen is comparable in size to UALVP 25077, the referred p3 (?)

m1. — UALVP 25079 is only slightly smaller (L=7.3, AW=5.2, PW=5.3) than m1, E. collinus, from Cochrane 2 (see below). The specimen is more elongate, with a longer, higher trigonid and shorter talonid. As in West's (1976) diagnosis for Desmatoclaenus hermaeus Gazin 1941, UALVP 25079 possesses a well developed lingually positioned paraconid. The paracristid extends transversely from the paraconid and cuts ventrally before steeply ascending in an arc to the protoconid apex. The trigonid basin is compressed anteroposteriorly, as in D. hermaeus, and both the pre- and postcingulids are poorly developed. The protoconid and metaconid are inflated and form interconnecting crest-like extensions into the trigonid basin anterior to the protocristid. The result is the formation of a smaller, secondary basin posterior to the main trigonid basin. The talonid is similar to the talonids in Ectocion, Phenacodus Cope 1873, and Tetraclaenodon Scott 1892, but differs in possessing a more labial connection of the cristid obliqua to the protoconid, and in lacking an entoconulid. Accessory cuspules are developed in the hypoflexid and on the talonid basin, labial to the talonid notch.

Discussion: In their primitive phenacodontid morphology, the specimens referred here most resemble teeth of Desmatoclaenus Gazin Van Valen (1978) has recently increased the number of species (and thus the temporal and geographic range) of Desmatoclaenus, from the single type species (D. hermaeus Gazin) recognized by West (1976), to include "Mioclaenus" protogonoides Cope 1882b and two new species — one (D. dianae) from the early Puercan of New Mexico and the other (D. mearae) from the early Tiffanian of Wyoming. D. mearae, from the Saddle locality, is known only from its upper molars (Van Valen 1978), and, although apparently slightly smaller, is, nevertheless, closest in size and geologic age to the Cochrane 2 species.

UALVP 25079 differs from m1, *D. hermaeus* and *D. protogonoides*, in its more labial connection of the cristid obliqua with the trigonid, and the development of a secondary posterior basin on the trigonid.

Genus <u>Ectocion</u> Cope 1882a

<u>Ectocion</u> <u>collinus</u> Russell 1929a

(Plate 51, fig. D; pl. 52, fig. A; table 34)

Type: UALVP 118, right M3.

Type locality: Cochrane site 1, Porcupine Hills Formation, southwestern Alberta.

Known age and distribution: Earliest Tiffanian (late Paleocene) of Alberta (type locality [Russell 1929a]; Cochrane 2 locality, Porcupine Hills Formation [Gingerich 1982b]), Montana (Douglass Quarry and Locality 68, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Simpson 1935, 1937; Krause and Gingerich 1983]; Locality 27, Tongue River Formation, Crazy Mountain Field, Wheatland County [Simpson 1935, 1937; Krause and Gingerich 1983]), and Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]).

Referred specimens: UALVP 25095, P2; UALVP 25088, 25091 and 25099, DP3's; UALVP 25094, P4; UALVP 25087, 25101 and 25102, M1's; UALVP 25089, M2; UALVP 25100, M1 or M2; UALVP 25093, p2; UALVP 25096 and 25104, dp3's; UALVP 120, 25083, 25090, 25092 and 25098, dp4's; UALVP 25110, right dentary fragment with p4-m3; UALVP 25086, m1; UALVP 25085, m2; UALVP 25015, m1 or m2; UALVP 25084, m3.

Description: The molar dentition and most of the premolars (both deciduous and permanent) of E. collinus have already been adequately described by Russell (1929a), Simpson (1935 [as "Gidleyina"]), West (1971 [as E. "montanensis"]), Gingerich (1982b) and Krause and Gingerich (1983); therefore, the description of the Cochrane 2 specimens will include only teeth at positions that have received little or no previous documentation.

DP3. — The deciduous upper third premolar of E. collinus was known to Krause and Gingerich (1983, table 5) but, to my knowledge, has never been described. West (1971) described the DP3 for the Torrejonian Tetraclaenodon puercensis (Cope 1881c) and the late Tiffanian Ectocion osbornianum Cope 1882a, which the Cochrane 2 specimens closely resemble in occlusal outline. UALVP 25099 preserves the cusps and crests of this tooth in detail. The largest cusp is the paracone, connected to a prominent parastyle via a long well-developed preparacrista. The parastylar lobe is anterolabially elongate. A distinct metacone is developed but is transversely compressed and closely appressed to the paracone. A small metastyle is present directly behind the metacone on a short postmetacrista. A well-developed postcingulum forms the posterior border of the tooth, extending from the metastyle to the posterolingual corner of the protocone. The protocone is relatively large and conical and is attached to an incipiently developed preprotocrista and paraconule.

UALVP 25099 is more advanced in comparison to the DP3 of Tetraclaenodon in possessing a distinct metacone and an incipient paraconule and preprotocrista. The specimen is more primitive than DP3, E. osbornianum, in lacking a distinct separation of paracone and metacone and in lacking an enclosed trigon basin, owing to the absence of a postprotocrista and metaconule (West 1971).

dp3. — The deciduous lower third premolar of E. collinus was not known to Krause and Gingerich (1983) in their study of this species from the Douglass Quarry of Montana and was only briefly described by West (1971, p. 22) for E. "montanensis".

The dp3's from Cochrane 2 lack cingulids and bear well-developed crests on the postvallid descending from the protoconid and from an incipiently developed metaconid, posterolingual to the protoconid. The paraconid, as preserved on UALVP 25096, is prominent and positioned high on the anterior slope of the protoconid. The labial and lingual sides of the talonid are inflated, causing the posterior region of the tooth to be much wider than the anterior. The talonid is single-cusped and simple in structure. Apical wear is present on all cusps and crests of the crown on UALVP 25096.

Discussion: The mean measurements for the sample of E. collinus from Cochrane 1 and 2 are outside of the range of variation for E. collinus from Douglass Quarry (see Text-fig. 3). Nevertheless, the sample from the Cochrane localities is still relatively small and further collecting will be required in order to determine the range of variation for the population.

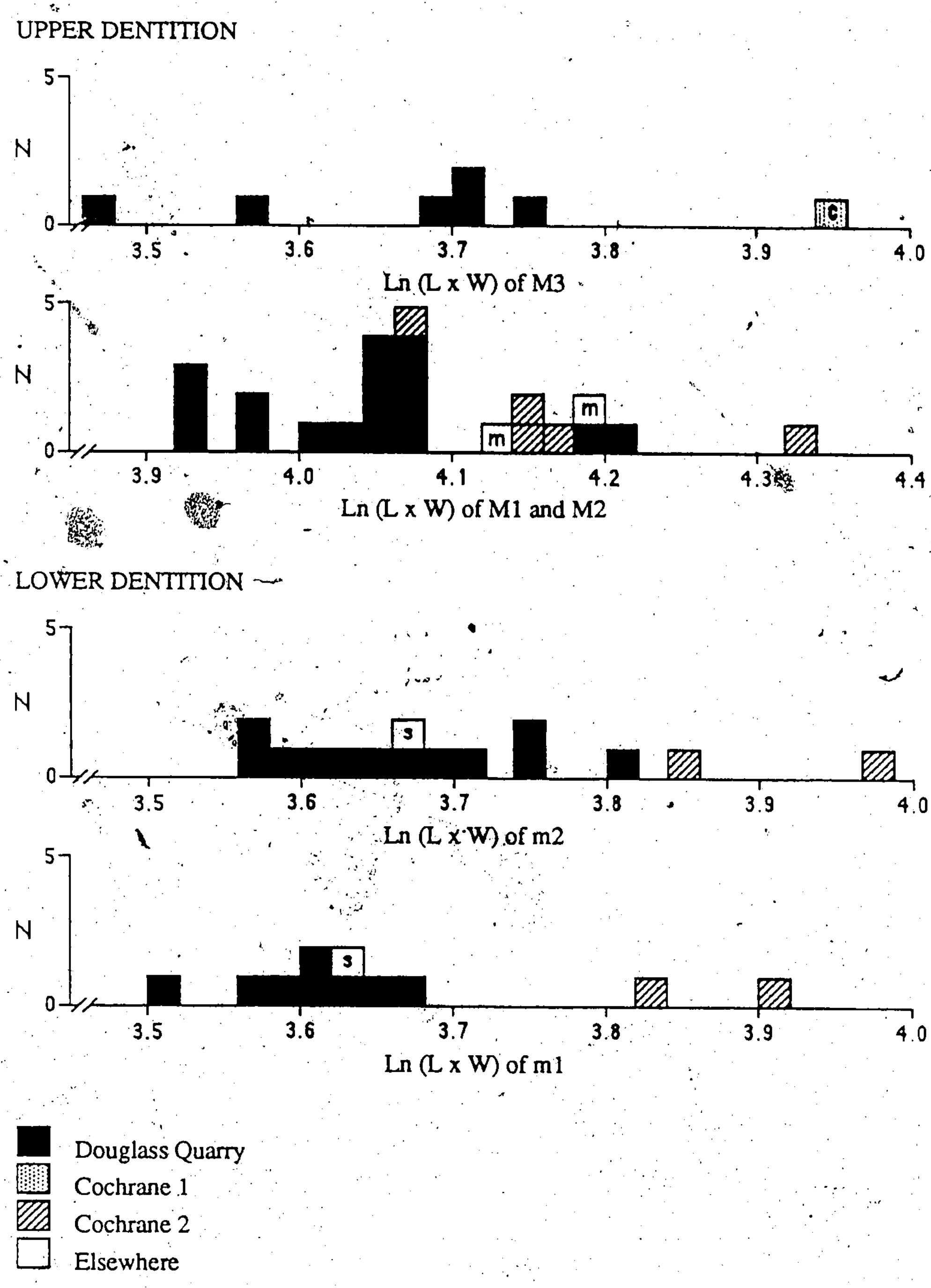
In comparison with the Douglass Quarry specimens, E. collinus from Cochrane 2 has more robust lower molars that bear a relatively higher paralophid and, in at least two specimens (UALVP 25085 and 25086), a more distinct paraconid. These characters further enhance the resemblance of this species of Ectocion to the ancestral genus Tetraclaenodon (West 1976).

Isolated specimens of E. collinus from the Keefer Hill ["Shotgun"] locality of Wyoming are virually identical to those in the Cochrane sample (pers. obs.). This is suggestive of a slightly older age for the Cochrane and Keefer Hill localities with respect to Douglass Quarry.

In comparison with other species of Ectocion, the holotype of E. collinus (UALVP 118) displays a relatively prominent hypocone on the postcingulum. The presence of this cusp (in addition to the large size of the tooth) motivated West (1976) to remove the specimen from Ectocion and place it into the genus Phenacodus (since a hypocone was supposed to be absent on M3 of Ectocion [West 1976]), as a representative of the latest

Paleocene and early Eocene P. vortmani Cope 1880. Gingerich (1982b) has since reevaluated West's identification and concluded that inclusion in Ectocion is valid based on the "lophodont" nature of the crown on UALVP 118. The collection of further material referable to E. collinus from Cochrane 2 confirms the interpretation of the holotype as representative of the earliest known species of Ectocion. Owing to the generally Tetraclaenodon-like nature of the specimens collected from Cochrane 2, the presence of a hypocone on the M3 is interpreted as a primitive retention from a Tetraclaenodon ancestor (as L. S. Russell [1929a] had believed originally). Comparison of the holotype with the M3 of T. puercensis reveals much similarity in overall structure. However, the hypocone on UALVP 118 is more reduced, while the entire tooth is more transverse and has a fully formed mesostyle and ectocingulum. The similarity of the oldest known Ectocion to much younger species of Phenacodus is therefore owing to the primitive retention of a hypocone, and a similar size as a probable result of parallelism — achieved at different times in the evolutionary history of separate (but closely related) lineages.

Schiebout (1974) described Ectocion cf. E. "montanensis" from the Black Peaks Formation (Big Bend National Park) of Texas. Based on the size and description of these specimens, they appear similar to the comparable dentition in E. collinus from Cochrane, and may indicate the presence of this species in the middle and late Tiffanian [Ti3 and Ti4 biochron zones] of southwestern North America (see Sloan 1987). Direct comparison of the Black Peaks material with the Cochrane sample will be required before this interpretation can be further assessed.



Text-fig. 3. Comparison of tooth size distributions of earliest Tiffanian Ectocion collinus from Douglass Quarry, Cochrane 1, Cochrane 2 and elsewhere. (c, m, and s refer to type specimens of Ectocion collinus, Ectocion "montanensis" and "Gidleyina silberlingi", respectively.)

Family ?Mesonychidae Cope 1875

Unidentified gen. and sp.

Referred specimen: UALVP 25111, premolar or molar talonid.

Description and discussion: UALVP 25111 is a large talonid fragment preserving the sectorial posterior heel of a premolar or molar characteristic of the Mesonychidae. The specimen possesses an inflated blade-like hypoconulid forming a relatively deep carnassiform notch between its anterior surface and the posterior surface of a missing protoconid. The hypoconulid leans strongly linguad. Two prominent labial and lingual cingula are developed along the base of the crown, disappearing at the posterior edge of the hypoconulid.

Due to the fragmentary nature of the specimen and the uncertainty of its tooth position, an identification beyond the familial level is not possible.

Order Pantodonta Cope 1873

Unidentified. gen. and sp.

(Plate 52, figs. B, C)

Referred specimen: UALVP 25113, lower canine.

Description and discussion: UALVP 25113 is similar in shape to the lower canine described by Simons (1960) for *Caenolambda jepseni* from the late Tiffanian of Wyoming (Polecat Bench Formation, Bighorn Basin, Bighorn County), but is substantially smaller (crown width=11.0), and presumably smaller than the lower canine in the early Tiffanian *C. pattersoni* Gazin 1956a from the Saddle locality (Fort Union Formation, Bison Basin, Fremont County) of Wyoming (the lower canine of *C. pattersoni* is unknown [Simons 1960; Gingerich and Childress, Jr. 1983]). As in *C. jepseni*, prominent, blade-like anterolingual and posterolabial crests are developed on the crown of UALVP 25113. This specimen represents the largest mammalian tooth collected from the Cochrane 2 locality.

Infraclass Eutheria incertae sedis

Order Uncertain

Family Palaeoryctidae (Winge 1917)

Genus Palaeoryctes Matthew 1913

Palaeoryctes cf. P. punctatus Van Valen 1966

(Plate 52, fig. D; pl. 53, figs. A—F; table 35)

Type of Palaeoryctes punctatus: AMNH 15850, right dentary fragment with damaged p4-m3 and associated right maxillary fragment with damaged M1-3, distal end of left humerus, proximal end of ulna.

Type locality: Site in the head of Big Sand Coulee, Willwood Formation, Clark's Fork Basin, Wyoming.

Known age and distribution for Palaeoryctes punctatus: Middle Tiffanian (late Paleocene) of North Dakota (Brisbane locality, Tongue River Formation, Williston Basin, Grant County [Holtzman 1978; pers. obs.]); ?latest Tiffanian of Wyoming (?Princeton Quarry, Polecat Bench Formation, Bighorn Basin, Park County [Rose 1981a]); middle Clarkforkian (earliest Eocene) of Wyoming (Locality SC-136, Willwood Formation, Clark's Fork Basin [Rose 1981a]); late Clarkforkian of Wyoming (type locality [Van Valen 1966; Rose 1981]).

Referred specimens: UALVP 25136, P4; UALVP 25132 and 25189, M1's; UALVP 25133, M2; UALVP 25134, M3; UALVP 18461, 18600, 18601, 25129, 25130 and 25131, MX lingual fragments; UALVP 18606 and 25229, m1's; UALVP 18603 and 25228, m2's; UALVP 18604, and 18605, m3's; UALVP 25135, mX.

Description: The lower molars referred to this species differ from the lower molars of Palaeoryctes puercensis Matthew 1913 in their larger size, less anteroposteriorly compressed trigonids, and relatively lower trigonid heights. In size, and in the more anteriorly directed paraconid on m1 and m2, these teeth are most similar to the lower molars of P. punctatus (Van Valen 1966).

The upper molar fragments referred here closely resemble certain specimens from the Brisbane locality of North Dakota described by Holtzman (1978).

Discussion: Comparison of the Cochrane 2 specimens with the sample from the Brisbane locality of North Dakota referred to "P. sp. cf. P. punctatus" (Holtzman 1978), indicates the latter to be a composite taxon consisting of two species. Teeth of the smaller of the two species are almost identical to comparable specimens of P. cf. P. punctatus from Cochrane 2 and includes SMM P77.8.61 (?M2) and P77.8.65 (m2). The larger species is morphologically similar to the other specimens and includes SMM P77.8.62 (?M2), P77.8.64 (m1), and P77.7.76 (m2).

Genus Pararyctes Van Valen 1966

Pararyctes pattersoni Van Valen 1966

(Plate 53, figs. G, H; table 36)

Type: UW 2002, left M1.

Type locality: Saddle locality, Fort Union Formation, Bison Basin, Fremont County, Wyoming.

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta (Cochrane 2 locality, Porcupine Hills Formation [Van Valen 1966]); early Tiffanian of Wyoming (type locality [Van Valen 1966]) and Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.; D. W. Krause, pers. comm. 1986]); middle Tiffanian of Alberta (UADW-2 locality, Paskapoo Formation, Blindman River [pers. obs.; Fox, in press]; Joffre Bridge Road Cut locality, lower level, Paskapoo Formation, Red Deer River [Fox, in press]; Hand Hills West locality, upper level, Paskapoo Formation, Hand Hills [Fox, in press]) and North Dakota (Brisbane locality, Tongue River Formation, Williston Basin, Grant County [Holtzman 1978; pers. obs.]); late Tiffanian of Alberta (Police Point locality, Ravenscrag Formation, Cypress Hills [Fox, in press]) and Saskatchewan (Roche Percée local fauna, Ravernscrag Formation [Fox, in press]).

Referred specimens: UALVP 25155, 25168 and 25200—25204, P4's (total: 7); UALVP 25140, 25141, 25145, 25148, 25160 and 25232, M1's (total: 6); UALVP 25138, 25148 and 25158, M2's; UALVP 25153, M3; UALVP 25193—25198 (total: 6), dp4's;

UALVP 25150, 25162 and 25170, m1's; UALVP 25142, 25143 and 25147 and 25230, m2's; UALVP 25151, Rm1 or m2; UALVP 25146 and 25159, m3's; UALVP 25142, 25143, 25147, 25149, 25156, 25161, 25162, 25167, 25170, 25172, 25177, mX's (total: 11).

Description and discussion: The first identification of Pararyctes from the Cochrane 2 locality was made by Van Valen (1966 p. 58) for a right upper molar (UALVP 428 [probably M2]) described by L. S. Russell (1932, p. 52, fig. 10) as P4 of "Diacodon septentrionalis?". This specimen is virtually identical to the upper molars of P. pattersoni, subsequently collected from Cochrane 2 and elsewhere. The upper and lower dentition of this palaeoryctid have been adequately described by Van Valen (1966) based on isolated material and nothing further need be added based upon the Cochrane 2 specimens.

The recent collection of articulated material of P. pattersoni from the middle Tiffanian of Alberta (R. C. Fox, pers. comm. 1986) and a complete skull of this species from the earliest Tiffanian of Wyoming (P. D. Gingerich, pers. comm. 1986) will provide a much more complete description of this taxon.

Pararyctes rutherfordi n. sp.

(Plate 53, fig. I)

Etymology: Named for the late Professor R. L. Rutherford in recognition of his work on the geology of the Cochrane region and contribution to the discovery of the Cochrane 2 locality.

Holotype: UALVP 25180, left M2.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Hypodigm: Type specimen and UALVP 25178-79, m1 or m2's.

Age and distribution: Earliest Tiffanian (late Paleocene) of Alberta — known only from the type locality.

Diagnosis: Differs from P. pattersoni in being substantially larger (molars approximately 40% larger than in P. pattersoni). Further differs from P. pattersoni in possessing a relatively broader postcingulum on M2.

Description: M2. — The type specimen, UALVP 25180 (L=2.8, W=4.7), is the crown of an upper molar lacking enamel and similar to the M2 of P. pattersoni (as described by Van Valen [1966]), albeit substantially larger. The postcingulum of this specimen differs in being relatively wider (anteroposteriorly) at its labial extent. The crests, cusps and wear of this specimen closely resemble comparable features on the upper molars of the type species.

m1 or m2. — Despite a considerable amount of anteroposterior crushing of its crown, UALVP 25178 (L=2.8*, AW=2.3, PW=1.9) is morphologically similar to the lower molars of Pararyctes pattersoni as described by Van Valen (1966), but differs in its larger size. UALVP 25179 (AW=1.8), is a trigonid similar to, but larger than, that of P. pattersoni; including the same pattern of apical wear (forming a broad V-shape along the trigonid cristids).

Discussion: The genus Pararyctes was erected by Van Valen (1966) for P. pattersoni (see above). The upper and lower molars referred to Pararyctes rutherfordi from Cochrane 2 are substantially larger than these teeth in P. pattersoni and are also larger than the comparable dentition in an undescribed new species (referred to as "Pararyctes sp.") from the Torrejonian of Alberta (Fox 1983; Fox, in press). In addition, P. rutherfordi is smaller in comparison with a new, undescribed, giant form of Pararyctes from the middle Tiffanian of Alberta (R. C. Fox, pers. comm. 1986; Fox, in press).

Although the sample is, at present, small, the presence of a new, larger species of Pararyctes, coexistent with P. pattersoni, at Cochrane 2 is clearly indicated. The meagre nature of the remains is such that the diagnosis presented may be altered pending the recovery of better preserved material.

Subfamily Didelphodontinae Matthew 1918

Didelphodontinae unident. gen. and sp.

(Plate 54, figs. A—E)

Referred specimens: UALVP 25187, M1; UALVP 1980, M2; UALVP 25186, M3.

Description: M1. — UALVP 25187 is highly transverse and anteroposteriorly short (L=3.1, W=5.1) with moderately connate paracone and metacone. The protocone is anteroposteriorly compressed and is the largest cusp of the crown. The paracone is larger than the metacone, and both are conical. The para- and metastylar lobes are well developed. The parastylar lobe is hook-shaped to accomodate the metastylar lobe of the P4. The metastylar lobe projects posterolabially and is fully rounded in occlusal view. A deep ectoflexus accentuates both labial lobes. The ectocingulum is relatively weak on UALVP 25187 and fades out at the ectoflexus, resulting in separate anterior and posterior segments on the parastylar and metastylar lobes, respectively. With the exception of a heavily worn parastyle, there are no additional stylar cusps. The preparacrista is short and weakly developed. The postmetacrista is continuous with the posterior ectocingulum. The conules are small but distinct. The paraconule is positioned significantly linguad with respect to the metaconule. The paraconule is heavily worn and appears as a transversely elongate pit, just anterolabial to the protocone. The metaconule is conical and is worn apically. The preparaconule crista extends labially to join with a weak preparacrista and the parastyle. Postparaconule and premetaconule cristae are absent. The postmetaconule crista is short and disappears at the posterolingual base of the metacone. The preprotocrista is only slightly higher than the postprotocrista. The trigon basin is shallow. The anterior and posterior sides of the protocone are high and lack cingula; however, a short, weak bulge extends anteriorly in cusp-like fashion from the center of the anterior protocone wall.

Apical wear truncates the protocone on UALVP 25187 and is also present on both the paracone and metacone. Heavy wear extends from the apex of the protocone along the preprotocrista to excavate the paraconule and continues along the preparaconule crista to the parastyle. Additional wear extends from the protocone along the postprotocrista to the metaconule.

M2. — UALVP 1980 (L=2.6, W=5.0) is similar to the M1 (UALVP 25187) in morphology but differs in possessing a slightly smaller protocone and a shorter labial region, with shallower ectoflexus and poorly developed parastylar and metastylar lobes (with the latter more reduced than the former). The paracone bears strong apical wear, while the metacone apex is broken off. The stylar shelf is moderately wide due to the poor development of the ectoflexus. Anterior and posterior segments of the ectocingulum are separated by an absence of cingulum development labial to the centrocrista (as on UALVP 25187). The development of a weak stylar cusp marks the posterior extent of the anterior segment of the ectocingulum. The parastyle was low and has been eroded away. Pre- and postcingula are completely absent, with only a faint depression present on the anterior wall of the protocone.

M3. — UALVP 25186 preserves most of the crown for this tooth position except for the stylar region. This tooth is extremely transverse as in M1 and M2, but is relatively smaller and narrower (L=2.0*, W=4.5*) than the previously described teeth. The protocone is significantly smaller and is near the size of the paracone. The paracone, in turn, is much larger and higher than the metacone. Both the paracone and metacone bear an equal amount of apical wear. The paracone is canted more anteriorly than the metacone. A paraconule is absent from UALVP 25186 and the preprotocrista extends from the protocone to the parastyle (which is not preserved). The preprotocrista is convexly bowed along its length from the paracone to the protocone. The metaconule is cusp-like, is worn, and is located directly lingual to the metacone. A short postmetaconule crista extends to the posterolingual base of the metacone. The paracone is taller than the metacone and has the preparacrista directed anterolabially, presumably, to the parastyle on an elongated parastylar lobe. A postmetacrista and metastylar lobe is absent. The anterior and posterior sides of UALVP 25186 are slightly convex and completely devoid of cingulum development.

Discussion: The affinity of these specimens appears to be closer to didelphodontine palaeoryctids (sensu Van Valen 1966) than to any other observed group. The Cochrane 2 molars differ from the upper molars of Gelastops Simpson 1935, Acmeodon Matthew and Granger 1921, and Didelphodus Cope 1882 in being more transverse lingually and in having a narrower stylar shelf and short, weak preprotocrista. The molars of this form further differ from those of Gelastops and Acmeodon and resemble Didelphodus in possessing a low parastyle with few or no additional stylar cusps and a less connate paracone and metacone.

Only two species of Didelphodus are currently recognized — D. absarokae (Cope 1881) and D. altidens (Marsh 1872) from the Eocene of southwestern North America (Van Valen 1966). Didelphodontinae unident. gen. and sp. resembles Didelphodus altidens more so than D. absarokae in the more transverse shape of the M2 with relatively short anteroposterior labial length. The Cochrane species further resembles D. altidens in having the cusps and crests relatively lower; the preparacrista and postmetacrista both gradually merging into the ectocingulum and stylar shelf; the metacone merging gradually into the metacrista without the formation of a sharp angle; the ectocingulum poorly developed with no trend toward cuspule formation; the conules reduced in size; the metacingulum less developed; the parastylar lobe relatively small and not anteriorly projecting; and the lingual face of the protocone rounded and the stylar area flatter.

The Cochrane 2 species differs from D. altidens in being more elongate lingually, in having a narrower stylar shelf, and in lacking carnassial notch development.

This didelphodontine palaeoryctid is also present in the earliest Tiffanian Douglass Quarry (Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County) of Montana (pers. obs.) and is represented by an isolated, uncatalogued, M1 or M2 that is virtually identical to the Cochrane specimens.

Palaeoryctidae unident. gen. and sp. 1

(Plate 54, figs. F—H)

Referred specimen: UALVP 25188, m3.

Description and Discussion: The specimen has a high and transversely wide trigonid and a small, low, talonid with a prominent hypoconulid, situated closer to the entoconid than to the hypoconid. The paraconid is transversely oriented and blade-like.

UALVP 25188 bears close resemblance to the m3's of Palaeoryctes and Cimolestes, and differs from both in being smaller (L=1.2, AW=1.0, PW=0.6) than any of the known species.

UALVP 25188 differs from the m3 of Cimolestes (and resembles Palaeoryctes) in possessing a more anteroposteriorly compressed trigonid with a more rounded, and relatively wide (transversely) paraconid, closely appressed to the metaconid. The Cochrane 2 specimen differs from the m3 of Palaeoryctes (and resembles Cimolestes) in having a low trigonid and a long talonid, which bears distinct, well separated, talonid cusps.

UALVP 25188 is smaller than the m3 of any other known palaeoryctid, and undoubtedly represents a new taxon. The recovery of additional specimens will be required before an adequate evaluation can be made of its affinities.

Palaeoryctidae unident. gen. and sp. 2

(Plate 55, figs. A—G; table 37)

Referred specimens: UALVP 25226, M1 or M2; UALVP 25218—25221 and 25225, m1's (total: 5); UALVP 333 (part 1) and 25214—25217, m2's (total: 5); UALVP 333 (part 2), 25210—25213 and 25227, m3's (total: 6).

Description and discussion: The referred specimens compare most favorably with the dentition of Cimolestes cerberoides Lillegraven 1969 from the Late Cretaceous Scollard Formation of Alberta. The lower molars differ from those of C. cerberoides in being smaller and in possessing reduced protoconids that are slightly lower in height than the metaconids. The metaconids are subequal in size with the protoconids and are inflated with respect to their condition in C. cerberoides. In addition, the teeth from Cochrane 2 consistently lack the development of a carnassial notch on the paracristid, although the protocristid notch is well developed.

The upper molar (UALVP 25226) referred here differs from the M1 and M2 of C. cerberoides in possessing an incipiently developed precingulum and a prominent, cuspate, postcingulum. In addition, the ectoflexus is deeper and the stylar shelf and metacone are relatively more reduced in UALVP 25226.

The lower molars assigned to this taxon differ in morphology between tooth positions in the same ways that they do in C. cerberoides. If not for the reduced condition of the protoconid, this small palaeoryctid would undoubtedly be referrable to the genus Cimolestes, with close affinity to C. cerberoides.

L. S. Russell (1929a) designated two lower molars, UALVP 333 (a trigonid and complete crown), that he collected from Cochrane 2 in 1927, as the paratypes of his new lepticrid species "Diacodon" septentrionalis (ibid., p. 173; 1932, p. 52). Comparisons made in this study indicate "D." septentrionalis (which was later placed in "Palaeictops" by Van Valen [1967]) to be a composite taxon, with the holotype (UALVP 126) referable to the pantolestid genus Propalaeosinopa (see P. septentrionalis below for further discussion) and the paratypes (UALVP 333) representing the m2 and m3, respectively, of the above palaeoryctid species.

Palaeoryctidae unident. gen. and sp. 3

(Plate 56, figs. A—C)

Referred specimen: UALVP 25222, m3.

Description: The crown of UALVP 25222 is elongate (L[illegible], AW=2.0; PW=1.7) and dominated by its cusps. The trigonid of UALVP 25222 appears relatively low due to the high talonid cusps and crests. The trigonid bears a prominent, acute protoconid with well developed para- and protocristids. The protoconid is roughly triangular in cross section with a rounded labial surface and nearly flat lingual face. The internal (lingual) face of the protoconid is only slightly concave. The metaconid is missing, but from the size and shape of its base it was probably subequal in size with the protoconid, and more conical in cross-section. The paraconid is also broken and was much smaller than the protoconid and metaconid. The paraconid is situated with its base slightly higher than the base of the metaconid, and is positioned anterolabial to the metaconid. The paraconid is appressed to the metaconid and (when complete) probably had its apex directed anterolingually. A short, but prominent, precingulid extends from the base of the paraconid to the anterolabial base of the protoconid. A second, faint, and cusp-like cingulid extends between the lingual bases of the paraconid and metaconid. The protoconid is slightly recurved posteriorly, in contrast to the talonid cusps, which curve anteriorly.

The talonid is narrow and anteroposteriorly elongate, and dominated by a prominent hypoconulid. The hypoconulid, in turn, is elongate, narrow, and aquiline. The hypoconid is slightly recurved lingually, while the entoconid is recurved to a similar degree anterolabially. The hypoconulid is positioned medially between the hypoconid and entoconid. The hypoconulid is the largest and highest talonid cusp, while the hypoconid is only slightly larger and higher than the entoconid. All of the talonid cusps are gracile, sharply acute, and well separated from each other by postcristids forming right angles. The cristid obliqua is straight and high and appears to have joined the postvallid labial to the protoconid-metaconid notch. A small mesoconid is developed high on the cristid obliqua, immediately preceding the hypoconid. The hypoflexid is shallow. The cristid obliqua is higher than the entocristid but both strongly descend to the trigonid from the apices of the hypoconid and entoconid, respectively. Although damaged, a large entoconulid was also present. The talonid basin is narrow and shallow, and is constricted posteriorly by the talonid cusps. The internal face of the hypoconulid is concave. This condition is similar but less extreme on the hypoconid. The entoconid has a convex internal surface that extends to the midpoint of the talonid basin. The external bases of all the talonid cusps are swollen.

The posterior root is anteroposteriorly elongate and narrow, and extends across the length of the talonid. The anterior root is much shorter (anteroposteriorly) and wider (transversely) than the posterior root.

Discussion: The greatest resemblance of UALVP 25222 is to the Late Cretaceous and Early Paleocene palaeoryctid Procerberus formicarum Sloan and Van Valen 1965. The specimen resembles the m3 of P. formicarum in the possession of a mesoconid and entoconulid, and in having the hypoconid higher relative to the entoconid. These similarities are considered to be primitive.

Nevertheless, the Cochrane specimen differs from m3, P. formicarum, in the following features:

1. In possessing a lower, more reduced paraconid.
2. In possessing a relatively longer protoconid segment of the paracristid.
3. In having the paraconid positioned further labially (more medial) on the trigonid and more anteriorly directed.

4. In possessing a more elongate and laterally compressed hypoconulid.
5. In possessing higher, sharper, and better curved entoconid, hypoconid, and hypoconulid, with sharper and higher cristids.
6. In displaying a smaller entoconulid and weaker mesoconid.
7. In having a relatively larger and more inflated metaconid.
8. In possessing a concave internal (anterior) surface on the hypoconulid, continuous with the talonid basin, and postcristids converging at the apex of the hypoconulid.
9. In having a more medially positioned hypoconulid situated equidistant from the entoconid and hypoconulid, or slightly closer to the hypoconid.
10. In having a narrower (transversely) posterior root.

The major structural differences from P. formicarum observed on UALVP 25222 (characters 1, 2, 3, 5, and 7) appear to be specializations for the enhancement of shear and hyperinsectivory (ie., mainly puncturing with little crushing involved during mastication). The increase in size of the metaconid coupled with the reduction of the paraconid can be interpreted as a provision for greater postvallid shear, while the higher, more acute talonid cusps and crests reduce the surface area used for grinding and create more area for cutting.

The strikingly unique construction of the talonid on UALVP 25222 warrants a special consideration of its affinities. According to Fox (1984a) two of the character states to be expected in the ancestral (primitive) eutherian m3 include a "hypoconulid approximately equidistant from hypoconid and entoconid, and centrally placed on [the] posterior talonid rim ... [and the] ... hypoconulid on m3 strongly developed, projecting upward in finger-like fashion" (ibid., p. 15). The presence of both characters on UALVP 25222 tend to support a more primitive phylogenetic relationship for this specimen with respect to the known Late Cretaceous and Paleocene palaeoryctids and may represent a retention of primitive characters.

It is probable that the differences cited from Procerberus are of great enough taxonomic value to constitute the erection of a new genus. However, the paucity of the material precludes an adequate diagnosis. Irrespective of this, UALVP 25222 appears to represent a distinct, highly specialized palaeoryctid taxon, possibly derived from Procerberus or an even more primitive palaeoryctid ancestor.

"Palaeoryctoid" n. gen. and sp.

(Plate 56, figs. D—F)

Referred specimen: UALVP 25232, m3.

Description and discussion: UALVP 25232 (L = 3.2, AW = 2.3, PW = 1.7) is a large m3, structurally similar to m3 in *Cimolestes cerberoides* (pers. obs.). The trigonid of UALVP 25232 is low and displays bulbous cusps. The protoconid is larger, but only slightly higher, than the metaconid. The paraconid is smaller and lower than the metaconid and is more lingually placed, directly anterior to the metaconid. The protoconid and metaconid are vertically oriented and the postvallid wall is straight. The para- and protocristids are long and lack distinct carnassial notches. The precingulid is well developed and cuspidate. The lingual side of the crown on UALVP 25232 is symmetrically arcuate from the paraconid to the hypoconulid, resulting in a strong labial curve in the talonid. The talonid is elongate, as is the hypoconulid, which extends posterolingually and is larger and higher than the hypoconid. There are two subequal cuspules (twinned) in the position of the entoconid. An even smaller entoconulid is also developed. The talonid basin shallow and the hypoflexid is deep. The cristid obliqua is labially convex and connects with the postvallid wall directly below the protoconid-metaconid notch.

UALVP 25232 differs from the m3 of *C. cerberoides* in the following features:

1. In possessing a lower trigonid.
2. In having an anteroposteriorly longer trigonid with more inflated cusps.
3. In possessing a more lingually situated and bulbous paraconid.
4. In having a lower protoconid.

5. In displaying para- and protocristids lacking distinct carnassial notches.

6. In having a shallower trigonid basin.

7. In having the lingual side of the crown symmetrically arcuate.

8. In bearing a reduced and doubled entoconid.

The affinity of this taxon is unknown. Morphologically, the specimen is suggestive of the Palaeoryctidae but is clearly divergent from known m3 structure in this group. The differences cited above from m3, C. cerberoides, appear to represent structural modifications of the ancestral palaeoryctid dental plan for more crushing and grinding (rather than puncturing and shearing) during mastication.

UALVP 25232 superficially resembles the m2's of some viverravid carnivorans in its low-crowned trigonid and distinctive talonid shape. However, it differs considerably from all known viverravid m2's in possessing a more transverse and anteroposteriorly compressed trigonid with reduced paraconid, and a doubled entoconid on the talonid.

Family Leptictidae Gill 1872

Genus Prodiacodon Matthew 1929

Prodiacodon cf. P. puercensis (Matthew and Granger 1918)

(Plate 57, figs. A—E; pl. 58, figs. A—C; table 38)

Type of Prodiacodon puercensis: AMNH 16011, maxillary fragment with P4, edentulous lower jaw fragments, humerous, femur, tibia, fibula, tarsals, carpals, and phalanges.

Type locality: Torrejon Arroyo locality, Nacimiento Formation, San Juan Basin, New Mexico.

Known age and distribution of Prodiacodon puercensis: Late Torrejonian (middle Paleocene) of New Mexico (type locality [Matthew and Granger 1918; Novacek 1977]) and Wyoming (Rock Bench Quarry, Fort Union Formation, Bighorn Basin, Park County [pers. obs.]; Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980]); earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]).

Referred specimens: UALVP 25241, DP3; UALVP 25237, P3; UALVP 25242, 25243 and 25251, P4's; UALVP 25234, 25246 and 25252, M1 or M2's; UALVP 25238, p3; UALVP 25236 and 25244, p4's; UALVP 25235, 25239, 25240, 25248 and 25249, m1's; UALVP 25245 and 25250, m2's; UALVP 25247, m3.

Description and discussion: These specimens most closely resemble teeth of *Prodiacodon puercensis* (Matthew and Granger 1918) from the late Torrejonian of New Mexico (Novacek 1977). The dental morphology of *P. puercensis* has been adequately described by Novacek (1977). The Cochrane 2 lower molars and premolars referred to *P.* cf. *P. puercensis* differ from comparable teeth on AMNH 16598 (upper and lower jaws) of *P. puercensis* from the type locality in being slightly smaller and more inflated. Entostylids and entocristids are absent from the talonids of all the Cochrane 2 specimens.

Although damaged, the P3 from Cochrane 2 (UALVP 25237) is longer than P3 on AMNH 16748 (palate and upper jaws of *P. puercensis*) from Torrejon Arroyo. The referred P4's and upper molars are nearly identical to these teeth in *P. puercensis*, but are slightly smaller in size and less transverse.

Rigby's (1980) "*Prodiacodon* cf. *puercensis*" from the Swain Quarry of Wyoming is similar in size to the Cochrane lower molars, and is, therefore, smaller than the type material, as well (contrary to the implication made by Rigby [1980, p. 56]). The p4's from Cochrane are slightly narrower than the Swain Quarry p4's. As with the type material, the upper molars from Cochrane 2 are slightly smaller and less transverse in comparison with the Swain Quarry specimens.

A right dentary fragment (PU 17429), preserving m2 and m3, from the late Torrejonian Rock Bench Quarry of Wyoming identified as "?*Palaeictops* sp." by Rose (1981, p. 146) is virtually identical to the lower molars from Cochrane 2. In additon, several uncatalogued specimens from Keefer Hill ["Shotgun local fauna"] identified as "*Palaeictops* sp." are also identical to comparable material of *P.* cf. *P. puercensis* from Cochrane 2.

L. S. Russell (1932, p. 52, fig. 9) tentatively referred an uncatalogued right M1 to "*Diacodon septentrionalis*?" (see discussion below under *Propalaeosinopa septentrionalis*). This tooth is most similar to M1, *P. puercensis* (Novacek 1977), and to the upper molars of *P.* cf. *P. puercensis* from Cochrane 2 and is herein referred to the latter species.

Prodiacodon concordiarcensis Simpson 1935

(Plate 58, figs. D, E; pl. 59, figs. A—E; table 39)

Type: USNM 9637, left dentary fragment with p2, p4, and m3.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality [Simpson 1937; Novacek 1977]) and Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980]); earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.; D. W. Krause, pers. comm. 1986]); early Tiffanian of Wyoming (Saddle locality, Fort Union Formation, Bison Basin, Fremont County [Gazin 1956a; Novacek 1977]).

Referred specimens: UALVP 25286—25288 and 25300, P3's (total: 4); UALVP 25263 and 25309, P4's; UALVP 25254, 25259, 25261, 25277 and 25278, M1's; UALVP 25279, 25280 and 25284, M2's; UALVP 25276 and 25293, M3's; UALVP 18429, 18471, 25267, 25271, 25274, 25275, 25290, 25295—25297, 25299, 25302, 25304, 25306 and 25310—25313, MX's (total: 18); UALVP 25269, p2; UALVP 25255, 25260, 25268, 25272, 25281, 25289, 25294 and 25308, p4's (total: 8); UALVP 25262, dentary fragment with m1-m3; UALVP 25266 and 25282, m1's; UALVP 25256, m2; UALVP 25257, 25258 and 25265, m1 or m2's; UALVP 18465, 25253, 25270, 25273, 25283, 25291, 25298 and 25301, m3's (total: 8).

Description: The lower dentition of this taxon has been described in detail by Simpson (1937), Gazin (1956a [as the junior synonym "Diacodon pearcei"]), and Novacek (1977) and no new information is provided by the Cochrane 2 sample. The upper dentition of P. concordiarcensis, however, while known (s[illegible]y 1980), has not (to date) been adequately described. As a result, the following centers on the identifiable parts of the upper dentition.

P3. — The specimens referred to this tooth position are less anteroposteriorly elongate in the labial region than is P3, P. puercensis (Matthew and Granger), and P. cf. P. puercensis from Cochrane 2, and are more triangular in occlusal outline.

P4. — UALVP 25263 is T-shaped in occlusal outline with a transverse and anteroposteriorly short lingual region, and elongate labial region. The paracone and metacone are close and are slightly more appressed to each other than on P4, P. furor Novacek 1977, with the paracone distinctly larger and taller than the metacone. The parastylar lobe is anteriorly elongate, as in P. furor, and much longer than the metastylar lobe. The paraconule is more prominent than the metaconule and an incipient precingulum and narrow, but distinct, postcingulum are developed. A hypocone is incipiently developed on the postcingulum.

Upper molars. — These teeth are virtually identical in structure to the upper molars of Prodiacodon puercensis that Novacek (1977, fig. 8) described and illustrated (on AMNH 16748, right maxillary fragment with P2-M3). The Cochrane 2 specimens referred to P. concordiarcensis differ in being smaller and more gracile, with a slightly deeper ectoflexus. Some of the M1's from Cochrane 2 develop weak stylocones (eg. UALVP 25261 and 25278).

Discussion: The presence of P. concordiarcensis in the earliest Tiffanian of Alberta represents a northerly range extension for this species and, along with material from the Douglass Quarry of Montana (pers. obs.; D. W. Krause, pers. comm. 1986), provides temporal continuity between the previous occurrences for this taxon, in the late Torrejonian (Gidley and Swain Quarries) and the early Tiffanian (Saddle locality [Ti2 biochron zone]) of western North America.

Prodiacodon furor Novacek 1977

(Plate 60, figs. A—C; table 40)

Type: AMNH 35291, right dentary fragment with p2-4.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality [Novacek 1977]) and Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980; pers. obs.]); earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.; D. W. Krause, pers. comm. 1986]) and Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]).

Referred specimens: UALVP 25334, maxillary fragment with P4-M2; UALVP 25326, P3; UALVP 25339, DP4; UALVP 25324, 25328, 25332, 25341 and 25345, P4's; UALVP 429, 25325 and 25336, M2's; UALVP 25330, 25331 and 25335, M1 or M2's; UALVP 25341, M3; UALVP 25337, p3; UALVP 25338, dp4; UALVP 25327, m1 or m2.

Description: The upper dentition of P. furor was not known to Novacek (1977) and is described below.

P4. — The P4's of this taxon are T-shaped in occlusal view, with an anteroposteriorly elongate labial region and a transversely elongate lingual region. The parastylar lobe is anteriorly elongate and is preserved in its entirety on UALVP 25328, revealing a prominent hook-shaped parastyle. In contrast, the metastylar lobe is poorly developed. The paracone is larger and taller than the metacone. Both cusps are slightly compressed transversely and are joined together for most of their heights. The conules are well developed. The precingulum is weak while the postcingulum is more distinct and bears a small hypocone.

M1 and M2. — The upper molars of P. furor differ from the upper molars of P. puercensis (AMNH 16748) as illustrated by Novacek (1977, fig. 8) [and including P. cf. P. puercensis from Cochrane 2] in being more transverse and anteroposteriorly compressed. They further differ in possessing a deeper ectoflexus, with a wider stylar shelf in the parastylar and metastylar regions, and weaker precingula.

m1 or m2. — UALVP 25327 represents the only lower molar from Cochrane 2 that can be referred with confidence to P. furor. The tooth is relatively transverse and is squared in occlusal view, and bears an anteroposteriorly short talonid. The base of the metaconid indicates that it was larger than the protoconid, even though the lingual side of the crown is damaged.

Discussion: In the features mentioned above, the specimens referred to P. furor from Cochrane 2 most closely resemble the conditions seen in Prodiacodon tauricinerei (Jepsen 1930a) from the Wasatchian (early Eocene) of Wyoming (Novacek 1977).

Comparison of the upper and lower dentition from Cochrane 2 with the type specimen (PU 13104, right dentary with C-m3) and PU 14726 (palate and maxillaries with right and left C-M3) of Prodiacodon tauricinerei reveals close similarity in structure (as Novacek [1977, p. 30] noted based upon the lower molars of these two species). The P. furor molars from Cochrane 2 differ in being slightly more transverse and compressed anteroposteriorly, with slightly deeper ectoflexus, and a P4 having a smaller hypocone and a greater joining of the paracone and metacone.

L. S. Russell (1932) tentatively identified an isolated left M2 (UALVP 429) from Cochrane 2 as "Diacodon septentrionalis?" (Russell 1932, fig. 8) [See Propalaeosinopa septentrionalis below for further discussion]. This specimen is clearly referable to P. furor as recognized in this study and is virtually identical to M2 on UALVP 25334, a maxillary fragment (preserving P4-M2) from Cochrane 2.

Novacek (1977), in his discussion of P. furor, suggested that USNM 9552, the upper dentition from the type locality that Simpson (1937) referred to Myrmecoboides montanensis Gidley 1915, may instead be referable to P. furor. Comparison of UALVP 25334 with the illustration of USNM 9552 (Simpson 1937, fig. 18) indicates substantial differences in morphology. The P4 of USNM 9552 appears to have a greater separation of paracone and metacone; a much shorter parastylar lobe, with smaller parastyle; and a less well developed postcingulum, lacking a hypocone. The upper molars of this specimen possess large parastylar lobes, more prominent precingula, and less expanded postcingula with smaller hypocones on M1 and M2 (see M. montanensis for further comparison).

The present evidence, therefore, supports Simpson's (1937) allocation of USNM 9552 as the P4-M3 of Myrmecoboides montanensis. Structural differences between the lower molars of P. furor and M. montanensis do not contradict, but in fact strengthen, the observed differences in the upper dentition of Myrmecoboides (ie., paraconid appression to the metaconid coupled with postcingulum and hypocone reduction, and precingulum expansion).

Genus Myrmecoboides Gidley 1915

Myrmecoboides montanensis Gidley 1915

(Plate 60, figs. D—G; table 41)

Type: USNM 8037, left dentary fragment with p1-m3.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (type locality [Gidley 1915; Simpson 1937; Novacek 1977]) and Wyoming (Rock Bench Quarry, Fort Union Formation, Bighorn Basin [Rose 1981a]; Swain Quarry, Fort Union Formation, Washakie Basin [Rigby 1980]); latest Torrejonian of Montana (Medicine Rocks I locality and Mehling site, Tongue River Formation, Carter County [pers. obs.]); earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.; D. W. Krause, pers. comm. 1986]; Bangtail locality, Fort Union Formation, western Crazy Mountain Basin [Gingerich, et al. 1983]).

Referred specimens: UALVP 25347, M1; UALVP 25346, m1; UALVP 25350, m1 or m2; UALVP 25348, m3; UALVP 25351, mX.

Description and discussion: The lower dentition of Myrmecoboides montanensis has been thoroughly described by Simpson (1937) and Novacek (1977). The Cochrane specimens differ from the type material only in possessing a closer appression of the paraconid with the metaconid and a slightly greater elongation of the talonid. These differences are the same as those outlined for the Swain Quarry sample of this species (Rigby 1980), and they are not considered to be of taxonomic significance.

Based upon its similarity with M1 of USNM 9552, a single M1 (UALVP 25347) is referable to M. montanensis from Cochrane 2. The argument presented above (see Prodiacodon furor) for the acceptance of USNM 9552 from Gidley Quarry as the upper dentition of M. montanensis (as Simpson [1937] interpreted it to be) makes UALVP 25347 (RM1) the first upper molar to be referred to this taxon since Simpson's (1937) description. The Cochrane 2 specimen is the same size as the M1 of P. furor but differs in possessing a higher and more continuous ectocingulum; slightly smaller paracone and metacone; lower protocone; a more prominent precingulum; and a narrower postcingulum, lacking a distinct hypocone. In addition, a well developed swelling of the enamel at the lingual base of the protocone provides an incipient connection between the pre- and postcingula.

The sample of Myrmecoboides from Cochrane 2 documents the first occurrence of this monotypic leptictid genus north of Montana — where it, once again, represents a rare faunal element.

Family Pentacodontidae Simpson 1937

Genus *Bisonalveus* Gazin 1956a

Bisonalveus browni Gazin 1956a

(Plate 61, figs. A—D; table 42)

Type: USNM 20928, left dentary with p4-m3 and posterior alveolus for p3.

Type locality: Saddle locality, Fort Union Formation, Bison Basin, Fremont County, Wyoming.

Known age and distribution: Earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]) and early Tiffanian of Wyoming (type locality [Gazin 1956a]).

Referred specimens: UALVP 18598, 25372 and 25392, P3's; UALVP 25352, maxillary fragment with P4-M2; UALVP 25361 and 25362, maxillary fragments with P4-M1; UALVP 18360, DP4; UALVP 18538, 18543, 18546, 18596, 18597, 25378, 25397, 25401, 25406, 25407, 25411 and 25427, P4's (total: 12); UALVP 18575 and18590, maxillary fragments with M1-M2; UALVP 25424, maxillary fragment with M2 and alveoli for M1; UALVP 18574 and 25363, maxillary fragments UALVP 18357, 18386, 18532, 18539, 18541, 18545, 18595, 25408, 25410, 25420, 25425, 25436 and 25437, M1's (total: 13); UALVP 25390 and 25439, maxillary fragments with M2; UALVP 18563, 25367, 25379, 25386, 25402, 25415, 25418 and 25432—25435, M2's (total: 11); UALVP 18365, 18550, 25364, 25375, 25377, 25388, 25394, 25419, 25421, 25429 and

25440, M3's (total: 11); UALVP 125, dentary fragment with p2-p3 and alveoli for c and p1, broken roots of p4, and anterior root of m1; UALVP 25356, dentary fragment with p2-p4; UALVP 25395, p2; UALVP 25353 and 25358, dentary fragments with p3-p4; UALVP 18549, 18551, 18560, 18561, 25368, 25381 and 25430, p3's (total: 7); UALVP 25441-25451 (total:11), dp4's; UALVP18534, 18540, 18559, 18566, and 18567, p4's; UALVP 18576, dentary fragment with p4-m1; UALVP 25357, dentary fragment with m1 and m2 trigonid; UALVP 18420, 18528, 18556, 18565, 18570, 25426, 25431, 25365, 25366, 25369, 25370, 25371, 25374, 25376, 25389 and 25414, m1's (total: 16); UALVP 18591 and 25355, dentary fragments with m1 talonid, m2-m3; UALVP 25354, dentary fragment with m2-m3 and alveoli for m1 and p4; UALVP 25360, dentary fragment with m2 talonid and m3; UALVP 25387, dentary fragment with m2 and alveoli for m3; UALVP 18359, 18362, 18363, 18424, 18529, 18536, 18542, 18547, 18569, 18571, 18572, 25383, 25398, 25399 and 25438, m2's (total: 15); UALVP 18376, 18394, 18553, 18554, 18557, 18578, 18593, 25393, 25403, 25413, 25416 and 25422, m1 or m2's (total: 12); UALVP 18527, 18530, 18533, 18548, 18555, 18558, 18564, 18568, 18573, 18592, 25373, 25380, 25382, 25385, 25391, 25404, 25412, 25417, 25423 and 25431, m3's (total: 20).

Description: The tooth positions p3-m3 for this taxon have already been described in detail by Gazin (1956a) and Krause and Gingerich (1983). The upper molars of B. browni have also been adequately described by Krause and Gingerich (1983). The Cochrane 2 specimens representing these tooth positions are virtually identical to the smaller Saddle and Douglass Quarry samples and add no new information to the previous descriptions. Therefore, the present description will be limited to the recognizable elements of the anterior dentition not previously known from this taxon.

P4. — UALVP 25352 preserves P4-M2 intact. P4, B. browni, is molariform and "hourglass"-shaped in occlusal outline. The tooth is transverse and nearly equal in width to the M1 (see Table 42). The labial length of the tooth is greater than the lingual length (across the protocone) and the anterior and posterior sides are strongly concave at the midlength. The cusps and cuspules of the crown are well-developed. The paracone is closely appressed with the metacone. The paracone is conical and much larger than the metacone and protocone. The parastyle and paraconule are prominent. The metaconule is incipiently developed and obscured by apical wear on all specimens. Well developed pre- and postcingula are present. The ectocingulum is similarly prominent and complete.

In comparison with the P4's of Aphronorus, the P4's of Bisonalveus differ in possessing a smaller and more vertically positioned paracone (as on M1, B. browni), prominent parastyle and paraconule, continuous ectocingulum, and an anteroposteriorly shorter lingual region. In addition, the P4 of B. browni is slightly smaller than the M1.

p2. — UALVP 125 preserves p2 and p3 of B. browni. The p2 is double-rooted and much smaller than the p3 (see Table 42). The tooth is transversely compressed and lacks a distinct talonid. A small hypoconulid is present posterior to the protoconid. The apex of the paraconid is strongly curved lingually. The paracristid is well-developed, extending as an arc in anterior view and veering lingually near the anterolingual base of the crown at a point slightly higher than the hypoconid apex. The paracristid continues posteriorly as a faint cingulid to the apex of the hypoconid (not observable on UALVP 125). The labial side of the crown is smooth and lacks cingulids.

dp4. — The specimens referred here are similar to m1, but are slightly smaller and transversely much narrower (see Table 42). The trigonid is more elongate, with a more linear alignment and wider spacing of the trigonid cusps. The precingulid is prominent on these specimens.

Discussion: The sample of B. browni from Cochrane 2 represents a northerly extension of the known distribution for this taxon, and is considerably larger than the collections from Wyoming and Montana (see Gazin 1956a; Krause and Gingerich 1983; [D. W. Krause, pers. comm. 1986]). This taxon is the most dentally abundant mammal from Cochrane 2 and represents approximately ten percent of the total number of identifiable specimens collected from the locality. B. browni is medium-sized in comparison with the other mammalian taxa from Cochrane 2 and does not appear to be indicative of any size bias during collecting in relation to the total sample. The dentition of B. browni is relatively generalized with respect to the other members of the Pentacodontidae (i.e., Pentacodon and Aphronorus) and suggests a more omnivorous diet. If this was the case, then the relative abundance (success) of B. browni at Cochrane 2 could be explained on this basis — as a consequence of the varied niches available to this form within the environment(s) sampled.

The dentary fragment catalogued as UALVP 125 was collected in 1926 by R. L. Rutherford from Cochrane 2 and tentatively identified as "Mixodectes? sp." by L. S. Russell (in Rutherford 1927, p. 41-42). Two years later Russell (1929a) referred to the same specimen as "Mixodectidae?, genus and species undetermined", expounding little on his 1927 identification, only to state that the premolars were "...too small to pertain to any known member of the family" (1929a: p. 168). Russell formally recorded the tooth positions represented by the premolars as p3 and p4 (pers. obs.). Comparison with the type of B. browni (USNM 20928) and the specimen described in Krause and Gingerich 1983 (PU 14580, right dentary with p3-m3, preserving alveoli for c and p1-2) reveals UALVP 125 to be the p2 and p3 of B. browni, with the alveoli of the canine and p1, broken roots of p4, and anterior root of m1 also preserved on the dentary fragment. Although not recognized as a pentacodontid until now, UALVP 125 represents the first specimen to be collected of the genus Bisonalveus.

Pentacodontidae n. gen. and sp.

(Plate 62, figs. A—F; pl. 63, figs. A—C; table 43)

Referred specimens: UALVP 25457, ?LP4; UALVP 25455 and 25456, M1 or M2's; UALVP 1982, m1?; UALVP 18577, m1 or m2; UALVP 18422, m2?.

Description and discussion: The Cochrane specimens appear to represent a new genus and species of exceedingly high-crowned pentacodontid (D. W. Krause, pers. comm. 1986), identical to the specimens described by Krause and Gingerich (1983) as "Cf. Aphronorus sp." from [illegible] Quarry (Melville Formation, eastern Crazy Mountain Basin, Sweetg[illegible]f Montana. This taxon will be described in detail elsewhere by Krause and Maas (in prep.) and therefore will not be formally described here. The lower molars of this form have already been adequately described by Krause and Gingerich (1983, pp. 166-168, fig. 7).

The referred specimen UALVP 1982 (Lm1?) was collected from Cochrane 2 in 1927 by L. S. Russell and was identified by him as "Diacodon cf. alticuspis" (Russell 1929a, p. 168). Comparisons made with the material referred to "Cf. Aphronorus sp." by Krause and Gingerich (1983 pp. 166-168, fig. 7) indicate that these specimens are conspecific, and best referred with additional specimens from both Cochrane 2 and Douglass Quarry into the Pentacodontidae, as a new genus and species (Krause and Maas, in prep.).

Family Pantolestidae Cope 1884

Genus Propalaeosinopa Simpson 1927

Propalaeosinopa septentrionalis n. comb. (Russell 1929a)

(Plate 63, figs. D—G; pl. 64, figs. A—D; table 44)

Holotype: UALVP 126, left dentary fragment with m3.

Type locality: Cochrane site 1, Porcupine Hills Formation, southwestern Alberta.

Known age and distribution: Late Torrejonian (middle Paleocene) of Montana (Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County [Simpson 1937]) and Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Rigby 1980]; Localites V-82004, V-82006, V-82040, Polecat Bench Formation, southern Bighorn Basin [Hartman 1986]); earliest Tiffanian (late Paleocene) of Alberta (type locality [Russell 1929a]), Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [Krause and Gingerich 1983]), and Wyoming (Locality V-82015, Polecat Bench Formation, southern Bighorn Basin [Hartman 1986]); early Tiffanian of Montana (Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin [Simpson 1936]); middle Tiffanian of Alberta (UADW-2 locality, Paskapoo Formation, Blindman River [Fox 1984b; pers. obs.]; Joffre Bridge Road Cut locality, lower level, Paskapoo Formation, Red Deer River [R. C. Fox, pers. comm. 1986]; Hand Hills West locality, upper level, Paskapoo Formation, Hand Hills [R. C. Fox, pers. comm. 1986]) and North Dakota (Brisbane and Judson localities, Tongue River Formation, Grant and Morton Counties [Holtzman 1978; pers. obs.]).

Referred specimens: UALVP 25462, maxillary fragment with P4; UALVP 18408, 25472 and 25474, M1's; UALVP 25460, 25461, 25469 and 25470, M2's; UALVP 25476, 25478, 25479, 25481, 25482 and 25488, M1 or M2's (total: 6); UALVP 25471, M3; UALVP 25464, dentary fragment with p2-p3; UALVP 25484 and 25486, p2's; UALVP 25477, p3; UALVP 25595—25598 (total: 4), dp4's; UALVP 25487, 25489 and 25490, p4's; UALVP 25466—25468 and 25480, m1's (total: 4); UALVP 25629, dentary fragment with m2-m3; UALVP 25463, dentary fragment with m2; UALVP 25475, 25485, 25492 and 25493, m2's; UALVP 25494—25499 (total: 6), m3's.

Description and discussion: In 1927, L. S. Russell identified a posterior fragment of a dentary preserving the terminal molar, from Cochrane locality 1, as a new species of the didelphid marsupial Thylacodon. Two years later Russell revised his original identification, describing this specimen as the holotype for a new species of Diacodon Cope 1875 (a leptictid insectivore), which he named D. septentrionalis (Russell 1929a, p. 173). Russell's hypodigm of "D." septentrionalis consisted of the type specimen (UALVP 126) from Cochrane 1 and two additional lower molars (UALVP 333) from Cochrane 2 that Russell included as paratypes. Later, in 1932 Russell tentatively referred three complete upper molars from Cochrane 2 to this taxon. Van Valen (1966) recognized one of the upper molars (considered by Russell to be a possible P4) that Russell had referred to "D." septentrionalis (UALVP 428) as belonging to his new genus and species of palaeoryctid, Pararyctes pattersoni (see P. pattersoni for further discussion). In his provisional classification of the Leptictidae Van Valen (1967, p. 232) placed "D." septentrionalis into the leptictid genus Palaeictops Matthew 1899 without discussion. Novacek (1977), in his review of the early Tertiary Leptictidae of North America, placed all Paleocene leptictids (with the exception of Myrmecoboides) in the genus Prodiacodon. Novacek (1977) did not recognize "Palaeictops" septentrionalis in his study due to the sparse nature of the material, but suggested a referral to Prodiacodon rather than Palaeictops, claiming that "...it is impossible to determine whether these molars are assignable to a new species, [Prodiacodon] puercensis, [Prodiacodon] tauricinerei, [Diacodon] alticuspis, or **a pantolestid"** (p. 34 [emphasis added]).

Comparisons made in the present study indicate that Russell's "D." septentrionalis (even with the exclusion of UALVP 428) is clearly a composite aggregation. Based upon comparison with collections of Propalaeosinopa "diluculi" from the late Paleocene of the U.S. and Canada, as well as with the original material from Gidley Quarry (Simpson 1937), the holotype of "D." septentrionalis (UALVP 126) is found to be virtually identical with the m3's of this pantolestid taxon.

Propalaeosinopa was erected by Simpson in 1927 for P. albertensis from the middle Tiffanian Erickson's Landing locality of Alberta. The number of species of Propalaeosinopa that should be recognized was originally by Van Valen (1967), and has been commented on by Holtzman (1978), Winterfeld (1982), and Krause and Gingerich (1983). Van Valen suggested a synonomy of P. "diluculi" and P. "thomsoni" (previously both were placed in the genus Bessoecetor by Simpson [1936; 1937]) with P. albertensis. This scheme was followed by Holtzman (1978), but has been rejected by most other workers. There is now general aggreement that P. "thomsoni" is conspecific with P. "diluculi", with the type of P. albertensis too poorly preserved for assessment (see Rose 1981 and Krause and Gingerich 1983). Recent collections of well-preserved material referable to P. albertensis, from localities other than Erickson's Landing, from the middle Tiffanian of Alberta (R. C. Fox, pers. comm. 1986) indicate that P. albertensis is distinct from P. "diluculi" (including P. "thomsoni"). Russell's "Diacodon" septentrionalis has priority over Simpson's "Palaeosinopa diluculi", with UALVP 126 as the type specimen.

The paratypes of "Diacodon" septentrionalis (UALVP 333) collected from Cochrane 2 do not belong to the same species as the holotype, but, instead, represent the lower molars of an unidentifed genus and species of palaeoryctid (see Palaeoryctidae unident. gen. and sp. 2 for further discussion). The upper molars tentatively referred in 1932 by Russell and illustrated in his figures 8 and 9 (1932, p. 52) are referable to two separate species of Prodiacodon — P. furor and P. cf. P. puercensis, respectively. As a result, the only specimen of Propalaeosinopa septentrionalis from Russell's 1932 hypodigm is the holotype, collected in 1927 from the Cochrane 1 locality. UALVP 126 remains one of only three identifiable specimens collected from Cochrane 1. Additional material from Cochrane 2 is virtually identical to the type specimen.

The dentition of P. septentrionalis was described in detail by Simpson in 1936 (as "Bessoecetor thomsoni") and in 1937 (as "Bessoecetor diluculi"). The Cochrane 2 specimens are well within the size ranges for other samples of P. septentrionalis from the Torrejonian and Tiffanian of western North America (see Table 44) and provide no supplemental descriptive information to that already provided by Simpson and others.

Genus *Paleotomus* Van Valen 1967

Paleotomus senior (Simpson 1937)

(Plate 64, figs. E—G)

Type: AMNH 33990, right m3.

Type locality: Scarritt Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweet grass County, Montana.

Known age and distribution: Earliest Tiffanian (late Paleocene) of Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin [Krause and Gingerich 1983]); early Tiffanian of Montana (type locality [Simpson 1937; Van Valen 1967]).

Referred specimen: UALVP 25603, m2.

Description: The m2 of *P. senior* was described in detail by Krause and Gingerich (1983). However, UALVP 25603 preserves the talonid better than does the m2 of PU 14616, a jaw fragment of *P. senior* with p3-4, m2-3, from Douglass Quarry (Krause and Gingerich 1983).

The Cochrane 2 specimen reveals the entoconid to be a prominent cusp, probably only slightly lower in height than the hypoconid. The enamel of the hypoconulid is obscured by wear but it would appear that this cusp was lower than the other two talonid cusps. The hypoconulid is medially located and only slightly projecting posteriorly. A prominent entoconulid is also developed in the center of the entocristid. The talonid is squared in occlusal outline. All of the talonid cusps are separated from each other by notches in the cristids, below which are depressions of the enamel.

Abrasion on the trigonid is evident on the tops of the paraconid, metaconid, and protoconid, as well as on the paracristid and protocristid. On the talonid, abrasion appears to be limited to the cristid obliqua, hypoconid and the precristid, joining it to the hypoconulid.

UALVP 25603 is slightly longer and narrower (L=4.7, AW=3.1, PW=2.8) than the m2 on PU 14616 but is otherwise identical to that tooth.

Discussion: The presence of P. senior at Cochrane 2 is the first occurrence of this species outside of Montana and represents a northerly increase in its known geographic range.

Paleotomus junior n. sp.

(Plate 65, figs. A—G; pl. 66, figs. A—C; table 45)

Etymology: Allusion to the small size of this species and its association with the sympatric P. senior.

Holotype: UALVP 25605, left m3.

Type locality: Cochrane site 2, Porcupine Hills Formation, southwestern Alberta.

Hypodigm: Type specimen and UALVP 25613, P4; UALVP 25604 and 25609, M1's; UALVP 18426 and 25614, MX's; UALVP 25607, p3; UALVP 25615—25617 (total: 3), dp4's; UALVP 25611 and 25612, m1 or m2's; UALVP 25606, 25608 and 25610, m3's.

Age and distribution: Latest Torrejonian (middle Paleocene) of Montana (Medicine Rocks I locality and the Mehling site, Tongue River Formation, Carter County [pers. obs.]); earliest Tiffanian (late Paleocene) of Wyoming (Keefer Hill locality ["Shotgun local fauna"], Fort Union Formation, Wind River Basin, Fremont County [pers. obs.]), Montana (Douglass Quarry, Melville Formation, eastern Crazy Mountain Basin, Sweetgrass County [pers. obs.]), and Alberta (type locality).

Diagnosis: Differs from Paleotomus senior (Simpson) and P. milleri Rigby 1980 in being smaller (approximately 40% smaller than P. senior and 20% smaller than P.

milleri). Differs from an undescribed species of Paleotomus from the early late Tiffanian of Saskatchewan in being approximately 45% smaller (pers. obs.).

Description: Upper molars. — With the exception of much smaller size, the labial and lingual fragments referred to this species are virtually identical to the M1's and M2's of P. milleri, described by Rigby (1980).

m3. — As in P. milleri, the protoconid is smaller in comparison with the metaconid. The trigonid carnassial notches are distinct but weakly developed. The talonid cusps are robust and well-defined and there is no trace of a mesoconid or entoconulid.

Discussion: The late Torrejonian Paleotomus milleri Rigby from the Swain Quarry of Wyoming was the previously smallest species of the genus. The presence of two distinctive species of Paleotomus at the Cochrane 2 locality is possibly indicative of a cladogenetic speciation event for this genus from the Torrejonian to the Tiffanian land-mammal age. P. milleri provides an ideal structural ancestor of intermediate size (20% smaller than P. senior and 20% larger than P. junior n. sp.) for the larger and smaller descendant species, P. senior and P. junior n. sp., respectively, from the earliest Tiffanian of Montana and Alberta.

A new species of early late Tiffanian Paleotomus (represented by undescribed specimens from the Roche Percée local fauna, Ravenscrag Formation, of southeastern Saskatchewn [pers. obs.; Fox and Krause, in prep.]) may represent a continuation of the larger P. senior lineage (pers. obs.; Fox, in press).

Family Mixodectidae Cope 1883

Genus *Eudaemonema* Simpson 1935

Eudaemonema cf. *E. cuspidata* Simpson 1935

(Plate 66, fig. D)

Type of *Eudaemonema cuspidata*: USNM 9314, left dentary with c, p2-m3, root of p1, and alveoli for incisors.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution for *Eudaemonema cuspidata*: Late Torrejonian (middle Paleocene) of Montana (type locality [Simpson 1937]).

Referred specimens: UALVP 25617 and 25618, M1 or M2's; UALVP 18412, m1 or m2.

Description: These teeth are virtually identical to the homologous teeth of *E. cuspidata* but differ primarily in being larger in all linear dimensions.

Upper molars.— UALVP 25617 (L=3.8*, W=5.1) is heavily worn and lacks enamel and, along with UALVP 25618 (L=4.2*, W=5.5), is missing the parastylar region of the crown. Nevertheless, the preserved crown structure of both specimens compares well with M1 and M2 on USNM 9558 (left maxillary fragment with M1-M3) from Gidley Quarry (Simpson 1937). These specimens differ from the older material mainly in their larger size.

Lower molar.— The talonid, UALVP 18412, possesses a less appressed hypoconulid and entoconid in comparison with the m1 and m2 of E. cuspidata, in addition to its slightly greater overall size (W=2.8).

Discussion: Several uncatalogued specimens from the Keefer Hill locality ["Shotgun local fauna"] (Fort Union Formation, Wind River Basin, Fremont County) of Wyoming are also referable to this taxon (pers. obs.) The specimens from both localities are larger than the homologous teeth of E. cuspidata and appear to be intermediate in morphology between the Torrejonian form and a new, as yet undescribed, species of Eudaemonema from the middle Tiffanian of Alberta (pers. obs.; Fox, in press). These specimens differ from the middle Tiffanian material in retaining more transverse and slightly smaller upper molars. The presence of Eudaemonema at Cochrane 2, as well as at the Keefer Hill locality, represents both a time and a range extension for the genus.

Superfamily Apatemyoidea Saban 1954

Family Apatemyidae Matthew 1909

Genus Jepsenella Simpson 1940

Jepsenella cf. J. praepropera Simpson 1940

(Plate 67, figs. A—D)

Type of Jepsenella praepropera: AMNH 35292, right dentary fragment with m1-m3.

Type locality: Gidley Quarry, upper Lebo Formation, Crazy Mountain Field, Sweetgrass County, Montana.

Known age and distribution for Jepsenella praepropera: Late Torrejonian (middle Paleocene) of Montana (type locality [Simpson 1940; McKenna 1963]) and Wyoming (Swain Quarry, Fort Union Formation, Washakie Basin, Carbon County [Szalay 1968b; Rigby 1980]).

Referred specimens: UALVP 25620, I1; UALVP 25619, M1; UALVP 25628, i1; UALVP 25624, p2; UALVP 25622, p3?; UALVP 25621 and 25626, dp4's.

Description: I1. — UALVP 25620 (L=4.5, minimum W=1.7) is structurally similar to the I1 of Labidolemur kayi, described and illustrated by Gingerich and Rose (1982a, p. 50, text-fig. 1: A, B) and of the Wasatchian L. serus, as described and figured by Gingerich (1982a, p. 61, text-fig. 2). The Cochrane specimen differs in having a slightly more elongate crown, resulting in a relatively longer and less curved anterocone.

M1. — UALVP 25619 is most similar in size and morphology to AMNH 89513, left M1 of J. praepropera from the Swain Quarry of Wyoming, described and figured by Szalay (1968b, pp. 2-8, figs. 1, 4). The Cochrane specimen differs from the Swain Quarry tooth in possessing a slightly more anteriorly oriented parastylar lobe, resulting in a bulge of the stylar shelf labial to the paracone. In addition, UALVP 25619 has a deeper ectoflexus and a more labial extension of the preparacrista to a small stylocone. The latter feature is not as distinct on AMNH 89513 as on the referred M2 of J. praepropera (AMNH 89512) described by Szalay (1968b, figs. 1, 2, 4). As well, the postcingulum on UALVP 25619 is only incipiently developed as a swelling on the posterolingual base of the protocone, and there is no hypocone development. Finally, UALVP 25619 is wider than it is long (L=1.8, W=2.1), unlike AMNH 89513, which is slightly longer than wide (Szalay 1968b).

i1. — The crown of UALVP 25628 is hook-shaped and bears a convex lateral (labial) side and a flat mesial side (W=1.4). The lateral side is considerably higher than the mesial side, giving the tooth a triangular outline in cross-section. The dorsal edges of the mesial and lateral sides are sharp and well-defined. The dorsal surface of the crown is slightly concave and widens posterior to the apex and then narrows again before the root. The root is laterally compressed and oblong in cross-section, with a flattened mesial side and more convex lateral side. A broad interdental facet is present along the mesial side of the crown.

p2. — UALVP 25624 (L=2.9, W=1.4) is referred here based upon its resemblance to the p2 of Labidolemur kayi Simpson 1929, illustrated by Gingerich and Rose (1982, text-fig. 2). The crown of the referred specimen is "wedge-shaped" and uniquely hooked as in the Clarkforkian apatemyid. A prominent posterior "heel" is developed on the crown. The root is strongly canted posteriorly and curves labially, presumably in order to avoid crowding the i1 in the dentary.

p3? — UALVP 25622 is similar to UALVP 25624 in morphology, but differs in being smaller (L=2.0, W=0.8). The tentative referral of this specimen as p3? is based upon the apparent reduction of this tooth position early in the evolutionary history of apatemyids (see Gingerich and Rose 1982; Gingerich 1982a). At present, the less parsimonious alternative would have UALVP 25622 representing the p2 of a separate, smaller species of apatemyid at Cochrane 2. Additional evidence for the latter hypothesis is wanting and will not be considered at present.

dp4. — UALVP 25621 (W=1.1) and 25626 (W=1.0) resemble the trigonids of m1 and m2 on the type specimen of J. praepropera (AMNH 35292) but differ in being smaller and lower-crowned, with thinner enamel. In addition, the paraconid is anteriorly elongated on both deciduous specimens.

Discussion: As far as is known to me, the incisors and anterior premolars of Jepsenella have never been described. The referred specimens are associated strictly on their size and similarity to the dentition of the closely related and younger-occurring Labidolemur Matthew and Granger 1921. As a result, the M1 (UALVP 25619) is the only dental element that can be comparatively assessed with respect to J. praepropera. The differences observed between the Cochrane specimen and M1, J. praepropera may imply a slightly more derived morphology for UALVP 25619.

Infraclass Eutheria incertae sedis

Order Uncertain

Family Uncertain

Unidentified gen. and sp.

(Plate 67, fig. E)

Referred specimen: UALVP 25627, M3?

Description: UALVP 25627 a crown of an anomolous, triangular M3? (L=1.9, W=2.6). The specimen has rounded corners and lacks cingula. The paracone and metacone are heavily worn along the centrocrista, where a broad apical wear facet is formed. The metacone is reduced while the paracone is moderately well-developed. The parastylar lobe is short and rounded, and supports a prominent parastyle. The stylar shelf is moderately wide anteriorly and narrows posteriorly at a shallow ectoflexus. The ectocingulum is well-developed, but interrupted by a small gap at its midlength. The posterior segment of the ectocingulum is short and fades labial to the metacone, a tiny cuspule is present anteriorly on the posterior segment. There is no postmetacrista, metastyle, or metastylar lobe. The postparacrista and premetacrista meet at a point labial to the paracone and metacone, but there is no connection of these crests with the ectocingulum and no mesostyle development. The protocone is tall and slightly recurved labially. The paraconule and metaconule are just anterolabial and posterolabial to the protocone; together, these cusps form a V-shaped configuration in occlusal view. The conules are small and cuspate and have been lowered by apical wear. The protocone is worn in the same manner as the conules. The pre- and postprotocrista are short and high. The premetaconule crista joins directly with the parastyle and is continuous with the ectocingulum. The postmetaconule crista curves posterolabially to join with a prominent neomorphic cusp formed lingual to the metacone. This accessory cusp is transversely elongate and lower, but only slightly smaller than, the metacone and is closely approximated with it. The extra cusp causes a posterior bulge in the wall of the tooth. An oval-shaped apical wear facet is developed on this cusp similar to the wear observed on the protocone and conules. The trigon basin is deep and located in the center of the tooth just lingual to the centrocrista. Postparaconule and premetaconule cristae are absent. Wear on the preparaconule crista extends from the base of the parastyle to near the paraconule.

The deep trigon basin and heavy wear on the internal faces of the paracone and metacone indicate that the hypoconid was prominently developed on the lower molars of this taxon.

Discussion: UALVP 25627 does not closely resemble the upper molars of any major group of Late Cretaceous or early Tertiary mammal and is only superficially similar to the M3 of palaeoryctids (due to lack of pre- and postcingula, the reduction of conules, and the presence of a labially recurved protocone). The closest resemblance of UALVP 25627 is to the M2 of L. S. Russell's <u>Thylacaelurus</u> <u>montanus</u> from the Chadronian (early Oligocene) Kishenehn Formation of southeastern British Columbia (Russell 1954). The features observed in common between the Cochrane molar and the upper molars of NMC 8910 include 1) the triangular occlusal outline with curved outwardly convex tooth margins and absence of lingual cingula; 2) the possession of a prominent cusp lingually adjacent to the metacone (positioned and shaped like a metaconule on UALVP 25627 and described as the metaconule by Russell on NMC 8910 [Russell 1954; Szalay 1969]); 3) a deep basin between the paracone and metacone; 4) the absence of internal conule cristae; and 5) the reduction of the parastylar lobe and preparacrista. UALVP 25627 strongly differs from the M2 of <u>Thylacaelurus</u> in 1) possessing reduced, cuspule-like conules in addition to the large neomorphic "metaconule"; 2) lacking the development of stylar cusps and the dilambdodont-like separation (by a "cleft") of paracone from metacone; 3) having a well-developed parastyle and ectocingulum; and 4) displaying centrocrista wear and not apical wear on the paracone and metacone. In addition, the paracone appears to be smaller than the metacone on the molars of NMC 8901, while the opposite condition is evident on UALVP 25627.

The similarities of UALVP 25627 to the M2 of Thylacaelurus could well be the result of convergence and the degree of affinity between these two forms must await the recovery of homologous tooth positions for comparison.

VII. CONCLUSIONS

Age of the Cochrane 2 Locality

Russell (1929, 1958) considered the Cochrane 2 locality to lie in the Paskapoo Formation and, based upon the sparse mammalian fauna available to him, interpreted the site to be latest Tiffanian to Clarkforkian in age. The age of the locality was considered to be latest Torrejonian or earliest Tiffanian by Krause (1978) based upon the presence of primates "*Paromomys* cf. *depressidens*", "*Pronothodectes*? sp.", *Elphidotarsius russelli*, and *Picrodus silberlingi*. Gingerich (1982b) suggested an earliest Tiffanian age based on the presence of the phenacodontid condylarth *Ectocion collinus*.

Carrigy (1970, 1971), in his study of Paleocene rocks in and around the Cochrane area, found the outcrops at Cochrane to pertain to the Porcupine Hills Formation, already known from further south in the province. He considered the Porcupine Hills strata to overlie the Paskapoo Formation in this region and concluded that the Porcupine Hills Formation (and, therefore, Cochrane 2) was younger than the Paskapoo deposits (which were known to be of late Paleocene age [Simpson 1927]). In this interpretation, Carrigy clearly ignored evidence for a more ancient age for the formation (Russell 1948, 1958; Fox 1968) and accepted Russell's youngest estimates.

Krause's (1978) estimate of a latest Torrejonian to earliest Tiffanian age for Cochrane 2 challenged Carrigy's age interpretation by identifying biostratigraphically restricted taxa which indicated ages no younger than the earliest Tiffanian. The age of the Paskapoo Formation at that time was confidently interpreted as middle to late Tiffanian (Krause 1978). The present study confirms Krause's (1978) interpretation that the Porcupine Hills Formation at Cochrane is older than the Paskapoo Formation (in the Red Deer area) and supports Gingerich's (1978) earliest Tiffanian age.

The evidence for an earliest Tiffanian age for the Cochrane 2 locality can now be made more confidently, based on the presence of the plesiadapid primates Nannodectes intermedius (="Pronothodectes? sp." of Krause 1978) and Plesiadapis praecursor, which are known to be restricted to the "Ti1" biostratigraphic zone (see Gingerich 1975, 1976; Krause and Gingerich 1983). The carpolestid primate, Elphidotarsius russelli, is known exclusively from the earliest Tiffanian, as is Ectocion collinus. In addition, the following taxa appear restricted to the earliest Tiffanian: Pristinictis connatus n. gen. and sp.; Apheliscinae n. gen. and sp.; and Pentacodontidae n. gen. and sp. (see Table 46).

An age determination for the strata in the Cochrane area that is older than the Paskapoo sediments to the northeast is independently confirmed by a recent palynological study by Demchuk (1988), which records more ancient species, based on pollens, in the Porcupine Hills strata than in the Paskapoo samples.

Faunal Comparisons

Other than Cochrane 1 and 2, only four additional earliest Tiffanian localities are currently recognized: Douglass Quarry (Krause and Gingerich 1983) and Bangtail (Gingerich, et al. 1983) of Montana; Keefer Hill ("Shotgun local fauna") (Keefer 1961; McGrew and Patterson 1962; Patterson and McGrew 1962; Van Valen 1966; D. E. Russell 1967; Gazin 1971; Gingerich 1976; West 1976; Holtzman and Wolberg 1977; Sloan 1987) and Little Muddy Creek (Gazin 1969) of Wyoming. The Douglass Quarry and Keefer Hill localities are now known by relatively large sample sizes, but are only partially described. The Bangtail and Little Muddy Creek localities, conversely, are represented by few specimens. A fifth site, referred to as the "Cub Creek (cc-4) Local Fauna" from the Clark's Fork Basin of Wyoming (currently under study by P. D. Gingerich [pers. comm. 1986]) is also represented by a small sample.

Faunal comparison of the Cochrane 2 locality with other earliest Tiffanian assemblages (Table 46) reveals greatest similarity with the faunas of the Keefer Hill and

Douglass Quarry localities. Study of the dental specimens assigned to taxa in common from all three localities reveals a more primitive assemblage in the Keefer Hill fauna and a slightly more derived assemblage in the Douglass Quarry fauna. Of special note is the presence of a more derived species of Baiotomeus, Plesiolestes, and Elphidotarsius and more dentally advanced Bisonalveus browni and Ectocion collinus at Cochrane than at Keefer Hill. The Cochrane species of Elphidotarsius and Ectocion appear to be more primitive than the Douglass Quarry representatives, along with the multituberculate Neoplagiaulax hunteri. On this basis, the Cochrane 2 fauna is considered to be intermediate in age between the Keefer Hill and Douglass Quarry localities of the western U. S. The faunas of the Little Muddy Creek of Wyoming and the Bangtail locality of Montana are still too small to provide adequate comparisons.

Diversity

An important aspect of the Cochrane 2 locality revealed by this study is its diversity. Rose suggests that the "...primary measure of diversity [is] the number of species in a sample" (1981b, p. 369) or species richness. The generic and specific richness of the Cochrane 2 locality exceeds by more than 30 taxa the known values for late Torrejonian and Tiffanian localities, and is unprecedented with respect to described Paleocene faunas. The species richness of the most important late Torrejonian to late Tiffanian localities (as they are currently recognized [subsequent to Rose 1981b]) is summarized in Text-fig. 4.

A potentially important difference in the faunal yields between Cochrane 2, Douglass Quarry, and most sites in the late Torrejonian and early Tiffanian may lie in the collection techniques used. In contrast to the other localities, the matrix from Cochrane 2 was screen-washed and then subsequently acid-washed to achieve maximum break-down into concentrate. According to Krause and Gingerich (1983): "The resistant matrix at Douglass Quarry does not lend itself well to screen-washing, and hence the smaller members of the fauna are not adequately represented, and possibly never will be" (p. 193). This consequence would effectively impede the collection of the majority of the multituberculates, lipotyphlans, primates, and Eutheria, incertae sedis recognized in the Cochrane 2 fauna, due to their exceedingly small size. These smaller taxa are prone to collecting bias when surface collecting and on-site quarrying are used exclusively.

Falsification of Rose's Hypothesis

In a study of the species composition and diversity of sixteen mammalian assemblages ranging from the late Torrejonian (middle Paleocene) to the early Wasatchian (early Eocene) of western North America, Rose (1981a, 1981b) proposed an hypothesis relating patterns of mammalian species diversity to climatic temperature changes. Rose proposed that the apparently high diversities observed in Torrejonian and Wasatchian faunas were related to the warm, equable environmental conditions evidenced by the megafloral data. Lower diversities in faunas from the intervening Tiffanian and Clarkforkian land-mammal ages was considered to be most probably related to cooler temperatures and less equable condition.

According to Krause and Gingerich:

> If there was a gradual decline in species diversity owing to climatic change, then, based on the well-sampled late Torrejonian Gidley Quarry and Rock Bench Quarry (1687 specimens, 57 species), and the middle Tiffanian Cedar Point Quarry (1988 specimens, 38 species), one might expect intermediate diversities during the early Tiffanian, provided that the localities have been adequately sampled and are not strongly biased by other factors (e.g., markedly different depositional environments) (1983, pp. 193-194).

A preliminary study by the author of the the majority of the specimens in the Keefer Hill and Douglass Quarry collections, as well as the latest Torrejonian Medicine Rocks I and Mehling Site assemblages, reveals species diversities on par with that observed in the late Torrejonian (see Text-fig. 4). Douglass Quarry was reported to possess an initial richness of 23 species (Krause and Gingerich 1983). Subsequent collections have more than doubled the original estimates (Krause, pers. comm. 1986). The Cochrane 2 locality is now represented by some 2000 specimens but its diversity is considerably higher than localities of the Torrejonian and middle Tiffanian.

As previously mentioned, species richness in the latest Torrejonian and earliest Tiffanian appears to exceed the "predicted" values required to satisfy Rose's hypothesis. Additional contradiction to the diversity—temperature premise comes from the middle Tiffanian Paskapoo Formation of Alberta, where species richness at the UADW-2 locality (see Text-fig. 4) apparently exceeds 50 species (Fox, in press) and approaches the numbers touted by Rose for the late Torrejonian.

Additionally, Rose's (1981a, 1981b) hypothesis predicted that the climatic disturbances in the Tiffanian would favor the rise of a few dominant (generalist) species that would be found in abundance at the localities, such as the genera Ptilodus (Multituberculata), Plesiadapis (Primates), and Ectocion (Condylarthra). Contrary to expectation, the faunas of Cochrane 2 and UADW-2 reveal these genera to be no more abundant than other members of the assemblages. At Cochrane 2, the generalist taxon Bisonalveus browni (a pentacodontid insectivore), is the most abundant mammal, but represents only 10% of the total sample, indicating greater species evenness.

If the data from the Cochrane 2 and UADW-2 localities are included, Rose's climatic deterioration, and its presumed effect, would need to be limited to the relatively short time interval between the earliest and middle Tiffanian. However, this would then contradict the paleobotanical evidence, which is reported by Rose (1981a, figs. 75D, E) to have involved gradual changes in response to cooler temperatures throughout the Tiffanian.

The unexpectedly high diversity at Cochrane 2 could be immediately explained (as previously mentioned) as a direct result of the rigorous screen-washing techniques employed in the laboratory. This would lead to the collection of the small component in the

Text-fig. 4. Summary of mammalian generic and species richness from late Torrejonian to latest Tiffanian of North America.

Land-mammal Age	Site	Genera No.	Species No.
Late Tiffanian	Princeton Quarry, Wyoming (Rose 1981a)	32	36
	Swan Hills local fauna, Alberta (Stonley, pers. comm. 1988)	28	34
	Roche Percée local fauna, Saskatchewan (Stonley, pers. comm. 1988)	26	30
Middle Tiffanian	Cedar Point Quarry, Wyoming (Rose 1981a)	33	38
	UADW-2 locality, Alberta (Fox in press)	36	51
	Judson-Brisbane, North Dakota (Holtzman 1978)	29	37
Early Tiffanian	Scarritt Quarry, Montana (Krause, pers. comm. 1986)	21	23
	Saddle locality, Wyoming (Gazin 1956a)	22	30
	Douglass Quarry, Montana (Krause, pers. comm. 1986)	35	49
Earliest Tiffanian	**Cochrane 2 locality, Alberta (present study)**	**65**	**86**
	Keefer Hill locality, Wyoming (Sloan, unpubl. data; pers. obs.)	45	53
Latest Torrejonian	Medicine Rocks I & Mehling Site (pers. obs.)	31	43
	Rock Bench Quarry, Wyoming (Rose 1981a)	43	57
	Swain Quarry, Wyoming (Rigby 1980)	44	52
Late Torrejonian	Gidley Quarry, Montana (Rose 1981a)	48	55

fauna, providing a more complete sample of the preserved diversity of the site. Even though the Cochrane 2 locality has been intermittently quarried over a substantial period of time (60 years); the total amount of matrix removed has been small. This is especially true in comparison to the much more extensively quarried Torrejonian localities (Gidley and Rock Bench Quarry) and particularly so with respect to the late Torrejonian Swain Quarry of Wyoming (Rigby 1980). Through screen-washing tonnes of matrix, more than 28,000 specimens have been accumulated from Swain Quarry. However, this produced only 50 species (see Text-fig. 4). Based upon this example, the Cochrane sample probably represents a relatively more accurate measure of the exceptional diversity in the earliest Tiffanian of western North America.

According to Rose:

> Species richness determined for most fossil samples (especially those from a single horizon) almost certainly **underestimate[s]** the total number of species in the original living community, because it is unlikely that all species originally present will be recovered even the best fossil samples provide only an estimate of the number of species once present (1981b, p. 369, emphasis added).

With respect to the unprecedented generic and specific numbers generated by the Cochrane 2 locality, the unusually high diversity may be a consequence of multi-environmental sampling, i.e., perhaps the mammals from both lowland and upland environments are represented. There is little evidence of abrasion among the teeth and jaws of the Cochrane sample and the number of heavily water-worn specimens is minimal, suggesting that they were not transported over long distances.

Implications for Future Research

The apparent diversity of the Cochrane 2 locality has potential implications, not only for paleontology, but for general ecology as well. What can be said about the effects of climate on the diversity of mammals if the environment of western North America in the earliest Tiffanian is considered to have been warm-temperate, as the paleobotanical evidence indicates? In comparison with the species richness found in modern mammalian faunas, Rose (1981a, 1981b) cited data on two studies of tropical regions. Seventy-seven (77) species of mammals (excluding bats) were found to inhabit the rainforests of North Borneo and 79 species (also excluding bats) were reported from a Panamanian rainforest. Rose noted that "... the relative frequency of small mammals increased in lower (warmer) latitudes" (1981b, p. 386).

Based on the above information, does the exceptionally high diversity at Cochrane indicated an environment comparable only to equatorial regions of the world today? If not, are there sufficient numbers of ecological niches available in a warm-temperate environment to "accommodate" the number of mammalian taxa present at Cochrane? Is it not the "competition" for varied ecological niches which is responsible for producing the diversity of tropical regions? Does not the shear number of genera and species from a single locality (horizon) at a particular point in time indicate a tropical rather than a warm-temperate climate, as we understand ecology today? Or does the evidence from Cochrane, alternatively, imply that the relationship between mammalian species diversity and climate should be reassessed? It seems to this author that the latter is more likely.

This study has raised questions about the evolution and faunal diversity of mammals across the Torrejonian—Tiffanian boundary. It is hoped that these findings will provide the background and impetus for future research on this unique locality and others of similar age. Future work at Cochrane 2 will be significant in providing much needed information on species richness and faunal succession for a poorly sampled interval in the evolutionary history of Paleocene mammals.

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Table 1. Measurements and descriptive statistics for the dentition of Mesodma pygmaea from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	9	2.4–2.6	2.54	0.07	2.8
	Width	21	0.9–1.3	1.14	0.13	11.4
P4	Length	3	1.7–2.0	1.83	0.15	8.2
	Width	4	0.6–0.7	0.65	0.06	9.2

Table 2. Measurements and descriptive statistics for the dentition of Mimetodon silberlingi from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	4	2.7–3.0	2.85	0.13	4.6
	Width	6	1.0–1.2	1.12	0.08	7.1
m1	Length	5	2.0–2.2	2.10	0.10	4.8
	Width	8	0.8–1.0	0.88	0.07	8.0
m2	Length	3	1.1–1.2	1.13	0.06	5.3
	Width	3	1.0	1.00	0.00	0.0
P4	Length	4	2.0–2.2	2.10	0.08	3.8
	Width	5	0.7–0.8	0.76	0.06	7.9
M2	Length	6	1.1–1.2	1.12	0.04	3.6
	Width	6	1.1–1.2	1.15	0.06	5.2

Table 3. Measurements and descriptive statistics for the dentition of Ectypodus cf. E. szalayi from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	4	2.8–3.1	2.93	0.15	5.1
	Width	6	1.0–1.1	1.07	0.05	4.7
m1	Length	1	2.0	2.00	—	—
	Width	1	1.0	1.00	—	—
m2	Length	1	1.3	1.30	—	—
	Width	1	1.1	1.10	—	—
P4	Length	1	2.0	2.00	—	—
	Width	1	0.8	0.80	—	—

Table 4. Measurements and descriptive statistics for the dentition of Parectypodus sinclairi from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	1	3.7	3.70	—	—
	Width	4	0.9–1.0	0.95	0.06	6.3
m1	Length	4	1.8–2.0	1.88	0.10	5.3
	Width	4	0.8–0.9	0.88	0.05	5.7
m2	Length	1	1.0	1.00	—	—
	Width	1	0.9	0.90	—	—
P4	Length	2	2.5–2.6	2.55	0.07	2.8
	Width	2	1.0–1.1	1.05	0.07	6.7

Table 5. Measurements and descriptive statistics for the dentition of Parectypodus cf. sylviae from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	5	1.7–2.0	1.86	0.11	5.9
	Width	5	0.7–0.8	0.74	0.06	8.1

Table 6. Measurements and descriptive statistics for the dentition of <u>Neoplagiaulax nelsoni</u> from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	18	3.2–4.3	3.94	0.17	4.3
	Width	27	1.3–1.5	1.42	0.07	4.9
m1	Length	27	2.2–2.5	2.29	0.08	3.5
	Width	32	0.9–1.1	1.10	0.03	3.0
m2	Length	22	1.3–1.5	1.42	0.05	3.5
	Width	22	1.1–1.2	1.17	0.05	4.3
P4	Length	27	2.6–3.1	2.87	0.18	6.3
	Width	34	1.0–1.4	1.17	0.10	8.6
M1	Length	3	2.9–3.2	3.07	0.15	4.9
	Width	27	1.3–1[illegible]	1.39	0.04	2.9
M2	Length	43	1.3–1.5	1.38	0.05	3.6
	Width	43	1.3–1.6	1.41	0.05	3.6

Table 7. Measurements and descriptive statistics for the dentition of Ptilodus sp. T from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	1	11.0	11.00	—	—
	Width	1	3.8	3.80	—	—
	Length 1	1	3.2	3.20	—	—
	Height	1	3.8	3.80	—	—
	Depth	1	4.1	4.10	—	—
m1	Length	0	—	—	—	—
	Width	3	2.1–2.3	2.23	0.12	5.2
m2	Length	3	3.2–3.4	3.33	0.12	3.6
	Width	4	2.5–2.6	2.58	0.05	1.9
P1	Length	1	3.4	3.40	—	—
	Width	1	2.8	2.80	—	—
P3	Length	4	3.8–4.0	3.95	0.19	4.8
	Width	4	2.9–3.6	3.16	0.31	9.8
P4	Length	4	6.2–7.0	6.63	0.39	5.9
	Width	4	3.0–3.5	3.23	0.22	6.8
M1	Length	2	6.6–7.0	6.80	0.28	4.1
	Width	2	2.9–3.4	3.15	0.35	11.1
M2	Length	2	3.2–3.3	3.25	0.07	2.2
	Width	2	3.0–3.2	3.10	0.14	4.5

Table 8. Measurements and descriptive statistics for the [illegible] of [illegible] sp. C from the Cochrane 2 locality.

Element	P.	N	OR	M	SD	CV
m1	Length	4	3.9–4.2	4.03	0.13	3.2
	Width	4	1.9–2.1	1.98	0.10	4.8
m2	Length	1	2.7	2.70	—	—
	Width	1	2.2	2.20	—	—
P1	Length	2	3.0–3.2	3.10	—	—
	Width	2	2.2–2.3	2.25	—	—
P3	Length	3	3.2–3.4	3.27	0.12	3.7
	Width	3	2.3–2.4	2.33	0.06	2.5
P4	Length	0	—	—	—	—
	Width	2	2.7–2.8	2.75	—	—
M1	Length	2	5.6–5.8	5.70	—	—
	Width	3	2.5–2.7	2.63	0.12	4.6
M2	Length	1	2.6	2.60	—	—
	Width	1	2.6	2.60	—	—

Table 9. Measurements and descriptive statistics for the dentition of *Ptilodus gnomus* n. sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	8	5.3–5.6	5.46	0.11	2.0
	Width	13	2.1–2.3	2.18	0.07	3.2
	Length 1	10	1.3–1.7	1.45	0.12	8.3
	Height	9	2.0–2.1	2.08	0.04	1.9
	Depth	12	2.1–2.8	2.58	0.19	7.4
m1	Length	6	2.7–3.0	2.77	0.12	4.3
	Width	8	1.3–1.4	1.36	0.05	3.7
m2	Length	8	1.8–2.1	1.89	0.10	5.3
	Width	8	1.5–1.7	1.61	0.08	5.0
P1	Length	12	1.8–2.2	2.00	0.14	7.0
	Width	12	1.2–1.8	1.60	0.15	9.4
P2	Length	11	1.8–2.2	2.06	0.11	5.3
	Width	11	1.6–2.0	1.80	0.13	7.2
P3	Length	20	1.8–2.2	2.07	0.14	6.8
	Width	21	1.4–1.7	1.55	0.09	5.8
P4	Length	14	3.2–3.9	3.60	0.19	5.3
	Width	19	1.5–1.9	1.76	0.10	5.7
M1	Length	3	3.8–4.0	3.93	0.12	3.1
	Width	6	1.7–1.8	1.77	0.05	2.8
M2	Length	11	1.7–2.1	1.91	0.12	6.3
	Width	11	1.8–2.1	1.94	0.09	4.6

Table 10. Measurements and descriptive statistics for the dentition of Baiotomeus russelli n. sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	1	3.6	3.60	—	—
	Width	1	1.5*	1.50	—	—
	Length 1	1	0.9*	0.90	—	—
	Height	1	1.2*	1.20	—	—
	Depth	1	1.9*	1.90	—	—
m1	Length	7	1.9–2.3	2.14	0.15	7.0
	Width	7	0.9–1.0	0.99	0.04	4.0
P4	Length	2	2.2–2.4	2.30	0.14	6.1
	Width	3	1.0–1.1	1.07	0.06	5.6

Table 11. Measurements and descriptive statistics for the dentition of *Ancorodon cochranensis* from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	14	4.4–5.0	4.69	0.20	4.3
	Width	16	1.6–1.8	1.78	0.05	2.8
	Length 1	14	1.0–1.3	1.12	0.08	7.1
	Height	15	1.8–2.1	1.94	0.07	3.6
P4	Length	12	3.6–4.0	3.81	0.14	3.7
	Width	16	1.2*–1.4	1.37	0.06	4.4

Table 12. Measurements and descriptive statistics for the dentition of Anconodon sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Length	1	3.2	3.20	—	—
	Width	1	1.0	1.00	—	—
P4	Length	4	2.7–3.0	2.83	0.13	4.6
	Width	6	1.1–1.3	1.17	0.08	6.8

Table 13. Measurements and descriptive statistics for the dentition of Archeronodon vossae n. sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
i1	Max. Dia.	17	1.4–1.8	1.63	0.12	7.4
	Min. Dia.	17	0.6–0.9	0.78	0.10	12.8
p4	Length	9	1.8–2.0	1.93	0.07	3.6
	Width	10	0.[illegible]–0.7	0.62	0.04	6.5
m1	Length	10	2.1–2.4	2.26	0.1[illegible]	4.4
	Width	13	1.0–1.1	1.01	0.03	3.0
m2	Length	12	1.1–1.3	1.23	0.06	4.9
	Width	12	1.1–1.3	1.15	0.07	6.1
I2	Max. Dia.	16	1.3–1.4	1.39	0.03	2.2
	Min. Dia.	16	0.7–0.8	0.78	0.04	5.1
P4	Length	10	1.5–1.7	1.66	0.07	4.2
	Width	11	0.6–0.8	0.72	0.06	8.3
M1	Length	5	2.4	2.40	0.00	0.0
	Width	8	1.3–1.4	1.33	0.05	3.8
M2	Length	5	1.4	1.40	0.0	0.0
	Width	5	1.3–1.4	1.34	0.06	4.5

Table 14. Comparison of Microcosmodontine p4's.[1]

Taxon	Acheronodon garbani	Microcosmodon arcuatus	Acheronodon vossae, n. sp.	"Microcosmodon" woodi	Microcosmodon conus	Pentacosmodon pronus	Microcosmodon rosei
Character:							
Sample Size	1	5	9	6	6	2	2
Length (M)	1.65	2.15	1.91	3.05	1.65	1.90	1.45
Width (M)	0.63	1.00	0.62	1.03	0.70	0.95	0.50
Serration Number	6	6	6	5-6	5	5	3
Labial and Lingual Ridges	Long and distinct (1/2 crown height)	Reduced and less distinct (1/3 crown height)	Short and indistinct	Short and indistinct	Short and indistinct	Long and distinct (1/2 crown height)	Absent
Posterolabial Basal Ledge	Very prominent	Prominent	Reduced	Reduced	Prominent	Reduced	Prominent
Serration Size	5th & 6th large & bulbous	6th large and bulbous	5th & 6th large & bulbous	Subequal & not bulbous	6th large and bulbous	Subequal & last bulbous	Subequal
Crown Height and Lateral Shape	Low and triangular	High and arcuate	Low and triangular	Low and triangular	High and arcuate	High and arcuate	Lower; less arcuate
Interserrational Valleys	Deep	Shallow	Deep	Deep	Shallow	Shallow	Shallow

[1] Modified from Archibald (1982).

Table 14. con't.

Taxon	Acheronodon garbani	Microcosmodon arcuatus	Acheronodon vossae, n. sp.	"Microcosmodon" woodi	Microcosmodon conus	Pentacosmodon pronus	Microcosmodon rosei
Character:							
Autapomorphies	—	Enamel prominently overhangs the anterobasal concavity.	Anterior face slightly concave from the apex of 1st serration.	Long, low blade. P4 longer than M1.	—	p3 absent	Absence of ridges on p4
Relative i1 Size and p4 : i1	Unknown	Large, with p4 much shorter than max. dia. incisor	Small, with p4 equal to max. dia. incisor	Small, with p4 longer than max. dia. incisor	Large, with p4 shorter than max. dia. incisor	Small,with p4 longer than max. dia. incisor	Large, with p4 shorter than max. dia. incisor

Table 15. Measurements and descriptive statistics for the dentition of Pentacosmodon sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
i1	Max. Dia.	9	1.1–1.4	1.23	0.13	10.6
	Min. Dia.	10	0.7–1.1	0.91	0.11	12.1
m1	Length	3	2.4–2.6	2.50	0.10	4.0
	Width	3	1.3–1.4	1.35	0.05	3.7
m2	Length	2	1.6	1.60	0.00	0.0
	Width	2	1.4	1.40	0.00	0.0
I2	Max. Dia.	2	1.2	1.20	0.00	0.0
	Min. Dia.	2	0.6–0.7	0.65	0.07	10.8
P4	Length	2	1.6–1.8	1.70	0.14	8.5
	Width	2	0.9	0.90	0.00	0.0
M1	Length	1	3.4	3.40	—	—
	Width	2	1.8–2.0	1.90	0.14	7.4

Table 16. Measurements and descriptive statistics for the dentition of Peradectes sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1	Length	3	1.5	1.50	0.00	0.0
	Width	3	1.5–1.7	1.63	0.12	7.4
M2 or 3	Length	2	1.4*–1.6	1.5	0.14	9.3
	Width	2	2.0–2.1	2.05	0.07	3.4
m1	Length	1	1.4	1.40	—	—
	Width	4	0.7	0.70	0.00	0.0
m2 or3	Length	6	1.5	1.50	0.00	0.0
	Width	9	0.9–1.0	0.98	0.04	4.1
m4?	Length	0	—	—	—	—
	Width	1	0.8	0.80	—	—

Table 17. Measurements and descriptive statistics for the dentition of Erinaceidae unident. gen. and sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1	Length	1	1.2	1.20	—	—
	Width	1	1.6	1.60	—	—
p2	Length	1	0.8	0.80	—	—
	Width	1	0.4	0.40	—	—
p3	Length	1	1.0	1.00	—	—
	Width	1	0.5	0.50	—	—
p4	Length	3	1.1–1.3	1.23	0.12	9.8
	Width	4	0.7–0.8	0.78	0.05	6.4
m1	Length	4	1.3–1.4	1.33	0.05	3.8
	Width	4	0.8–0.9	0.88	0.05	5.7
m2	Length	7	1.1–1.2	1.16	0.05	4.3
	Width	7	0.8–0.9	0.84	0.05	6.0
m3	Length	1	1.1	1.10	—	—
	Width	1	0.7	0.70	—	—

Table 18. Measurements and descriptive statistics for the dentition of Leptacodon sp.1 from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	3	1.3–1.5	1.40	0.10	7.1
	Width	1	1.5	1.50	—	—
M1	Length	4	1.3–1.5	1.38	0.10	7.3
	Width	3	1.7–2.0*	1.80	0.17	9.4
M2	Length	3	1.2–1.4	1.33	0.12	9.0
	Width	2	1.9	1.90	0.00	0.0
M3	Length	1	1.1	1.10	—	—
	Width	1	1.8	1.80	—	—
dp4	Length	1	1.4	1.40	—	—
	Width	1	1.0	1.00	—	—
p4	Length	1	1.5	1.50	—	—
	Width	2	0.5–0.8	0.65	0.21	32.3
m1	Length	1	1.2	1.20	—	—
	Width	1	0.9	0.90	—	—
m2	Length	3	1.2–1.4	1.30	0.10	7.7
	Tri. Width	3	0.8–1.1	0.93	0.15	16.1
	Tal. Width	3	0.9–1.0	0.93	0.06	6.5
m3	Length	1	1.4	1.40	—	—
	Tri. Width	2	0.8–0.9	0.85	0.07	8.2
	Tal. Width	2	0.8	0.80	0.00	0.0

Table 19. Measurements and descriptive statistics for the dentition of Leptacodon sp. 2 from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	2	1.5–1.6	1.55	0.07	4.5
	Width	2	2.0	2.00	0.00	0.0
M1	Length	4	1.6–1.7	1.63	0.05	3.1
	Width	5	2.1–2.2	2.16	0.05	2.3
M2	Length	6	1.5–1.7*	1.58	0.08	5.1
	Width	2	2.1	2.10	0.00	0.0
M3	Length	3	1.1–1.3	1.23	0.15	12.2
	Width	3	1.8–1.9	1.83	0.06	3.3
p4	Length	1	1.6	1.60	—	—
	Width	1	0.9	0.90	—	—
m1	Length	5	1.6	1.60	0.00	0.0
	Tri. Width	6	1.1–1.3	1.13	0.08	7.1
	Tal. Width	5	1.1–1.3	1.14	0.09	7.9
m2	Length	5	1.6	1.60	0.00	0.0
	Tri. Width	10	1.1–1.2	1.12	0.04	3.6
	Tal. Width	5	1.0–1.2	1.08	0.08	7.4
m3	Length	2	1.6	1.60	0.00	0.0
	Tri. Width	2	0.9–1.1	1.00	0.14	14.0
	Tal. Width	2	0.8–0.9	0.85	0.07	8.2

Table 20. Measurements and descriptive statistics for the dentition of "Leptacodon" munusculum from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	2	1.2–1.3	1.25	0.07	5.6
	Width	2	1.4–1.6	1.50	0.14	9.3
M1	Length	3	1.0–1.3	1.13	0.15	13.3
	Width	3	1.5–1.6	1.57	0.06	3.8
M2	Length	3	1.1–1.2	1.12	0.06	5.4
	Width	3	1.6	1.60	0.00	0.0
p4	Length	1	1.3	1.30	—	—
	Width	1	0.6	0.60	—	—
m1	Length	0	—	—	—	—
	Width	4	0.8–1.0*	0.88	0.10	11.4
m1 or 2	Length	4	1.1–1.2	1.13	0.05	4.4
	Width	4	0.8	0.80	0.00	0.0
m2	Length	3	1.1–1.3	1.20	0.10	8.3
	Width	4	0.8–0.9	0.85	0.06	7.1
m3	Length	2	1.1–1.1	1.05	0.07	6.7
	Width	2	0.7	0.70	0.00	0.0

Table 21. Measurements and descriptive statistics for the dentition of Ignacius fremontensis from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
DP4	Length	1	1.7	1.70	—	—
	Width	1	1.9	1.90	—	—
P4	Length	4	1.6	1.60	0.00	0.0
	Width	4	1.9–2.0	1.95	0.06	3.1
M1	Length	1	1.8	1.80	—	—
	Width	1	2.3	2.30	—	—
M2	Length	4	1.8–1.9	1.88	0.05	2.7
	Width	1	2.6	2.60	—	—
M3	Length	4	1.3–1.7	1.53	0.17	11.1
	Width	4	2.1–2.5	2.28	0.17	7.5
p4	Length	4	1.4–1.5	1.43	0.10	7.0
	Width	4	0.9–1.1	1.03	0.10	9.7
m1	Length	3	1.8–1.9	1.83	0.06	3.3
	Width	3	1.3–1.4*	1.33	0.06	4.5
m2	Length	2	1.6–1.9	1.75	0.21	12.0
	Width	2	1.3–1.4	1.35	0.07	5.2
m3	Length	1	2.4	2.40	—	—
	Width	2	1.3–1.4	1.35	0.07	5.2

Table 22. Measurements and descriptive statistics for the dentition of Ignacius cf. I. frugivorus from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
I1	Length	1	2.5	2.50	—	—
	Width	1	2.2	2.20	—	—
P4	Length	2	1.7–1.8	1.75	0.07	4.0
	Width	1	2.0	2.00	—	—
M1	Length	1	1.9	1.90	—	—
	Width	1	2.5*	2.50	—	—
M2	Length	0	—	—	—	—
	Width	1	2.8	2.80	—	—
M3	Length	1	1.4	1.40	—	—
	Width	1	2.3	2.30	—	—
dp4	Length	1	1.8	1.80	—	—
	Width	1	1.1	1.10	—	—
p4	Length	1	1.7	1.70	—	—
	Width	1	1.2	1.20	—	—
m1	Length	4	1.9–2.0	1.95	0.06	3.1
	Width	4	1.5	1.50	0.00	0.0
m2	Length	3	1.8–1.9	1.83	0.06	3.2
	Width	6	1.5–1.6	1.53	0.05	3.3
m3	Length	1	2.4	2.40	—	—
	Width	3	1.4	1.40	0.00	0.0

Table 23. Measurements and descriptive statistics for the dentition of Nannodectes intermedius from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P3	Length	3	1.7–2.0	1.83	0.15	8.2
	Width	2	2.3–2.4	2.35	0.07	3.0
DP4	Length	1	2.2	2.20	—	—
	Width	1	2.6	2.60	—	—
P4	Length	1	2.0*	2.00	—	—
	Width	1	2.8*	2.80	—	—
M1	Length	3	2.4–2.6	2.50	0.10	4.0
	Width	3	3.5–3.9*	3.73	0.21	5.6
M2	Length	3	2.5–2.6	2.53	0.06	2.4
	Width	3	3.8–3.9	3.83	0.06	1.6
M3	Length	1	2.5	2.50	—	—
	Width	1	3.5	3.50	—	—
dp4	Length	2	2.4–2.5	2.45	0.07	2.9
	Width	2	1.7–1.8	1.75	0.07	4.0
p4	Length	3	1.9–2.0	1.93	0.06	3.1
	Width	3	1.9–2.0	1.93	0.06	3.1
m1	Length	1	2.6	2.60	—	—
	Width	2	2.2	2.20	0.00	0.0
m2	Length	3	2.6–2.7	2.67	0.06	2.3
	Width	3	2.4	2.40	0.00	0.0
m3	Length	2	3.7–3.8	3.75	0.07	1.9
	Width	2	2.4–2.5	2.45	0.07	2.9

Table 24. Measurements and descriptive statistics for the dentition of Plesiadapis praecursor from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
I1	Length	0	—	—	—	—
	Width	1	2.5	2.50	—	—
DP4	Length	1	2.4	2.40	—	—
	Width	1	3.0	3.00	—	—
P4	Length	1	2.2	2.20	—	—
	Ant. Width	1	3.3	3.30	—	—
	Post. Width	1	3.1	3.10	—	—
M1 or 2	Length	1	2.7	2.70	—	—
	Width	2	3.8–4.0	3.90	0.14	3.6
dp4	Length	1	2.6	2.60	—	—
	Width	3	1.4–1.9	1.66	0.25	15.1
p4	Length	2	2.1–2.2	2.15	0.07	3.3
	Width	2	2.1–2.3	2.20	0.14	6.4
m1	Length	3	2.6–2.8	2.70	0.10	3.7
	Width	3	2.3–2.5	2.40	0.10	4.2
m2	Length	3	2.8–3.0	2.93	0.12	4.1
	Tri. Width	3	2.6–2.8	2.70	0.10	3.7
	Tal. Width	2	2.7–2.8	2.75	0.07	2.6
m3	Length	2	3.7–4.2	3.93	0.25	6.4
	Width	4	2.5–2.7	2.58	0.10	3.9

Table 25. Measurements and descriptive statistics for the dentition of Elphidotarsius russelli from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
I1	Length	0	—	—	—	—
	Width	1	1.0	1.00	—	—
P3	Length	2	1.6–1.7	1.65	0.07	4.2
	Width	1	2.1	2.10	—	—
P4	Length	1	1.7	1.70	—	—
	Width	1	2.2	2.20	—	—
p4	Length	2	2.3–2.4	2.35	0.07	3.0
	Width	2	1.4	1.40	0.00	0.0
m1	Length	1	1.4	1.40	—	—
	Width	1	1.4	1.40	—	—
m2	Length	2	1.3–1.5	1.40	0.14	7.1
	Width	2	1.4–1.5	1.45	0.07	4.8

Table 26. Measurements and descriptive statistics for the dentition of Picrodus silberlingi from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	1	1.0	1.00	—	—
	Width	1	1.1	1.10	—	—
M1	Length	2	2.4–2.6	2.5	0.14	5.6
	Width	2	2.6	2.60	0.00	0.0
M3	Length	2	1.1	1.10	0.00	0.0
	Width	2	1.3–1.4	1.35	0.07	5.2
m3	Length	1	1.3	1.30	—	—
	Width	1	1.0	1.00	—	—

Table 27. Measurements and descriptive statistics for the dentition of Simpsonicits pegus from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	1	3.7*	3.70	—	—
	Width	1	2.6	2.60	—	—
M1	Length	1	3.0	3.00	—	—
	Width	0	—	—	—	—
dp4	Tri. Width	1	1.7	1.70	—	—
	Tri. Length	1	1.9	1.90	—	—
	Tri. Height	1	3.5	3.50	—	—
p4	Length	1	3.4	3.40	—	—
	Width	2	1.3	1.30	0.00	0.0
m1	Tri. Width	2	2.5	2.50	0.00	0.0
	Tri. Length	2	2.0	2.00	0.00	0.0
	Tri. Height	2	4.0	4.00	0.00	0.0
	Post. Width	1	1.8	1.80	—	—

Table 28. Measurements and descriptive statistics for the dentition of Chriacus pelvidens from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1	Length	1	7.3	7.30	—	—
	Width	1	9.1	9.10	—	—
M2	Length	1	6.8	6.80	—	—
	Width	1	9.5	9.50	—	—
m1	Length	1	7.5	7.50	—	—
	Tri. Width	1	5.1	5.10	—	—
	Tal. Width	1	5.5	5.50	—	—
m2	Length	1	7.8	7.80	—	—
	Tri. Width	1	5.4	5.40	—	—
	Tal. Width	1	5.9	5.90	—	—

Table 29. Measurements and descriptive statistics for the dentition of Chriacus cf. C. baldwini from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1	Length	3	5.8–6.1	5.97	0.15	2.5
	Width	2	7.5–7.6	7.55	0.07	0.9
M2	Length	1	6.7	6.70	—	—
	Width	1	8.6	8.60	—	—
m1 or m2	Length	1	6.0	6.00	—	—
	Tri. Width	1	5.0	5.00	—	—
	Tal. Width	2	5.0–5.5	5.25	0.35	6.7

Table 30. Measurements and descriptive statistics for the dentition of Thryptacodon orthogonius n. comb. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
p4	Width	1	2.6	2.60	—	—
m2	Length	1	6.3	6.30	—	—
	Tri. Width	1	5.1	5.10	—	—
	Tal. Width	1	5.5	5.50	—	—
m3	Length	1	5.9	5.90	—	—
	Tri. Width	1	4.6	4.60	—	—
	Tal. Width	1	4.2	4.20	—	—

Table 31. Measurements and descriptive statistics for the dentition of Litomylus dissentaneus from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	1	2.8	2.80	—	—
	Width	1	3.2	3.20	—	—
M1	Length	2	2.9–3.3	3.10	0.28	9.0
	Width	2	3.6–4.0	3.80	0.28	7.4
M2	Length	2	3.2–3.5*	3.35	0.21	6.3
	Width	2	4.0–4.3	4.15	0.21	5.1
M3	Length	2	2.7	2.70	0.00	0.0
	Width	2	3.3–3.5	3.40	0.14	4.1
p4	Length	1	3.4	3.40	—	—
	Width	1	1.7	1.70	—	—
m1	Length	1	3.1	3.10	—	—
	Tri. Width	1	2.5	2.50	—	—
	Tal. Width	1	2.5	2.50	—	—
m2	Length	0	—	—	—	—
	Width	1	2.2	2.20	—	—
m3	Length	2	3.6	3.60	0.00	0.0
	Tri. Width	2	2.2	2.20	0.00	0.0
	Tal. Width	3	2.0	2.00	0.00	0.0

Table 32. Measurements and descriptive statistics for the dentition of Litomylus grandaletes n. sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	1	3.3	3.30	—	—
	Width	1	4.4	4.40	—	—
M1	Length	3	4.0–4.2	4.07	0.12	3.0
	Width	3	5.5–5.8	5.67	0.15	2.7
M2	Length	3	4.3–4.4	4.33	0.06	1.4
	Width	3	6.0–6.3	6.17	0.15	2.4
M3	Length	2	3.4–3.5	3.45	0.07	2.0
	Width	3	4.6–5.1	4.90	0.26	5.3
m1	Length	1	4.0	4.00	—	—
	Width	2	3.1	3.10	0.00	0.0
m2	Length	3	4.3–4.5	4.40	0.10	2.3
	Width	3	3.6–3.8	3.70	0.10	2.7
m3	Length	1	4.7	4.70	—	—
	Tri. Width	1	3.3	3.30	—	—
	Tal. Width	1	3.1	3.10	—	—

Table 33. Measurements and descriptive statistics for the dentition of Apheliscinae n. gen. and sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	2	2.3–2.8	2.55	0.35	13.7
	Width	2	2.7–3.1	2.90	0.28	9.7
M1 or 2	Length	2	2.4–2.5	2.45	0.07	2.9
	width	2	3.5–3.6	3.55	0.07	2.0
p4	Length	2	2.6–2.9	2.75	0.21	7.6
	Width	4	1.6–1.9	1.70	0.08	4.7
m1	Length	0	—	—	—	—
	Width	1	1.6	1.60	—	—
m2	Length	2	2.4–2.6	2.50	0.14	5.6
	Tri. Width	2	2.0–2.2	2.10	0.14	6.7
	Tal. Width	2	1.9–2.1	2.00	0.14	7.0
m3	Length	0	—	—	—	—
	Width	1	1.6	1.60	—	—

Table 34. Measurements and descriptive statistics for the dentition of Ectocion collinus from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P2	Length	1	3.6	3.60	—	—
DP3	Length	3	5.5–6.1	5.73	0.32	5.6
	Width	3	5.5–6.0*	5.70	0.26	4.6
DP4	Length	1	6.5	6.50	—	—
	Width	1	7.3	7.30	—	—
M1	Length	3	7.5–8.0*	7.77	0.25	3.2
	Width	3	7.5–8.2	7.97	0.40	5.0
M1 or 2	Length	1	7.3	7.30	—	—
	Width	1	8.8	8.80	—	—
M2	Length	1	7.8	7.80	—	—
	Width	1	9.6	9.60	—	—
p2	Length	1	5.3	5.30	—	—
	Width	1	2.6	2.60	—	—
dp3	Length	1	6.9	6.90	—	—
	Width	2	3.5	3.50	0.00	0.0
dp4	Length	4	7.9–8.1	8.00	0.12	1.5
	Width	4	4.7–5.4	5.00	0.36	7.2
p4	Length	1	7.6	7.60	—	—
	Width	1	5.4	5.40	—	—
m1	Length	2	7.5–7.8	7.65	0.21	2.8
	Tri. Width	2	6.0–6.1	6.05	0.07	1.2
	Tal. Width	2	6.1–6.4	6.25	0.21	3.4

Table 34. con't

Element	P	N	OR	M	SD	CV
m2	Length	2	7.6–8.0	7.80	0.28	3.6
	Tri. Width	2	6.2–6.7	6.45	0.35	5.4
	Tal. Width	2	6.0–6.3	6.15	0.21	3.4
m3	Length	2	8.2–8.3	8.25	0.07	0.9
	Tri. Width	2	5.2–5.5	5.35	0.21	3.9
	Tal. Width	2	4.5–4.7	4.60	0.14	3.0

Table 35. Measurements and descriptive statistics for the dentition of Palaeoryctes cf. P. punctatus from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1	Length	2	2.0	2.00	0.00	0.0
	Width	1	2.0	2.00	—	—
M2	Length	1	1.5	1.50	—	—
	Width	1	2.5*	2.50	—	—
m1	Length	1	1.9	1.90	—	—
	Tri. Width	2	1.4	1.40	0.00	0.0
	Tal. Width	1	1.2	1.20	—	—
m2	Length	1	1.8	1.80	—	—
	Tri. Width	2	1.4	1.40	0.00	0.0
	Tal. Width	1	1.1	1.10	—	—
m3	Length	0	—	—	—	—
	Tri. Width	2	1.3–1.4	1.35	0.07	5.2
	Tal. Width	0	—	—	—	—

Table 36. Measurements and descriptive statistics for the dentition of <u>Pararyctes pattersoni</u> from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	6	1.5–1.9	1.75	0.14	8.0
	Width	4	1.9–2.0	1.98	0.05	2.5
M1	Length	5	1.7–1.8*	1.76	0.05	2.8
	Width	3	2.4–2.6	2.53	0.12	4.7
M2	Length	2	1.6	1.60	—	—
	Width	0	—	—	—	—
M3	Length	1	1.4	1.40	—	—
	Width	1	3.0	3.00	—	—
dp4	Length	2	1.6	1.60	0.00	0.0
	Width	6	0.9–1.1	1.0	0.06	6.0
p4	Length	1	2.0	2.00	—	—
	Width	1	1.0	1.00	—	—
m1 or 2	Length	1	1.6	1.60	—	—
	Width	1	1.4	1.40	—	—
m1 or 3	Length	1	1.6	1.60	—	—
	Width	1	1.3	1.30	—	—
m2	Length	1	1.7	1.70	—	—
	Width	3	1.3–1.4	1.37	0.06	4.4
m3	Length	1	1.7	1.70	—	—
	Tri. Width	1	1.4	1.40	—	—
	Tal. Width	2	0.9	0.90	0.00	0.0

Table 37. Measurements and descriptive statistics for the dentition of Palaeoryctidae unident. gen. and sp. 2 from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1 or 2	Length	1	2.5*	2.50	—	—
	Width	1	3.4	3.40	—	—
m1	Length	4	2.2–2.4	2.33	0.10	4.3
	Tri. Width	4	1.6–1.7	1.68	0.05	3.0
	Tal. Width	4	1.4–1.5	1.48	0.05	3.4
m2	Length	2	2.2–2.3	2.25	0.07	3.1
	Tri. Width	5	1.8–1.9	1.82	0.04	2.2
	Tal. Width	2	1.4	1.40	0.00	0.0
m3	Length	2	2.6	2.60	0.00	0.0
	Tri. Width	6	1.5–1.9*	1.66	0.16	9.6
	Tal. Width	2	1.2–1.3*	1.25	0.07	5.6

Table 38. Measurements and descriptive statistics for the dentition of Prodiacodon cf. P. puercensis from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
DP3	Length	1	3.1	3.10	—	—
	Width	1	2.2	2.20	—	—
P3	Length	1	3.3	3.30	—	—
	Width	1	2.1	2.10	—	—
P4	Length	3	2.6–2.8*	2.73	0.12	4.4
	Width	3	3.5–3.6	3.53	0.06	1.7
M1 or 2	Length	2	2.7–2.8*	2.75	0.07	2.6
	Width	3	3.8–3.9	3.83	0.06	1.6
p3	Length	1	2.8	2.80	—	—
	Width	1	1.2	1.20	—	—
p4	Length	2	3.5–3.8	3.65	0.21	5.8
	Width	2	1.8–1.9	1.85	0.07	3.8
m1	Length	4	2.8–3.0	2.95	0.10	3.4
	Tri. Width	4	2.2	2.20	0.00	0.0
	Tal. Width	4	2.2	2.20	0.00	0.0
m2	Length	2	3.1	3.10	0.00	0.0
	Tri. Width	3	2.3–2.4	2.35	0.06	2.6
	Tal. Width	2	2.1	2.10	0.00	0.0
m3	Length	0	—	—	—	—
	Width	1	2.4	2.40	—	—

Table 39. Measurements and descriptive statistics for the dentition of Prodiacodon concordiarcensis from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P3	Length	4	1.7–1.8	1.78	0.05	2.8
	Width	4	1.4–1.5	1.43	0.05	3.5
P4	Length	2	1.7–2.0*	1.85	0.21	11.4
	Width	2	2.2–2.5	2.35	0.21	8.9
M1	Length	4	1.8–2.0	1.93	0.10	5.2
	Width	2	2.8–2.9	2.85	0.07	2.5
M2	Length	1	2.0	2.00	—	—
	Width	2	2.7–2.8	2.75	0.07	2.6
M3	Length	2	1.7–2.0	1.85	0.21	11.4
	Width	2	2.8–2.9	2.85	0.07	2.5
p4	Length	4	2.0–2.1	2.03	0.05	2.5
	Width	5	1.1–1.2	1.12	0.05	4.5
m1	Length	2	1.8–1.9	1.85	0.07	3.8
	Tri. Width	2	1.3	1.30	0.00	0.0
	Tal. Width	2	1.1–1.2	1.15	0.07	6.1
m2	Length	4	1.7–1.9	1.80	0.08	4.4
	Tri. Width	5	1.4	1.40	0.00	0.0
	Tal. Width	4	1.1–1.2	1.13	0.05	4.4
m3	Length	3	1.8–1.9	1.83	0.06	3.3
	Tri. Width	8	1.3–1.4	1.33	0.05	3.8
	Tal. Width	4	0.9–1.0	0.95	0.06	6.3

Table 40. Measurements and descriptive statistics for the dentition of Prodiacodon furor from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P3	Length	1	2.5*	2.50	—	—
DP4	Length	1	2.6	2.60	—	—
	Width	1	2.6*	2.60	—	—
P4	Length	6	2.1–2.6	2.43	0.19	7.8
	Width	3	3.0–3.2	3.10	0.10	3.2
M1	Length	1	2.0	2.00	—	—
	Width	1	3.3	3.30	—	—
M2	Length	4	2.2–2.3	2.23	0.05	2.2
	Width	4	3.7–3.9	3.78	0.10	2.7
M3	Length	1	2.0*	2.00	—	—
p3	Length	1	1.6	1.60	—	—
	Width	1	0.8	0.80	—	—
dp4	Length	1	2.0	2.00	—	—
	Width	1	1.4	1.40	—	—
m1	Length	1	2.0	2.00	—	—
	Width	1	1.8	1.80	—	—

Table 41. Measurements and descriptive statistics for the dentition of *Myrmecoboides montanensis* from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1	Length	1	2.3	2.30	—	—
	Width	1	3.4	3.40	—	—
m1	Length	1	2.6	2.60	—	—
	Tri. Width	1	1.6	1.60	—	—
	Tal. Width	1	1.6	1.60	—	—
m1 or m2	Length	0	—	—	—	—
	Tri. Width	1	1.8	1.80	—	—
	Tal. Width	1	1.5	1.50	—	—
m3	Length	1	2.6	2.60	—	—
	Tri. Width	1	1.9	1.90	—	—
	Tal. Width	1	1.6	1.60	—	—

Table 42. Measurements and descriptive statistics for the dentition of Bisonalveus browni from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P3	Length	4	1.8–2.0	1.90	0.12	6.3
	Width	2	1.9–2.0	1.95	0.07	3.6
P4	Length	10	2.0–2.4	2.17	0.14	6.5
	Width	9	2.6–3.3	2.86	0.23	8.0
M1	Length	10	2.2–2.7	2.40	0.21	8.8
	Width	10	2.8–3.4	3.13	0.18	5.8
M2	Length	16	2.3–2.7	2.49	0.12	4.8
	Width	14	3.6–4.1	3.76	0.14	3.7
M3	Length	10	1.7–1.9	1.77	0.07	4.0
	Width	9	2.6–2.9	2.74	0.12	4.4
Dp4	Length	5	2.2–2.3	2.22	0.05	2.3
	Width	9	1.2–1.4	1.29	0.08	6.2
p2	Length	3	1.2–1.4	1.27	0.12	9.5
	Width	3	0.8–0.9	0.83	0.06	7.2
p3	Length	10	1.7–1.9	1.80	0.07	3.9
	Width	10	1.2–1.3	1.25	0.05	4.0
p4	Length	8	1.9–2.4	2.10	0.17	8.1
	Width	8	1.4–1.7	1.51	0.11	7.3
m1	Length	14	2.1–2.6	2.34	0.14	6.0
	Tri. Width	19	1.4–2.1	1.70	0.21	12.4
	Tal. Width	20	1.5–2.1	1.71	0.16	9.4

Table 42. con't.

Element	P	N	OR	M	SD	CV
m2	Length	9	2.2–2.6	2.48	0.13	5.2
	Tri. Width	13	1.6–2.2	1.97	0.18	9.1
	Tal. Width	14	1.5–2.1	1.79	0.15	8.4
m3	Length	11	2.2–2.7	2.53	0.14	5.5
	Tri. Width	21	1.5–1.8	1.71	0.08	4.7
	Tal. Width	15	1.2–1.7	1.45	0.11	7.6

Table 43. Measurements and descriptive statistics for the dentition of Pentacodontidae n. gen. and sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4?	Length	1	3.4	3.40	—	—
	Wifth	1	4.1	4.10	—	—
m1?	Length	2	3.4–3.5*	3.45	0.07	2.0
	Width	2	2.7–2.9	2.80	0.14	5.0
m2?	Length	1	3.0	3.00	—	—
	Width	1	2.6	2.60	—	—

Table 44. Measurements and descriptive statistics for the dentition of Propalaeosinopa septentrionalis from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
M1	Length	3	2.4–2.5	2.43	0.06	2.5
	Width	2	3.1–3.2	3.15	—	—
M2	Length	4	2.3–2.6	2.45	0.13	5.3
	Width	3	3.4–3.8	3.63	0.21	5.8
M3	Length	0	—	—	—	—
	Width	1	2.4	2.40	—	—
p2	Length	2	2.0	2.00	0.00	0.0
	Width	2	0.8	0.80	0.00	0.0
p3	Length	1	2.4	2.40	—	—
	Width	1	1.0	1.00	—	—
dp4	Length	0	—	—	—	—
	Width	5	1.1–1.4	1.18	0.13	11.0
p4	Length	3	2.7*–3.0	2.80	0.17	6.1
	Width	4	1.1–1.3	1.25	0.10	8.0
m1	Length	2	2.1–2.2	2.15	0.07	3.3
	Width	2	1.6	1.60	0.00	0.0
m2	Length	4	2.2–2.4	2.28	0.10	4.3
	Width	6	1.7–1.8	1.72	0.04	2.3
m3	Length	2	2.8–2.9	2.85	0.07	2.5
	Tri. Width	5	1.6–1.8	1.72	0.08	4.7

Table 45. Measurements and descriptive statistics for the dentition of *Paleotomus junior* n. sp. from the Cochrane 2 locality.

Element	P	N	OR	M	SD	CV
P4	Length	1	3.3	3.30	—	—
	Width	1	3.4	3.40	—	—
M1	Length	2	3.2–3.3	3.25	0.07	2.2
	Width	1	4.4*	4.40	—	—
dp4	Length	2	3.5–3.7	3.60	0.14	3.9
	Width	3	1,5–1.6	1.57	0.06	3.8
[illegible]	Length	1	3.3	3.30	—	—
	Width	1	1.2	1.20	—	—
m3	Length	2	3.5–3.6	3.55	0.07	2.0
	Ant. width	3	2.4–2.5	2.47	0.06	2.4
	Post. width	2	1.6–1.9	1.75	0.21	12.0

Table 46. Biostratigraphic comparison of selected mammals from the Cochrane 2 locality, Alberta with occurrences of comparable late Torrejonian (middle Paleocene) and early Tiffanian (late Paleocene) faunas.

OCCURRENCES:	G. Q.	S. Q.	R. B. Q.	M. R. I & M. S.	K. H.	D. Q.	B. Q.	L. M. C.	S. L.	Sc. Q.
COCHRANE TAXA:										
Ectypodus cf. E. szalayi	S-	S-	—	S	—	—	G	G	—	G+
Parectopodus sinclairi	S-	—	—	S/	S/	—	—	—	—	—
Parectopodus cf. P. sylviae	—	S	—	S	—	—	—	—	—	—
Parectopodus n. sp	—	—	—	S/	—	—	—	—	—	—
Neoplagiaulax nelsoni	—	S	S	S	S	S	—	—	—	S
Neoplagiualax cf. N. hunteri	—	—	—	—	—	S+	—	—	—	S+
Ptilodus titanus	—	—	—	?S	S	S	—	—	G+	G+
Ptilodus cedrus	G-	—	G-	—	S	S	—	?S	S	S
Ptilodus gnomus n. sp.	—	G-	—	—	—	S	—	—	S+	S/
Baiotomeus russelli n. sp.	G-	G-	G-	G-	G-	—	—	—	—	—
Anconodon gidleyi	S	—	S	—	S	S	—	S	—	—
Anconodon cochranensis	S	—	S	S	G+	S	—	—	S	—
Peradectes sp.	—	—	—	—	—	S/	—	—	S+	—
Elpidophorus cf. E. elegans	G-	—	—	—	—	S/	—	—	—	S+
?Palaechthon sp.	G	—	G	?G	S	—	G	—	—	—
Plesiolestes cf. P. sirokyi	—	G-	G-	?G	G-	—	G-	—	S+	—
Ignacius fremontensis	—	—	S-	—	S	—	—	—	—	—

Table 46. con't.

OCCURRENCES:	G. Q.	S. Q.	R. B. Q.	M. R. I & M. S.	K. H.	D. Q.	B. Q.	L. M. C.	S. L.	Sc. Q.
Ignacius cf.I. frugivorus	—	—	—	—	S	G	—	—	—	S+
?Pronothodectes sp.	?G-	—	G+	G+	—	—	—	—	—	—
Nannodectes intermedius	—	—	—	—	S	S	S	?S	G+	G+
Plesiadapis praecursor	—	—	—	—	S	S	—	—	G+	G+
Plesiadapis cf. P. anceps	—	—	—	—	—	—	—	—	S	S
Elphidotarsius russelli	G-	—	G-	G-	G-	S+	—	—	—	—
Carpodaptes cf. C. hazelae	—	—	—	—	S	—	—	—	—	S+
Pristinictis connatus n. gen. and sp.	—	—	—	—	—	S	—	—	—	—
Simpsonictis cf. S. tenuis	S-	?S-	S-	S-	—	—	—	—	—	—
Simpsonictis pegus	—	—	S	—	S	S	—	—	?S	—
Thryptacodon orthogonius	—	—	—	—	—	S	—	—	S	G+
Colpoclaenus cf. C. keeferi	—	—	?G	—	S	?S	—	—	—	—
Claenodon cf. C. montanensis	S-	G	G	G	?S	S	—	—	S	S
Litomylus dissentaneus	S	S	S	S	S	S	—	—	S	—
Apheliscinae n. gen. and sp.	—	—	—	—	—	S	—	—	—	—
Desmatoclaenus cf. D. mearae	—	—	—	—	—	—	—	—	S/	?S
Ectocion collinus	—	—	—	—	S-	S+	—	—	G+	—
Prodiacodon cf. P. puercensis	—	S-	—	—	S	—	—	—	—	—
Prodiacodon concordiarcensis	S	S	—	—	S	S	—	—	S	—

Table 46. con't.

OCCURRENCES:	G. Q.	S. Q.	R. B. Q.	M. R. I & M. S.	K. H.	D. Q.	B. Q.	L. M. C.	S. L.	Sc. Q.
Prodiacodon furor	S	—	—	?S	S	S	—	—	—	[illegible]
Myrmecoboides montanensis	S	S	?S	?S	S	S	S	—	—	—
Bisonalveus browni	—	—	—	—	S-	S	—	—	S	—
Pentacodontidae n. gen. and sp.	—	—	?G	—	—	S	—	—	—	—
Paleotomus senior	—	—	—	?S-	—	S	—	—	—	S
Paleotomus junior	—	G-	—	S	S	S	—	—	—	—
Eudaemonema cf. E. cuspidata	S-	—	S-	S-	S	—	—	—	—	—
Jepsenella cf. J. praepropera	S-	S-	S-	S-	?G	—	—	—	—	—

G. Q. = Gidley Quarry
S. Q. = Swain Quarry
R. B. Q. = Rock Bench Quarry
M. R. I & M. S. = Medicine Rocks I & Mehling Site
K. H. = Keefer Hill
D. Q. = Douglass Quarry
B. Q. = Bangtail Quarry
L. M. C. = Little Muddy Creek
S. L. = Saddle Locality
Sc. Q. = Scarritt Quarry

G = Genus occurs in comparative fauna.
S = Species occurs in comparative fauna.
? = Congenerity or conspecifity questionable.
+ = Morphologically most similar species of genus in comparative fauna more derived.
- = Morphologically most similar species of genus in comparative fauna less derived.
/ = Relative primitiveness of morphologically most similar species of genus in comparative fauna indeterminate.

PLATES

Plate 1. Cochrane 2 Locality

A Foothills east of Cochrane, Alberta

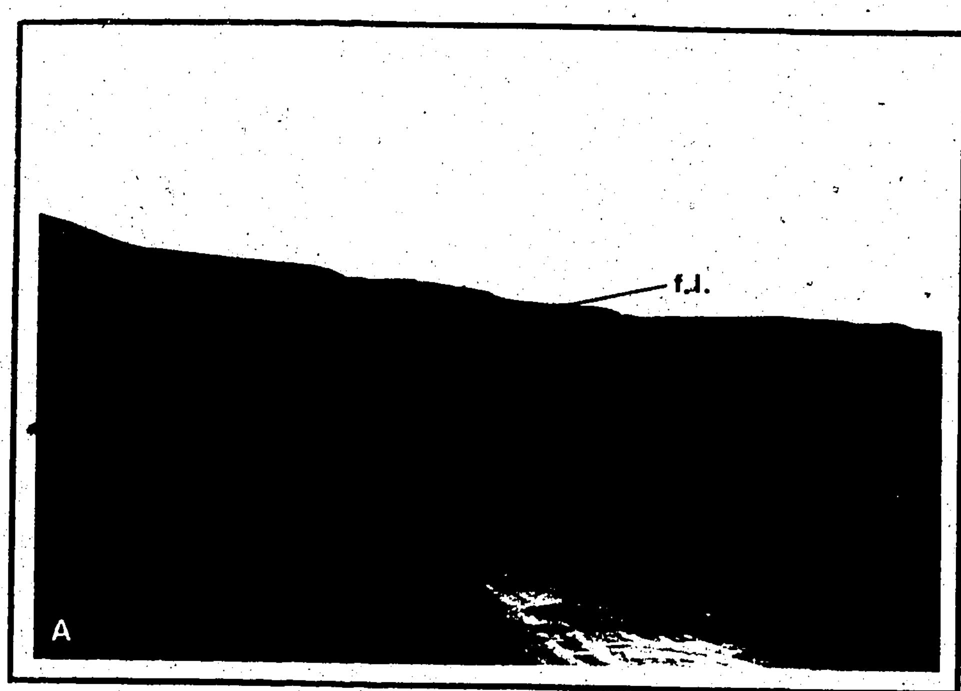
f. l. fossil layer

B Outcrop at the Cochrane locality

A figure sitting near the center of the photograph, at the fossil layer, provides an indication of scale.

m. s. massive sandstone, highly cross–bedded

f. l. fossil layer, siltstones and shales


f.l.
A

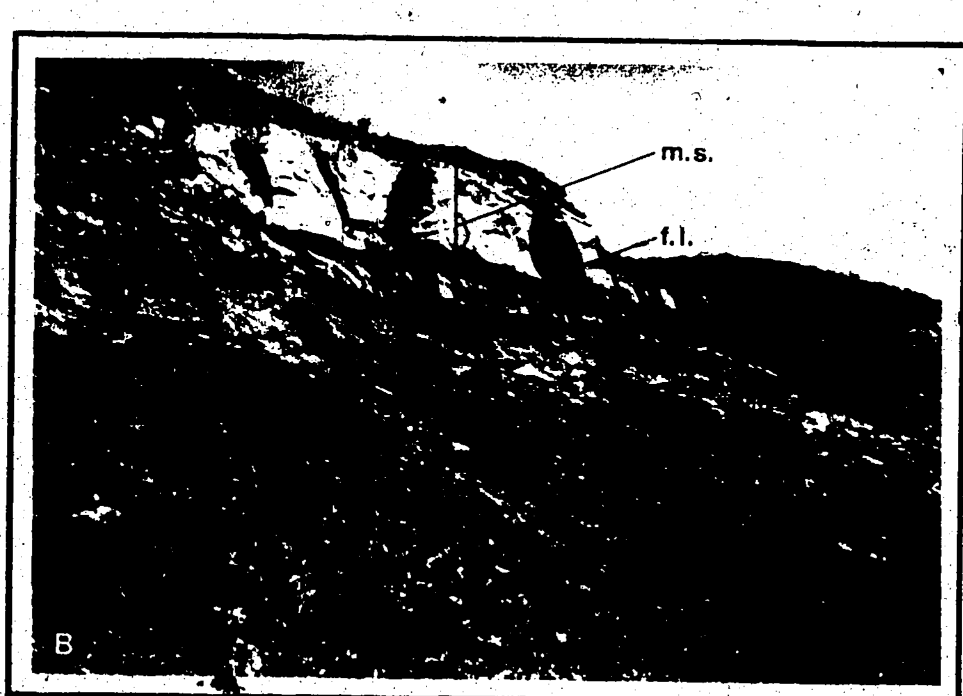

m.s.
f.l.
B

Plate 2. <u>Mesodma pygmaea</u>

A Labial view, UALVP 24424, right p4, length 2.6, about x 10.8.

B Lingual view, UALVP 24424, p4, length 2.6, about x 10.8.

C Labial view, UALVP 24455, left p4, length 2.6, about x 10.8.

D Lingual view, UALVP 24455, left p4, length 2.6, about x 10.8.

E Stereophotographic pair, occlusal view, UALVP 24455, left p4, length 2.6, about x 10.8.

F Labial view, U[illegible]P 24435, left P4, length 1.7, about x 10.6.

G Lingual vi[illegible]4435, left P4, length 1.7, about x 10.6.

<u>Mimetodon silber[illegible]</u>

H Labial view, [illegible] 24396, right p4, length 2.8, about x 10.5.

I Lingual view, UALVP 24396, right p4, length 2.8, about x 10.5.

Plate 3. <u>Ectypodus</u> cf. <u>E</u>. <u>szalayi</u>

A Labial view, UALVP 24383, left p4, length 3.1, about x 10.5.

B Lingual view, UALVP 24383, left p4, length 3.1, about x 10.5.

C Labial view, UALVP 24385, right P4, length 2.0, about x 10.5.

D Lingual view, UALVP 24385, right P4, length 2.0, about x 10.5.

<u>Ectypodus</u> sp.

E Labial view, UALVP 24390, right p4, length 2.4, about x 10.4.

F Lingual view, UALVP 24390, right p4, length 2.4, about x 11.5.

<u>Parectypodus</u> <u>sinclairi</u>

G Labial view, UALVP 24361, left p4, length 3.7, about x 11.1.

H Lingual view, UALVP 24361, left p4, length 3.7, about x 11.1.

Plate 4. <u>Parectypodus sinclairi</u>

A Labial view, 24365, right P4, length 2.5, about x 11.4.

B Lingual view, UALVP 24365, right P4, length 2.5, about x 11.4.

C Stereophotographic pair, occlusal view, UALVP 24365, right P4, length 2.5, about x 11.4.

<u>Parectypodus</u> cf. <u>P</u>. <u>sylviae</u>

D Labial view, UALVP 18403, left P4, length 1.9, about x 11.6.

E Lingual view, UALVP 18403, left P4, length 1.9, about x 11.6.

F Stereophotographic pair, UALVP 18403, occlusal view, left P4, length 1.9, about x 11.8.

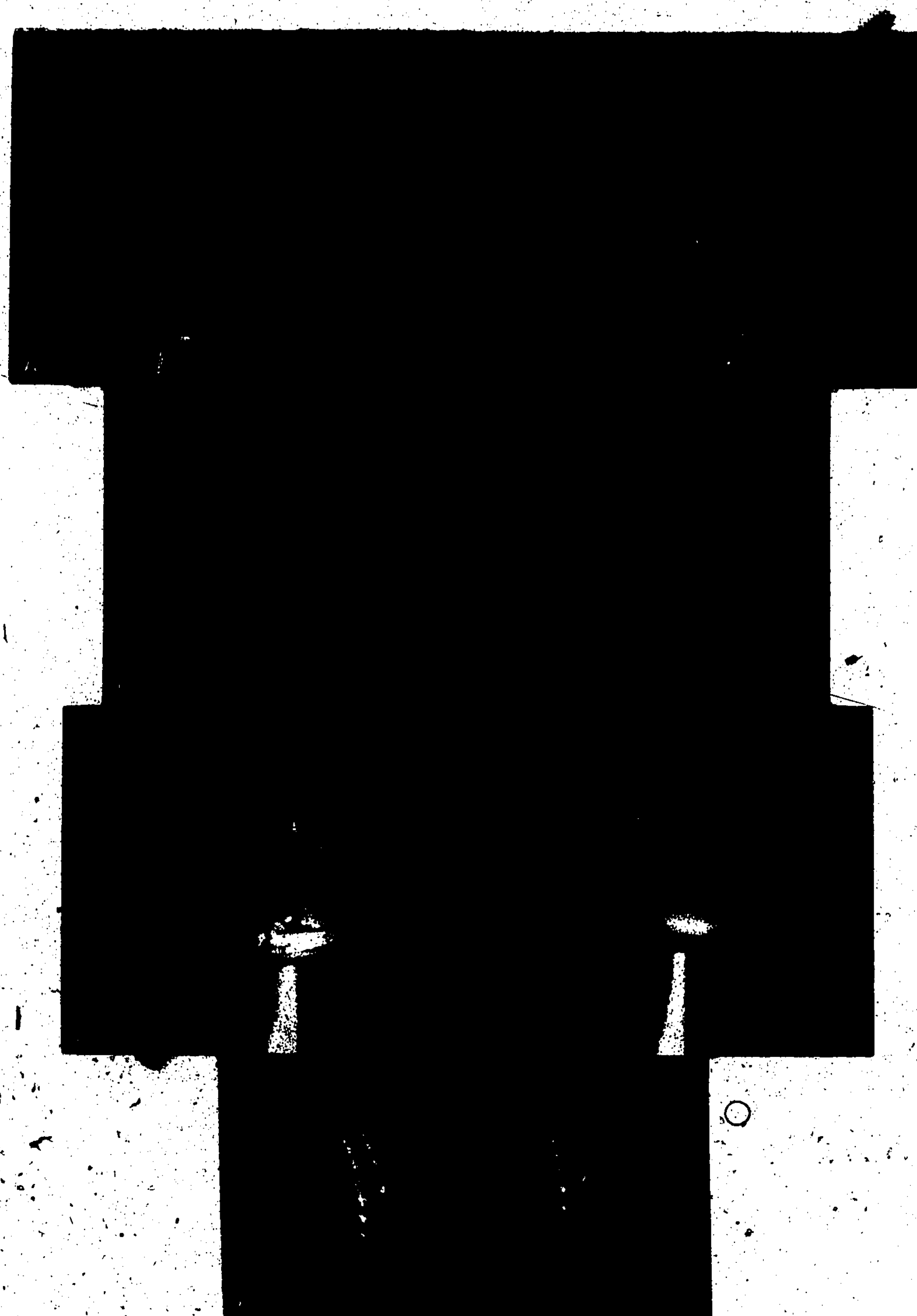


Plate 5. *Parectypodus* n. sp.

A Labial view, UALVP 24377, right p4, length 3.8, about x 11.6.

B Lingual view, UALVP 24377, right p4, length 3.8, about x 11.6.

C Labial view, UALVP24378, left P4, length 2.9, about x 10.5.

D Lingual view, UALVP 24378, left P4, length 2.9, about x 10.5.

E Stereophotographic pair, occlusal view, UALVP 24378, left P4, length 2.9, about x 11.2.

Neoplagiaulax nelsoni

F Labial view, UALVP 18880, left dentary fragment having p4—m2, length of p4, 3.9, about x 8.7.

G Lingual view, UALVP 18880, left dentary fragment having p4—m2, length of p4, 3.9, about x 8.7.

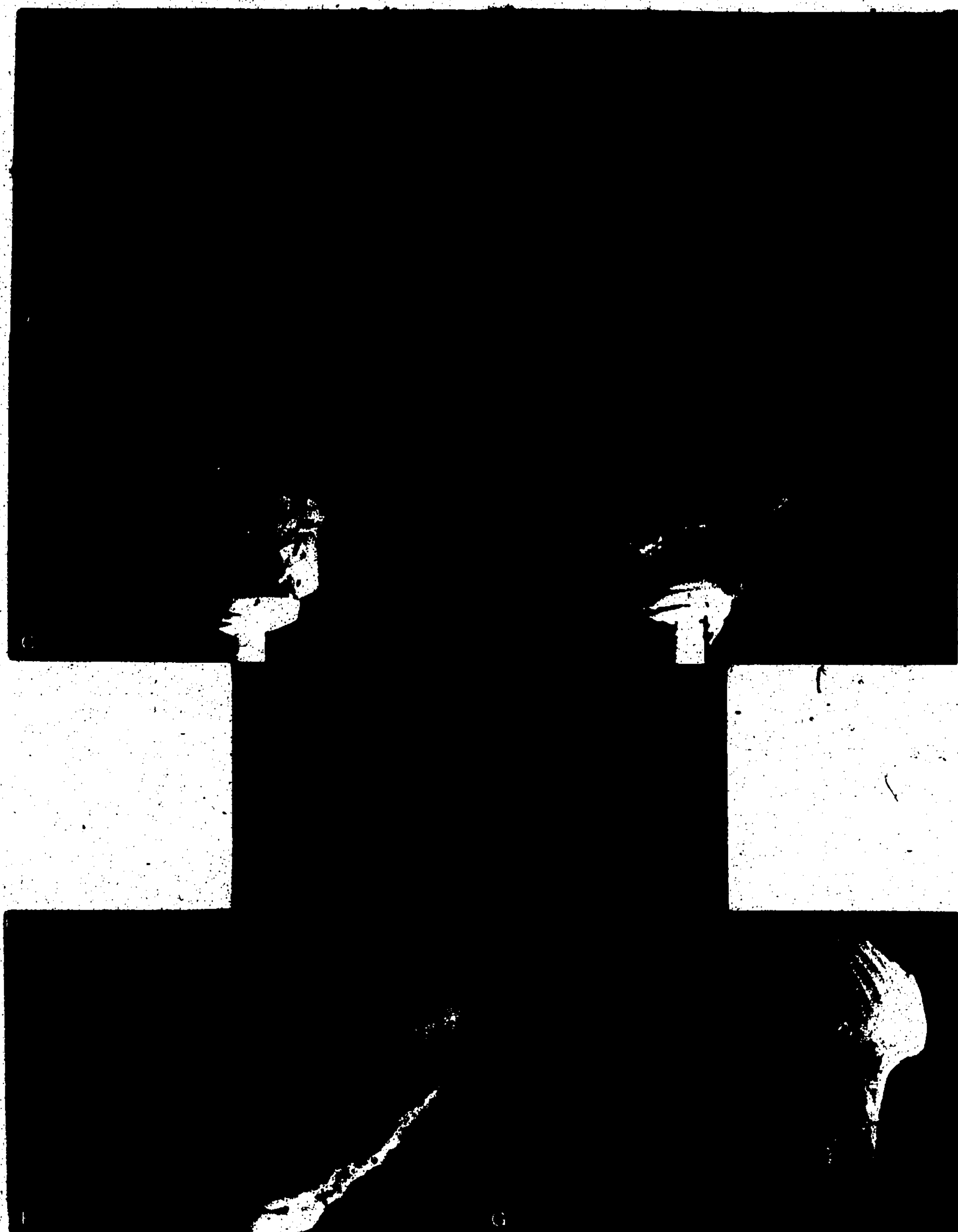


Plate 6. Neoplagiaulax nelsoni

A Labial view, UALVP 18814, right p4, length 3.9, about x 11.8.

B Lingual view, UALVP 18814, right p4, length 3.9, about x 11.8.

C Labial view, UALVP 18816, right P4, length 2.8, about x 11.8.

D Lingual view, UALVP 18816, right P4, length 2.8, about x 11.8.

E Stereophotographic pair, occlusal view, UALVP 18816, right P4, length 2.8, about x 11.8.

Neoplagiaulax cf. N. hunteri

F Labial view, UALVP 18840, right P4, length 2.3, about x 14.8.

G Lingual view, UALVP 18840, right P4, length 2.3, about x 14.8.

Plate 7. <u>Neoplagiaulax</u> cf. <u>N</u>. <u>hunteri</u>

A Stereophotographic pair, occlusal view, UALVP 18840, right P4, length 2.3, about x 14.8.

Neoplagiaulacidae unident. gen. and sp.

B Labial view, UALVP 24485, right p4, lingual crown height 1.4, about x 11.4.

C Lingual view, UALVP 24485, right p4, lingual crown height 1.4, about x 11.4.

D Lingual view, UALVP 24486, right P4, length 1.6, about x 11.9.

E Labial view, UALVP 24486, right P4, length 1.6, about x 11.9.

F Stereophotographic pair, occlusal view, UALVP 24486, right P4, length 1.6, about x 15.0.

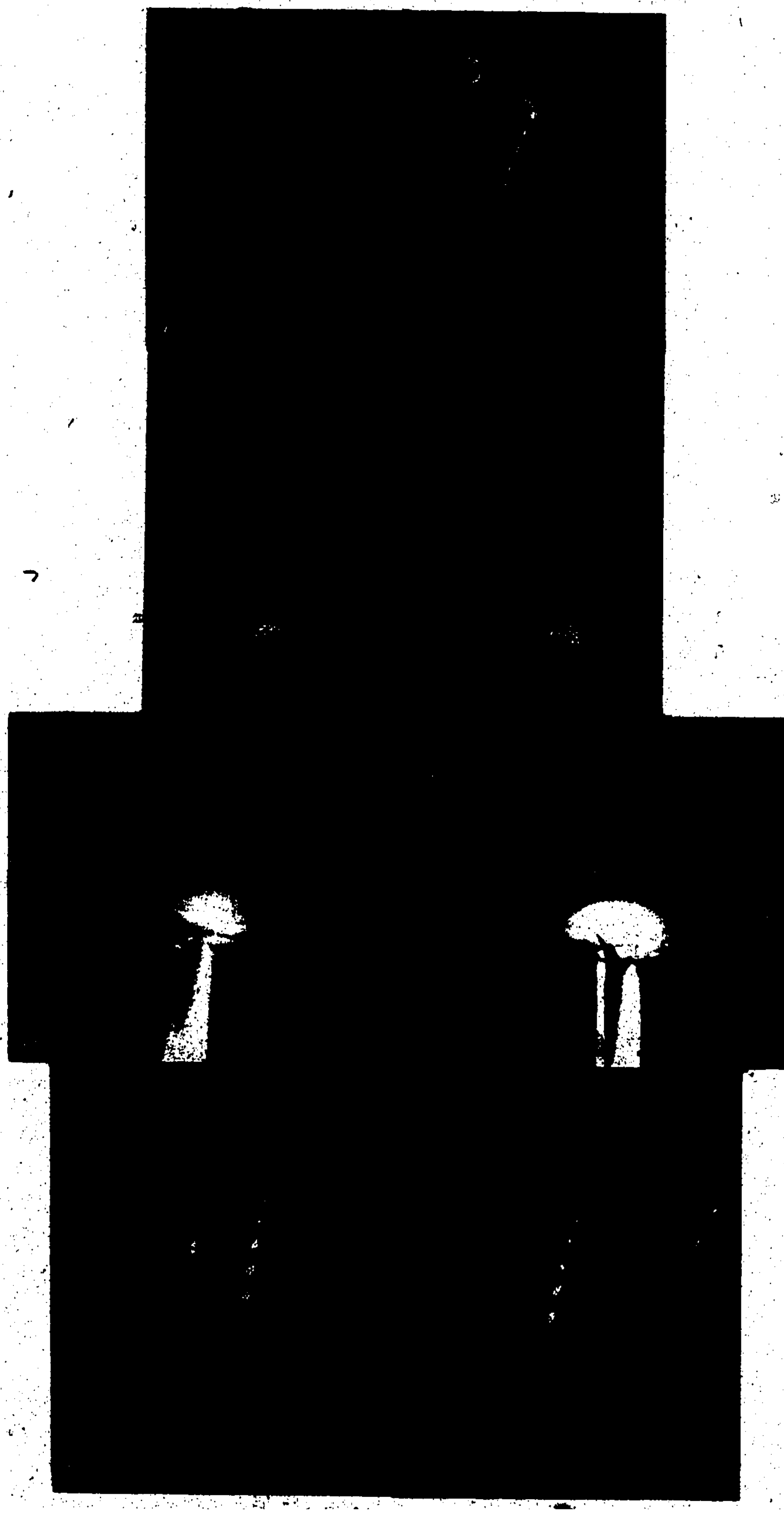
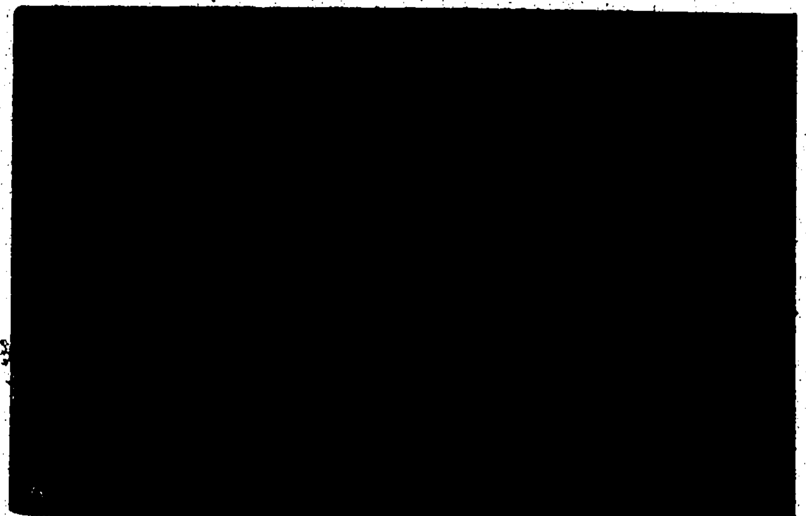


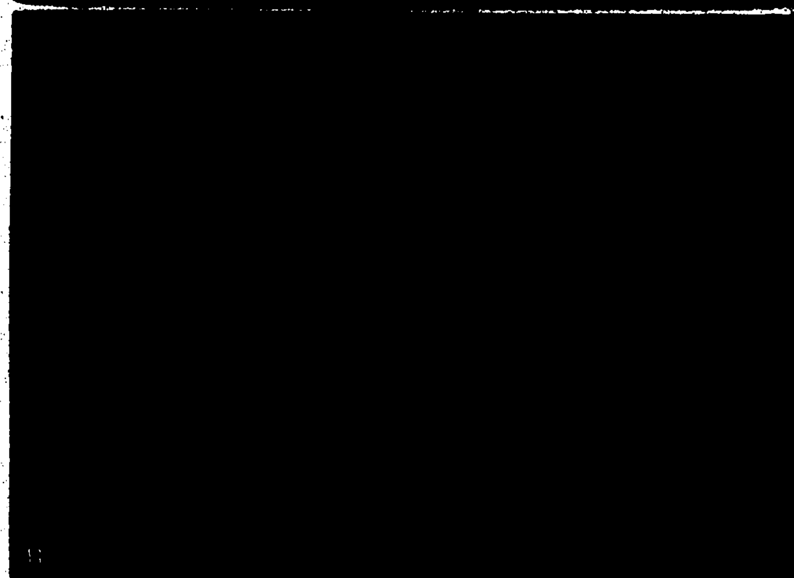
Plate 8. <u>Ptilodus</u> sp. T

A Stereophotographic pair, occlusal view, UALVP 18624, right P3, length 4.0, about x 9.3.

B Stereophotographic pair, occlusal view, UALVP 18623, left P4, length 6.9, about x 11.6.

C Stereophotographic pair, occlusal view, UALVP 18621, right maxillary fragment having M1—M2, width M2, 3.0, about x 8.3.





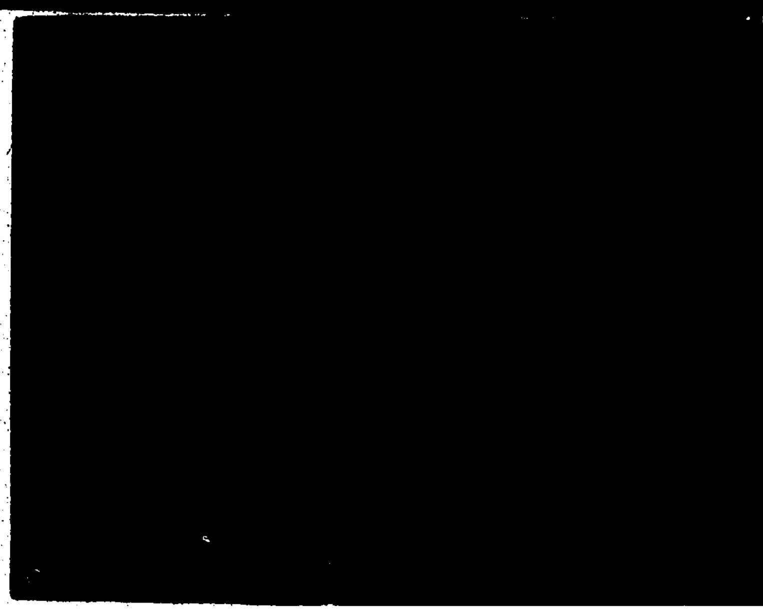


Plate 9. Ptilodus sp. T

A Labial view, UALVP 18620, right dentary fragment having p3—p4, length p4, 11.0, about x 3.3.

Ptilodus sp. C

B Stereophotographic pair, occlusal view, UALVP 18648, left m1, length 3.9, about x 11.8.

Ptilodus gnomus n. sp.

C Stereophotographic pair, occlusal view, UALVP 18669 (holotype), left P4, length 3.5, about x 11.8.

D Labial view, UALVP 18670, left dentary fragment having i1—p4, length p4, 5.5, about x 5.3.

[redacted]

Plate 10. <u>Baiotomeus russelli</u> n. sp.

A Labial view, UALVP 18787 (holotype), left P4, length 2.2, about x 11.0.

B Lingual view, UALVP 18787 (holotype), left P4, length 2.2, about x 11.0.

C Stereophotographic pair, occlusal view, UALVP 18787 (holotype), left P4, length 2.2, about x 11.1.

D Stereophotographic pair, occlusal view, UALVP 18791, right m1, length, 2.2, about x 12.1.

Ptilodontidae, unident. <u>gen. and sp.</u>

E Stereophotographic pair, occlusal view, UALVP 18804, left m1, width 2.6, about x 12.3.

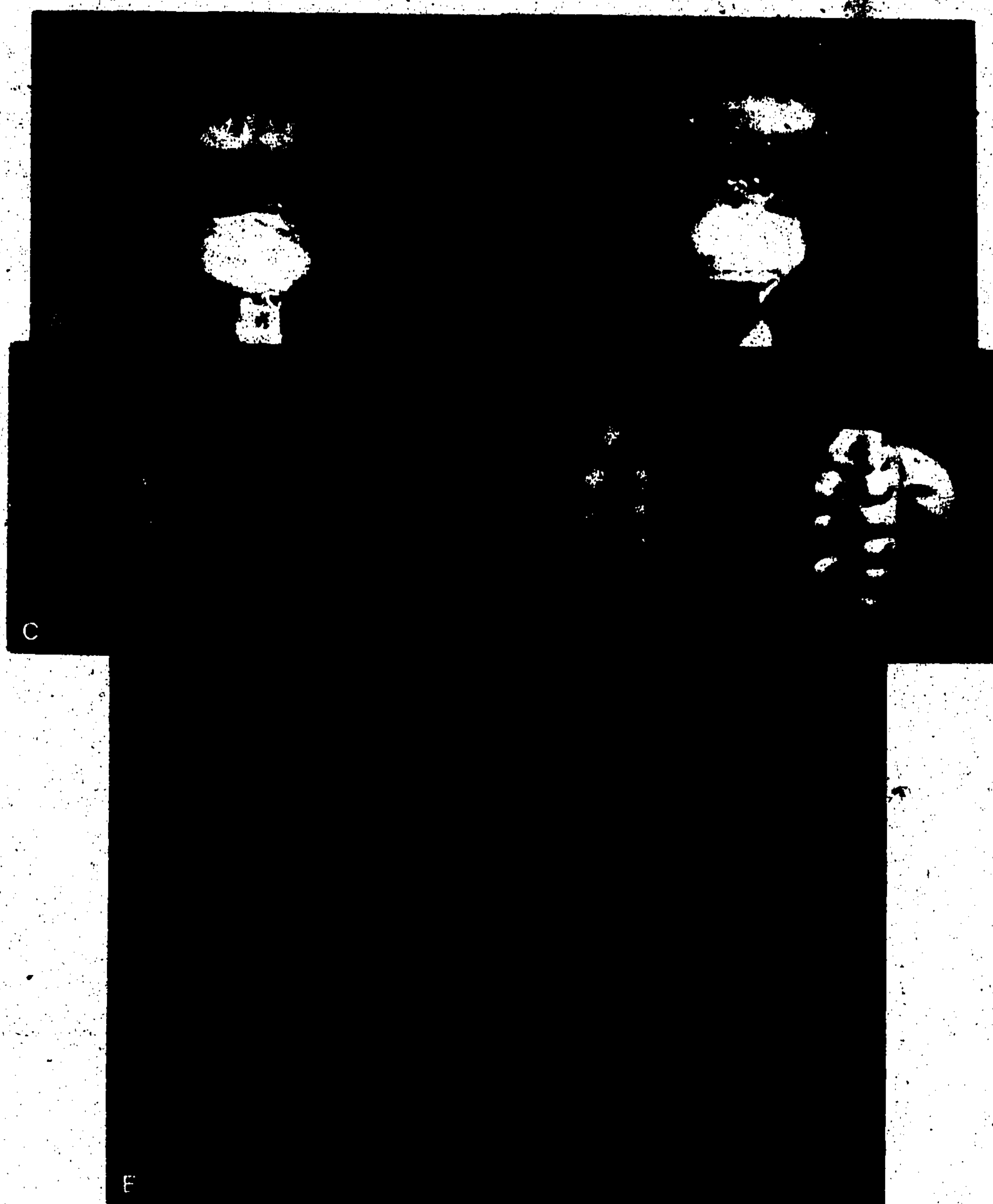

C
E

Plate 11. Anconodon gidleyi

A Labial view, UALVP 24488, left P4, length 5.0, about x 10.4.

B Lingual view, UALVP 24488, left P4, length 5.0, about x 10.4.

C Stereophotographic pair, occlusal view, UALVP 24488, left P4, length 5.0, about x 10.4.

Anconodon cochranensis

D Stereophotographic pair, occlusal view, UALVP 24511, left P4, length 3.7, about x 10.4.

E Labial view, UALVP 24511, left P4, length 3.7, about x 10.4.

F Lingual view, UALVP 24511, left P4, length 3.7, about x 10.4.

G Labial view, UALVP 24541, left m1, length 2.8, about x 11.1.

H Lingual view, UALVP 24541, left m1, length 2.8, about x 11.1.

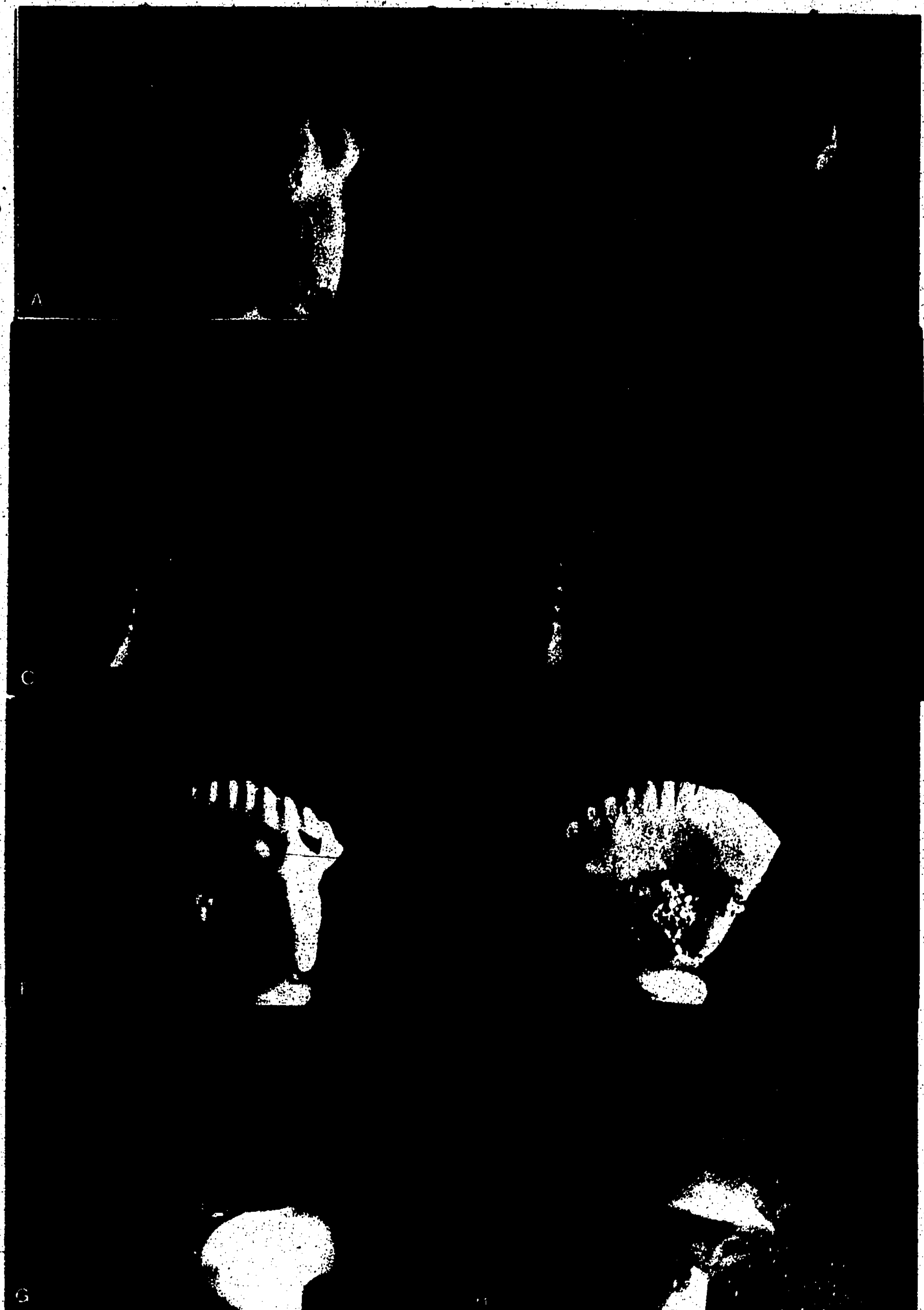

A
C
G

Plate 12. <u>Anconodon cochranensis</u>

A Stereophotographic pair, occlusal view, UALVP 24541, left m1, length 2.8, about x 11.1.

<u>Anconodon</u> sp.

B Labial view, UALVP 24540, left p4, length 3.2, about x 10.3.

C Lingual view, UALVP 24540, left p4, length 3.2, about x 10.3.

D Labial view, UALVP 24535, left P4, length 3.0, about x 10.3.

E Lingual view, UALVP 24535, left P4, length 3.0, about x 10.3.

F Stereophotographic pair, occlusal view, UALVP 24535, left P4, length 3.0, about x 10.3.

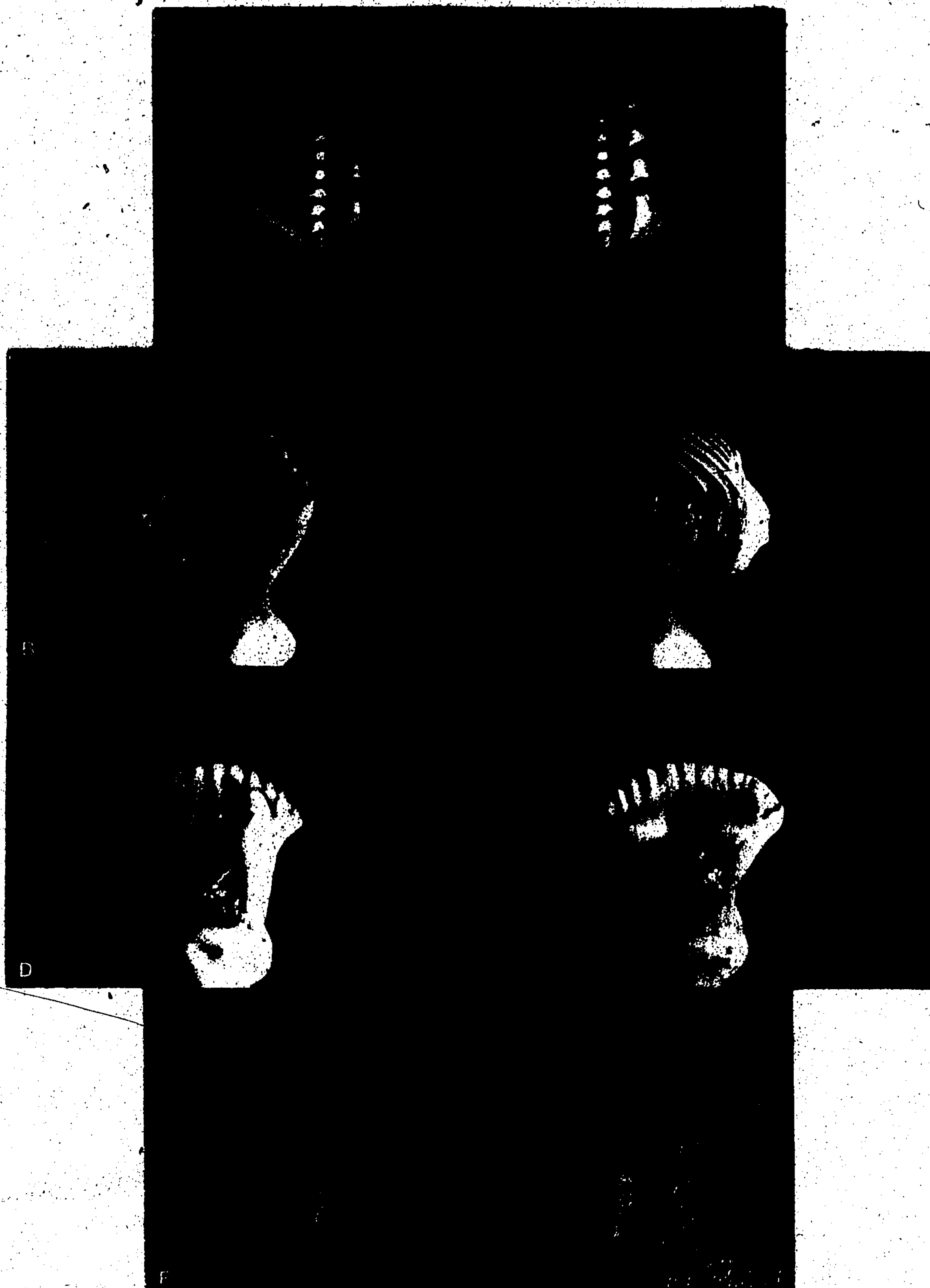

B
D
F

Plate 13. Eucosmodontinae unident. gen. and sp.

A Labial view, UALVP 24682, right M1, length 7.0, about x 10.3.

B Lingual view, UALVP24682, right M1, length 7.0, about x 10.3.

C Stereophotographic pair, occlusal view, UALVP 24682, right M1, length 7.0, about x 10.3.

<u>Acheronodon vossae</u> n. sp.

D Labial view, UALVP 24550 (holotype), left dentary fragment having p4 and alveolus of p3, length of p4, 2.0, about x 11.5.

E Lingual view, UALVP 24550 (holotype), left dentary fragment having p4 and alveolus of p3, length of p4, 2.0, about x 11.5.

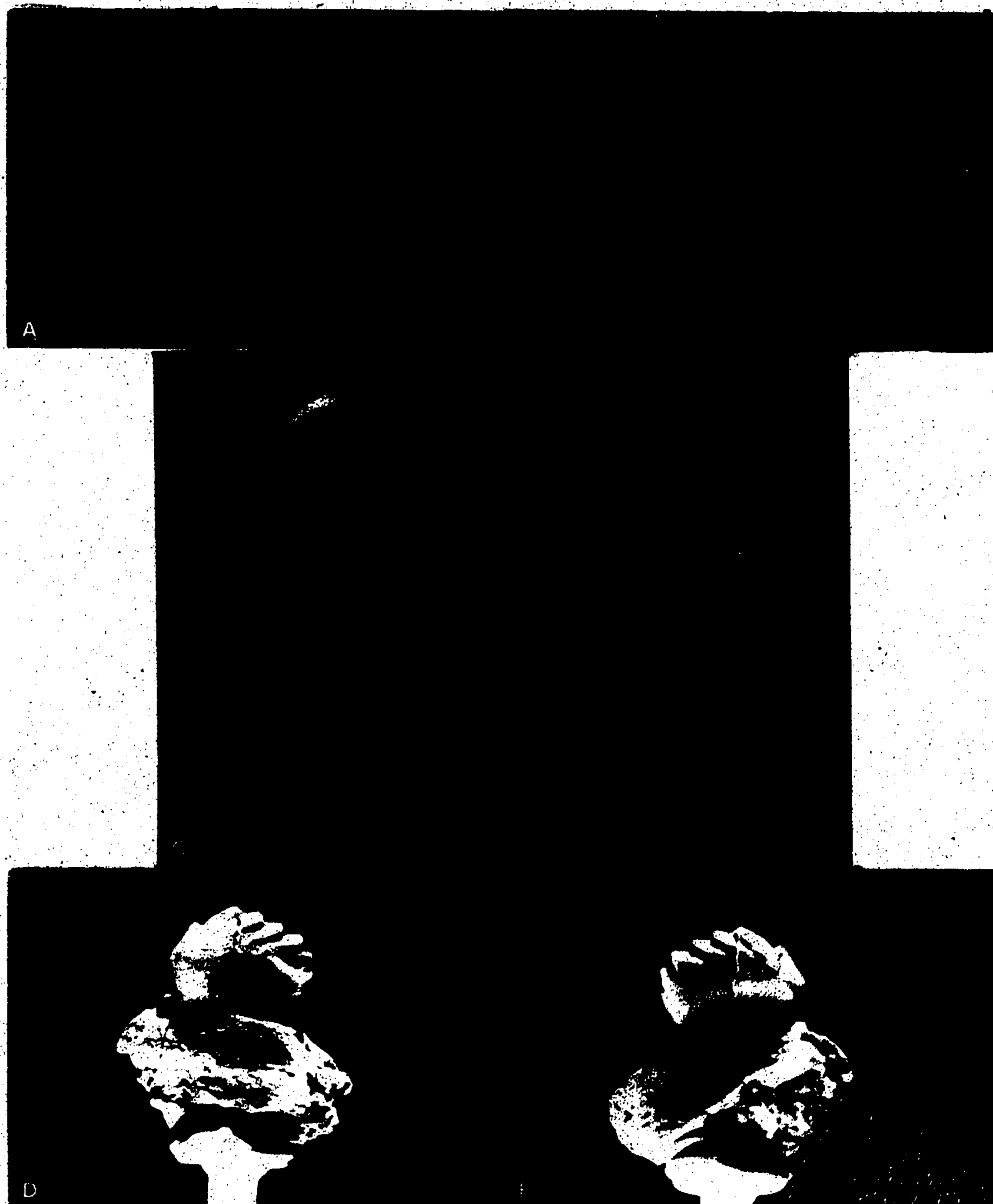

A
D

Plate 14. <u>Acheronodon</u> <u>vossae</u> n. sp.

A Stereophotographic pair, occlusal view, UALVP 24550 (holotype), left dentary fragment having p4 and alveolus of p3, length of p4 2.0, about x 11.0.

B Medial view, UALVP 24627, right i1, maximum width 1.6, about x 10.6.

C Labial view, UALVP 24627, right i1, maximum width 1.6, about x 10.6.

D Labial view, UALVP 24565, right m1, length 2.2, about x 11.8.

E Lingual view, UALVP 24565, right m1, length 2.2, about x 11.8.

F Stereophotographic pair, occlusal view, UALVP 24565, right m1, length 2.2, about x 12.3.

G Stereophotographic pair, occlusal view, UALVP 24588, left m2, length 1.4, about x 11.4.

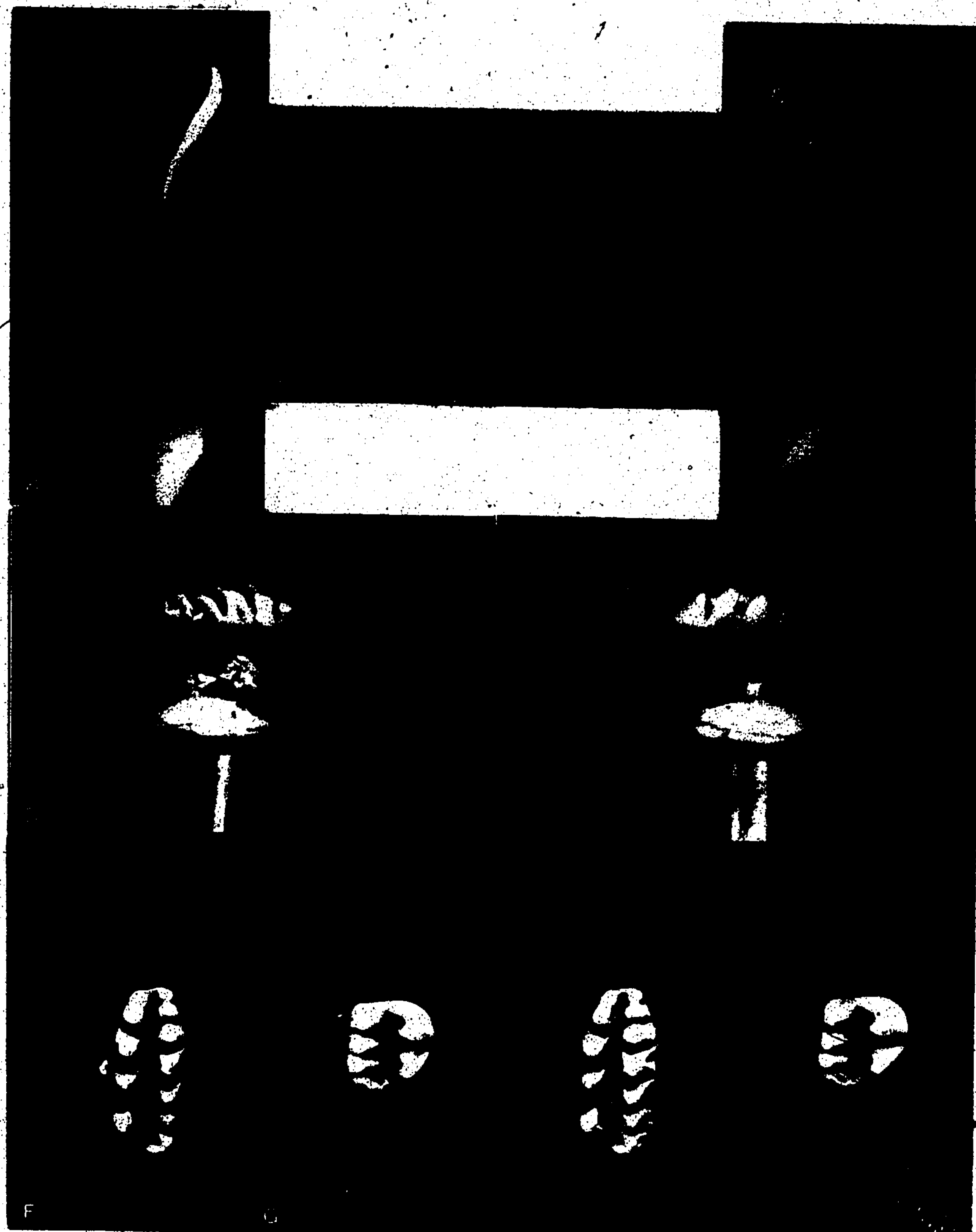

F

Plate 15. <u>Acheronodon</u> <u>vossae</u> n. sp.

A Labial view, UALVP 24613, left I1, maximum width 1.4, about x 11.4.

B Labial view, UALVP 24555, right P4, length 1.7, about x 11.5.

C Lingual view, UALVP 24555, right P4, length 1.7, about x 11.5.

D Stereophotographic pair, occlusal view, UALVP 24555, right P4, length 1.7, about x 11.5.

E Labial view, UALVP 24595, right M1, length 2.4, about x 11.5.

F Lingual view, UALVP 24595, right M1, length 2.4, about x 11.5.

G Stereophotographic pair, occlusal view, UALVP 24595, right M1, length 2.4, about x 10.6.


A

Plate 16. Pentacosmodon sp.

A Labial view, UALVP 24671, left i1, maximum width 1.4, about x 11.4.

B Occlusal view, UALVP 24671, left i1, maximum width 1.4, about x 11.4.

C Medial view, UALVP 24671, left i1, maximum width 1.4, about x 11.4.

D Labial view, UALVP 24650, right m1, length 2.5, about x 11.5.

E Lingual view, UALVP 24650, right m1, length 2.5, about x 11.5.

F Stereophotographic pair, occlusal view, UALVP 24650, right m1, length 2.5, about x 11.5.

G Labial view, UALVP 24648, right m2, length 1.6, about x 11.3.

H Stereophotographic pair, occlusal view, UALVP 24648, right m2, length 1.6, about x 11.3.

Plate 17. <u>Pentacosmodon</u> sp.

A Labial view, UALVP 24652, left P4, length 1.6, about x 11.3.

B Lingual view, UALVP 24652, left P4, length 1.6, about x 11.3.

C Stereophotographic pair, occlusal view, UALVP 24652, left P4, length 1.6, about x 11.3.

D Stereophotographic pair, occlusal view, UALVP 24660, left M1, length 3.4, about x 11.0.

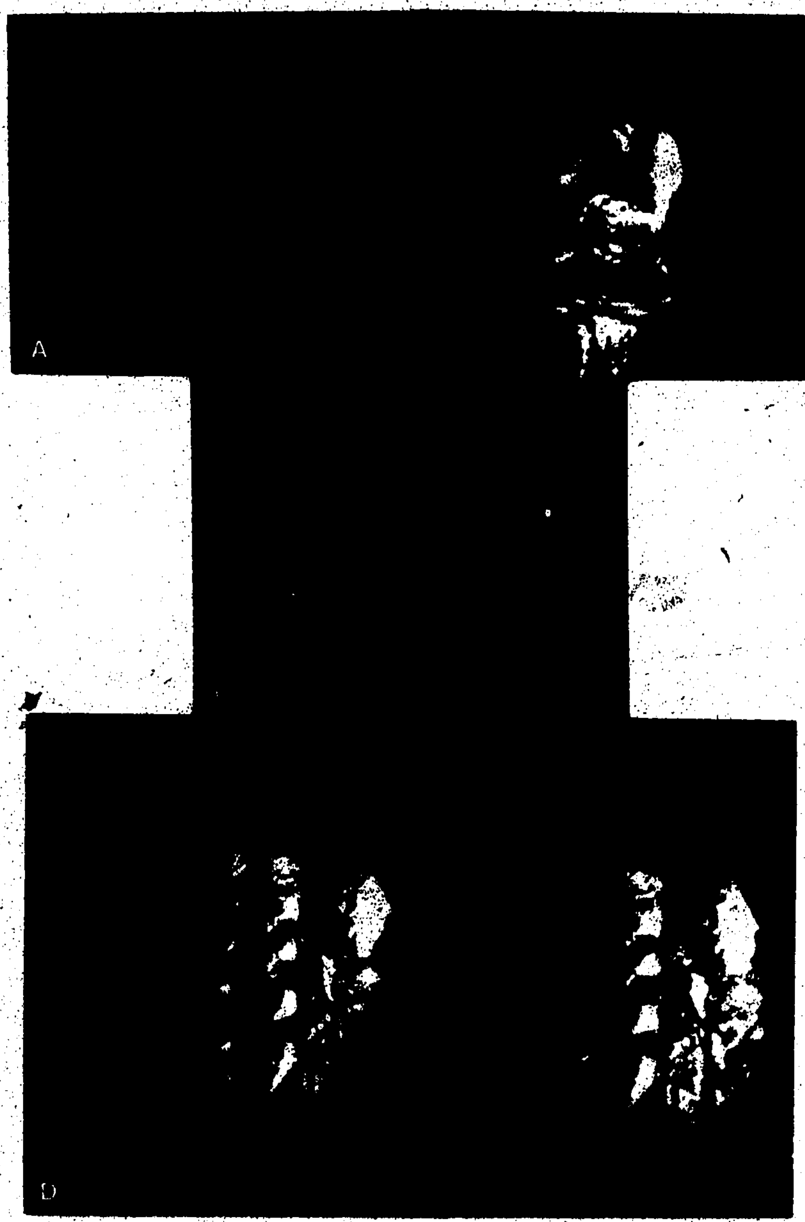


Plate 18. *Peradectes* sp.

A Stereophotographic pair, occlusal view, UALVP 18580, left M1, length 1.5, about x 12.0.

B Stereophotographic pair, occlusal view, UALVP 24694, left M2 or M3, length 1.6, about x 12.0.

C Labial view, UALVP 18586, right m1, length 1.4, about x 12.1.

D Stereophotographic pair, occlusal view, UALVP 18586, right m1, length 1.4, about x 12.1.

E Lingual view, UALVP 18586, right m1, length 1.4, about x 12.1.

F Labial view, UALVP 18581, right m2 or m3, length 1.5, about x 12.3.

G Stereophotographic pair, occlusal view, UALVP 18581, right m2 or m3, length 1.5, about x 12.3.

H Lingual view, UALVP 18581, right m2 or m3, length 1.5, about x 12.3.

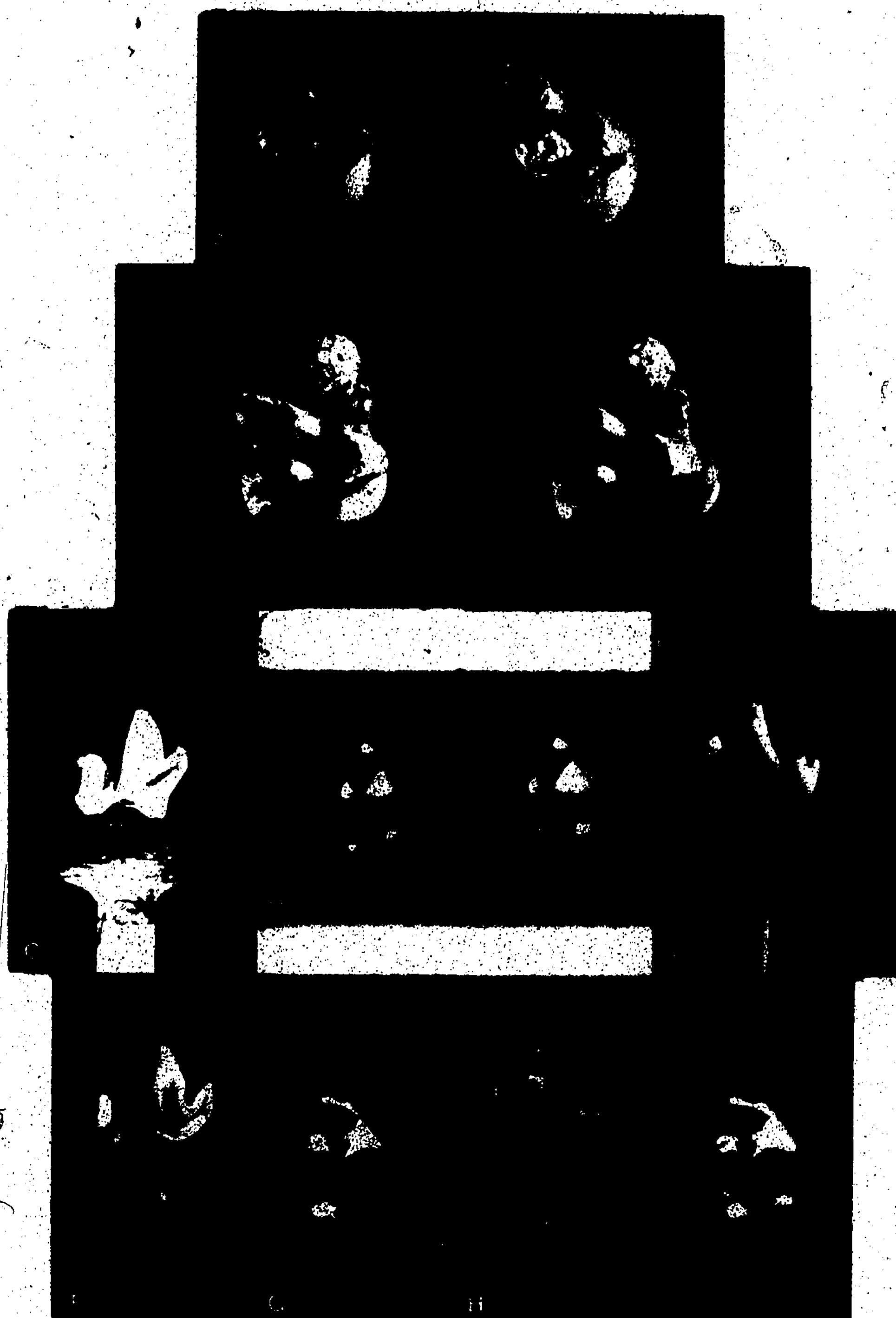


Plate 19: Litocherus sp.

A Stereophotographic pair, occlusal view, UALVP 24744, right dp4, length 2.2, about x 11.8.

B Stereophotographic pair, occlusal view, UALVP 24746, right P4, length 1.8, about x 11.7.

C Labial view, UALVP 24746, right P4, length 1.8, about x 12.2.

Litocherus cf. L. lacunatus

D Stereophotographic pair, occlusal view, UALVP 24747, left M2, length 1.8, about x 11.7.

Erinaceidae unident. gen. and sp.

E Stereophotographic pair, occlusal view, UALVP 25550, right M1, width 1.6, about x 11.9.

F Stereophotographic pair, occlusal view, UALVP 24735, left M2, width 1.4, about x 10.7.

Plate 20. Erinaceidae unident. gen. and sp.

A Labial view, UALVP 24703, left dentary fragment having p2—p4, length p4, 1.3, about x 11.5.

B Lingual view, UALVP 24703, left dentary fragment having p2—p4, length p4, 1.3, about x 11.5.

C Stereophotographic pair, occlusal view, UALVP 24703, left dentary fragment having p2—p4, length p4, 1.3, about x 11.5.

D Stereophotographic pair, occlusal view, UALVP 24699, left dentary fragment having p4—m1, length p4, 1.3, about x 11.5.

E Labial view, UALVP 24699, left dentary fragment having p4—m1, length p4, 1.3, about x 11.5.

F Lingual view, UALVP 24699, left dentary fragment having p4—m1, length p4, 1.3, about x 11.5.

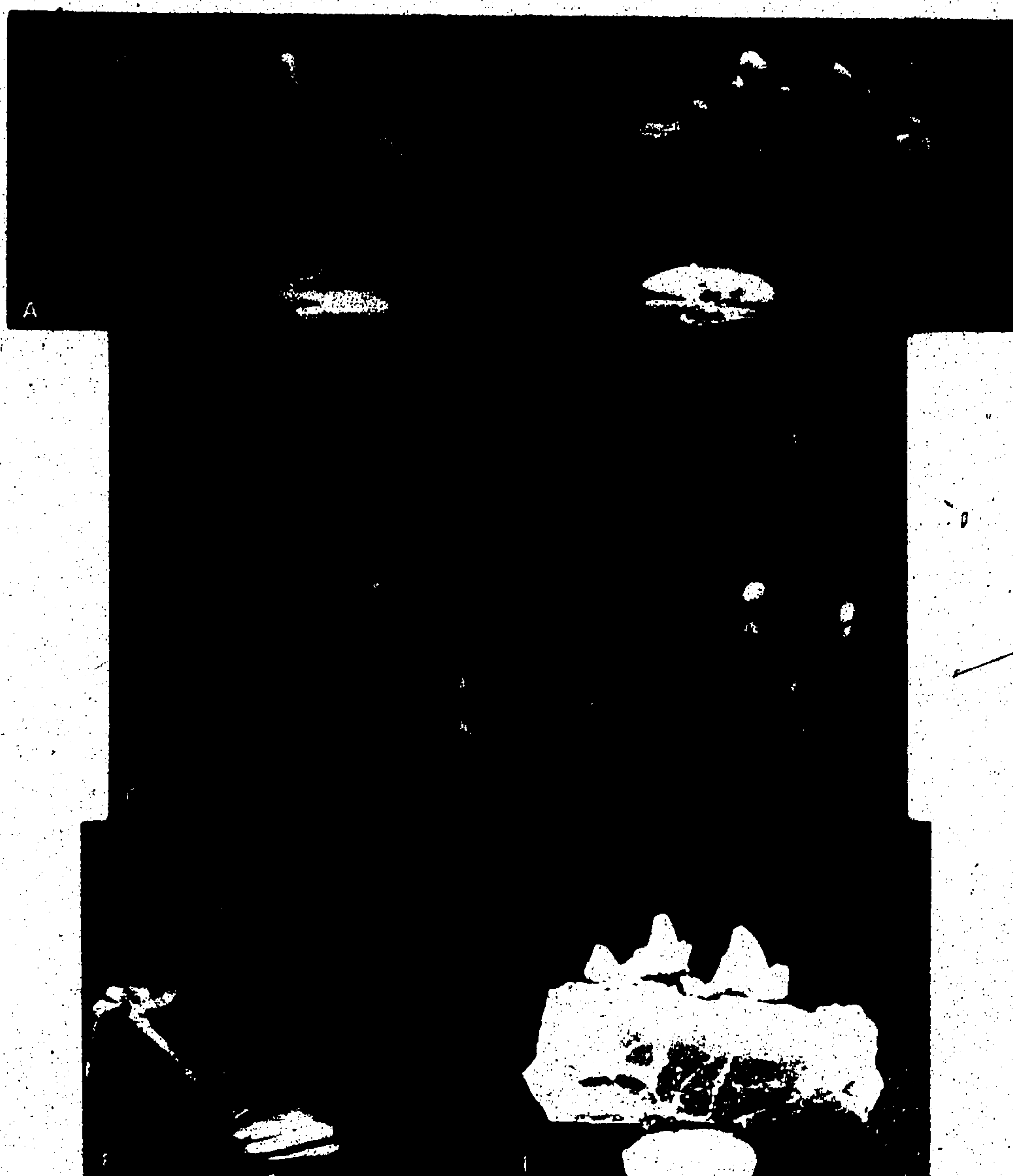

A

Plate 21. <u>Leptacodon</u> sp. 1

A Stereophotographic pair, occlusal view, UALVP 25560, right P4, length 1.3, about x 12.3.

B Labial view, UALVP 25560, right P4, length 1.3, about x 12.3.

C Stereophotographic pair, occlusal view, UALVP 24767, right M1, length 1.5, about x 12.0.

D Stereophotographic pair, occlusal view, UALVP 24770, left M2, length 1.4, about x 12.0.

E Labial view, UALVP 25527, right m2, length 1.2, about x 12.5

F Stereophotographic pair, occlusal view, UALVP 25527, right m2, length 1.2, about x 12.5

G Lingual view, UALVP 25527, right m2, length 1.2, about x 12.5

Plate 22. *Leptacodon* sp. 2

A Stereophotographic pair, occlusal view, UALVP 25510, right P4, length 1.5, about x 12.0.

B Stereophotographic pair, occlusal view, UALVP 25508, right M1, length 1.6, about x 11.9.

C Stereophotographic pair, occlusal view, UALVP 25511, left M2, length 1.7, about x 11.5.

D Labial view, UALVP 24798, right dentary fragment having p4, length p4 1.6, about x 11.3.

E Lingual view, UALVP 24798, right dentary fragment having p4, length p4 1.6, about x 11.3.

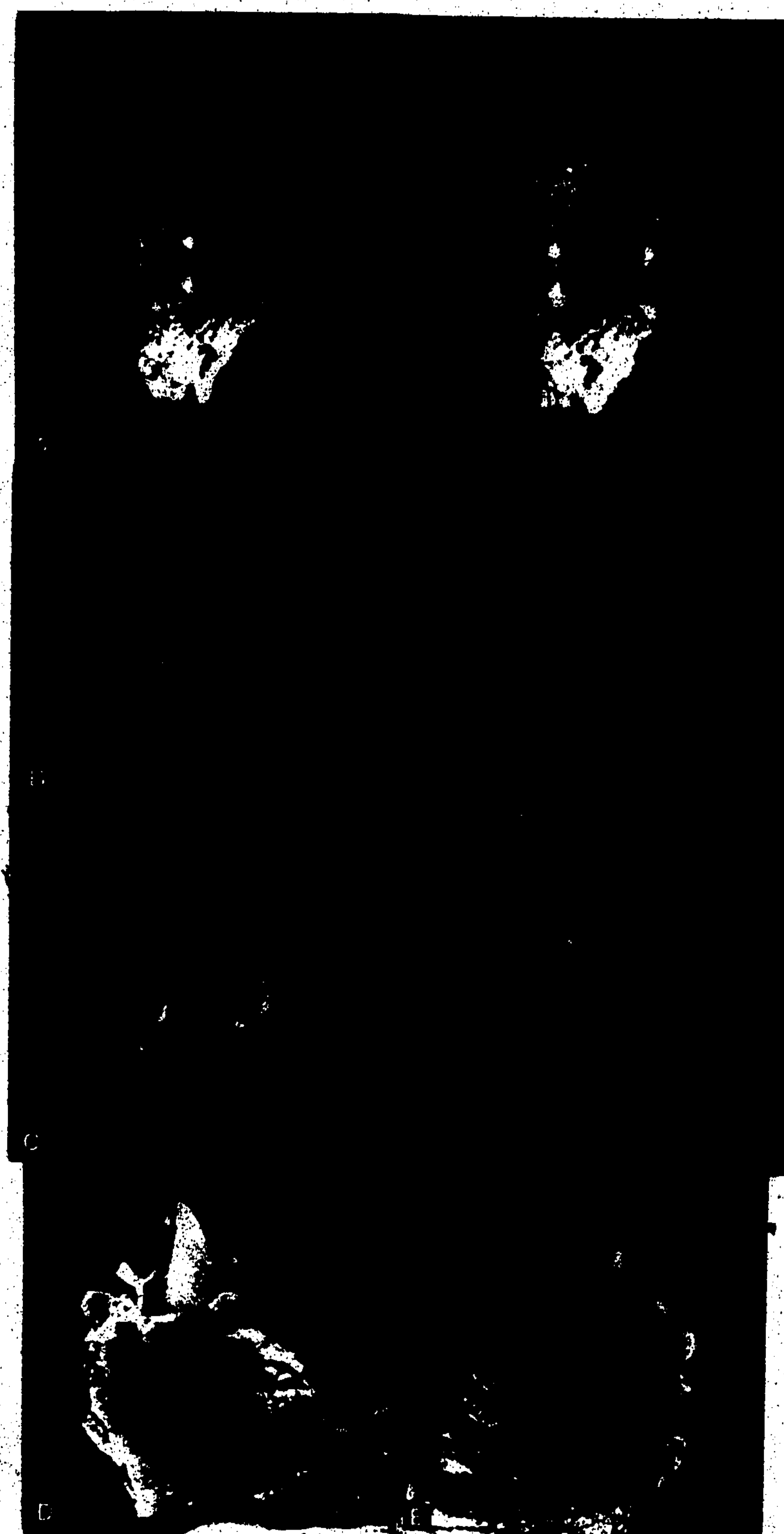


Plate 23. *Leptacodon* sp. 2

A Stereophotographic pair, occlusal view, UALVP 24798, right dentary fragment having p4, length p4, 1.6, about x 11.3.

B Labial view, UALVP 25503, left m1, length 1.6, about x 12.5.

C Labial view, UALVP 25500, left dentary fragment having m2, length m2, 1.6, about x 12.5.

D Stereophotographic pair, occlusal view, UALVP 25500, left dentary fragment having m2, length m2 1.6, about x 12.2.

E Stereophotographic pair, occlusal view, UALVP 24794, left m3, length 1.6, about x 11.3.

F Labial view, UALVP 24794, left m3, length 1.6, about x 11.3.

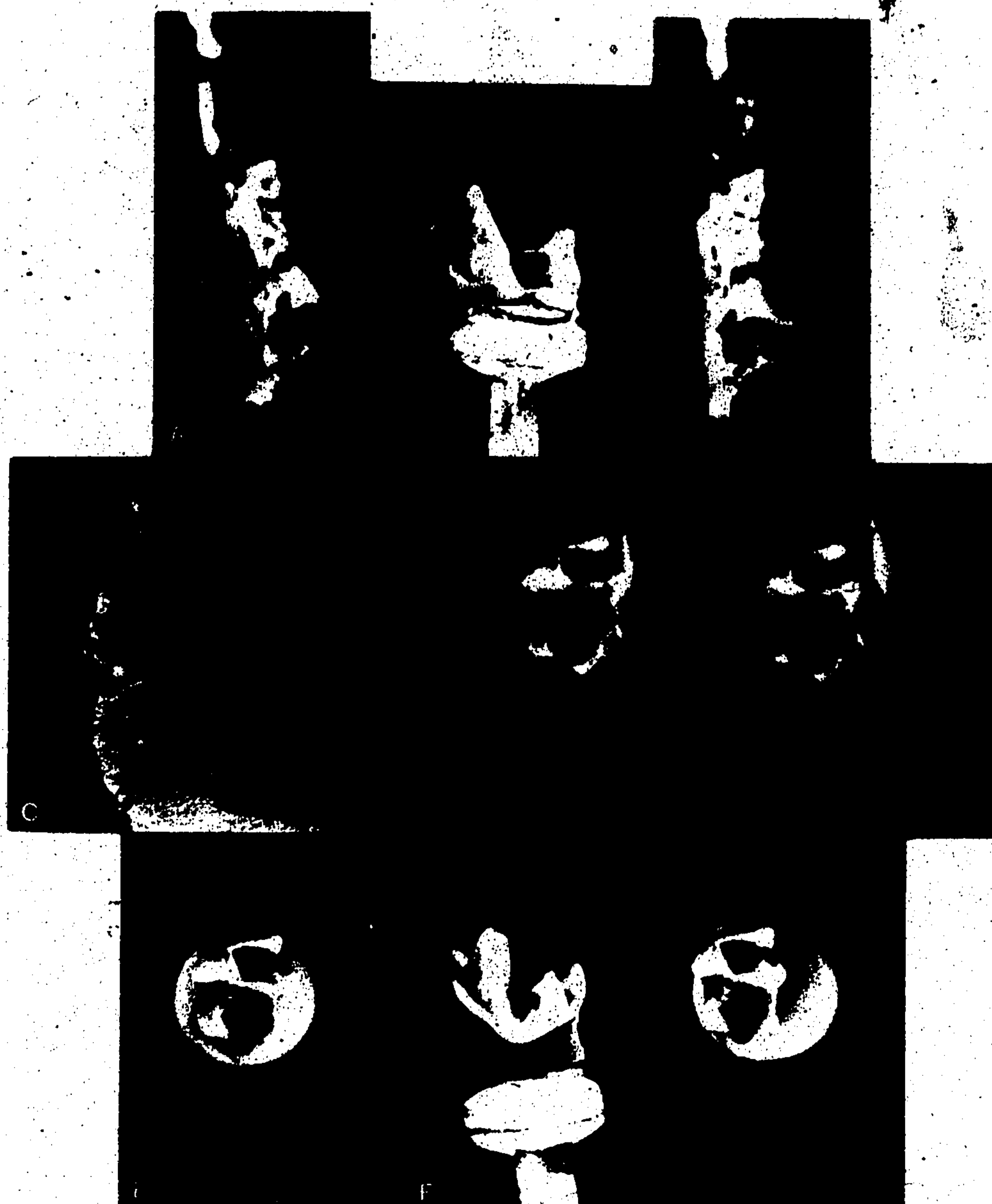

C
F

Plate 24. "Leptacodon" munusculum

A Stereophotographic pair, occlusal view, UALVP 25554, right P4, length 1.3, about x 11.5.

B Labial view, UALVP 25554, right P4, length 1.3, about x 11.5.

C Stereophotographic pair, occlusal view, UALVP 25555, left M1, length 1.3, about x 11.9.

D Stereophotographic pair, occlusal view, UALVP 25553, left M2, length 1.2, about x 11.7.

E Labial view, UALVP 25535, right dentary fragment having m1—m2, length m2, 1.1, about x 10.8.

F Stereophotographic pair, occlusal view, UALVP 25535, right dentary fragment having m1—m2, length m2, 1.1, about x 10.8.

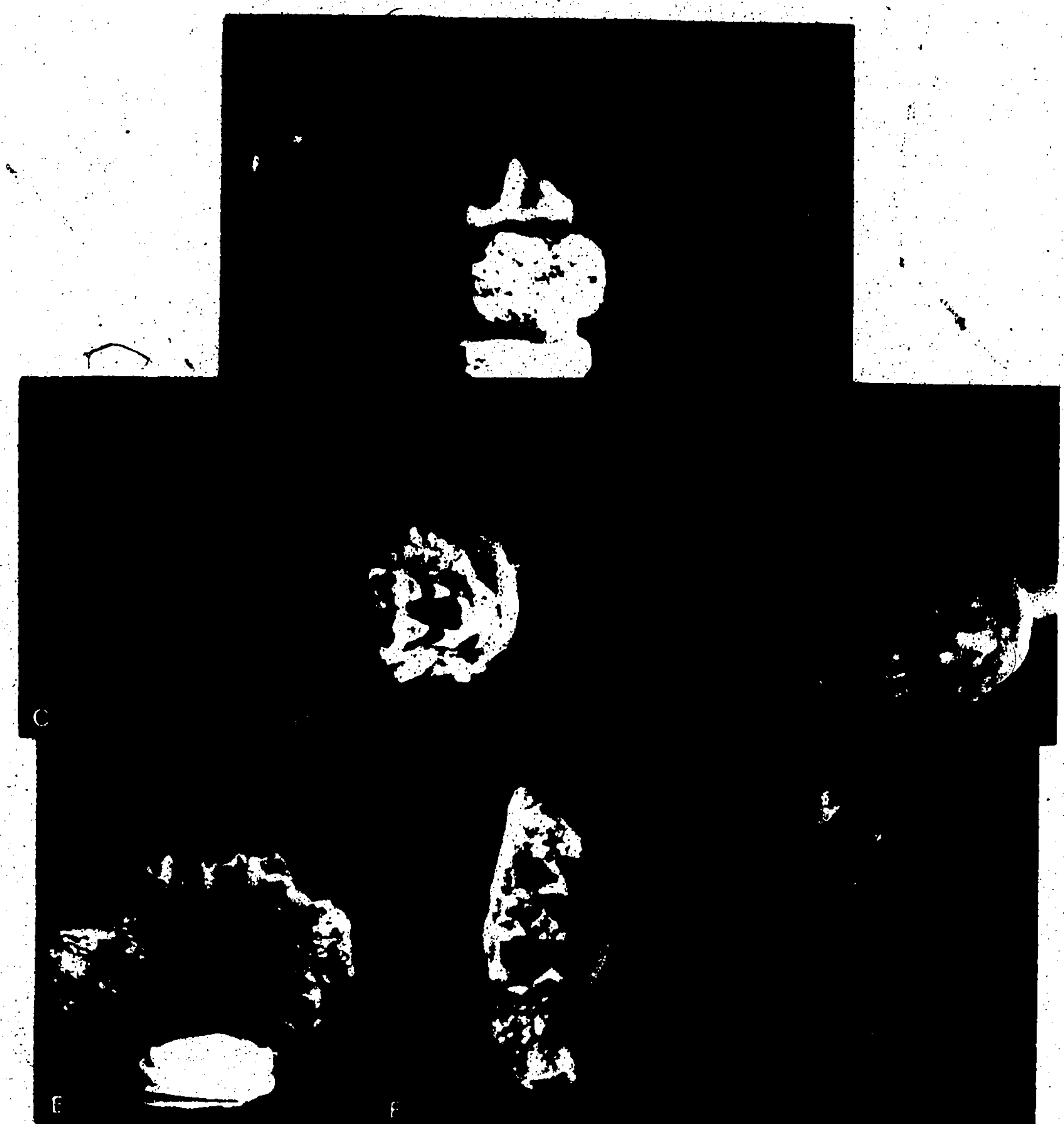

C
E
F

Plate 25. Cf. Nyctitherium n. gen. and sp.

A Stereophotographic pair, occlusal view, UALVP 25569, right M1, length 1.3, about x 11.5.

B Labial view, UALVP 25567, right m1, length 1.3, about x 12.3.

C Stereophotographic pair, occlusal view, UALVP 25567, right m1, length 1.3, about x 12.3.

D Lingual view, UALVP 25567, right m1, length 1.3, about x 12.3.

Limaconyssus sp.

E Labial view, UALVP 25572, right dentary fragment having p4 and alveoli for m1, length p4, 1.1, about x 12.7.

F Lingual view, UALVP 25572, right dentary fragment having p4 and alveoli for m1, length p4, 1.1, about x 12.7.

G Stereophotographic pair, occlusal view, UALVP 25572, right dentary fragment having p4 and alveoli for m1, length p4, 1.1, about x 12.7.

H Labial view, UALVP 25571, left m1, length 1.1, about x 11.8.

I Lingual view, UALVP 25571, left m1, length 1.1, about x 11.8.

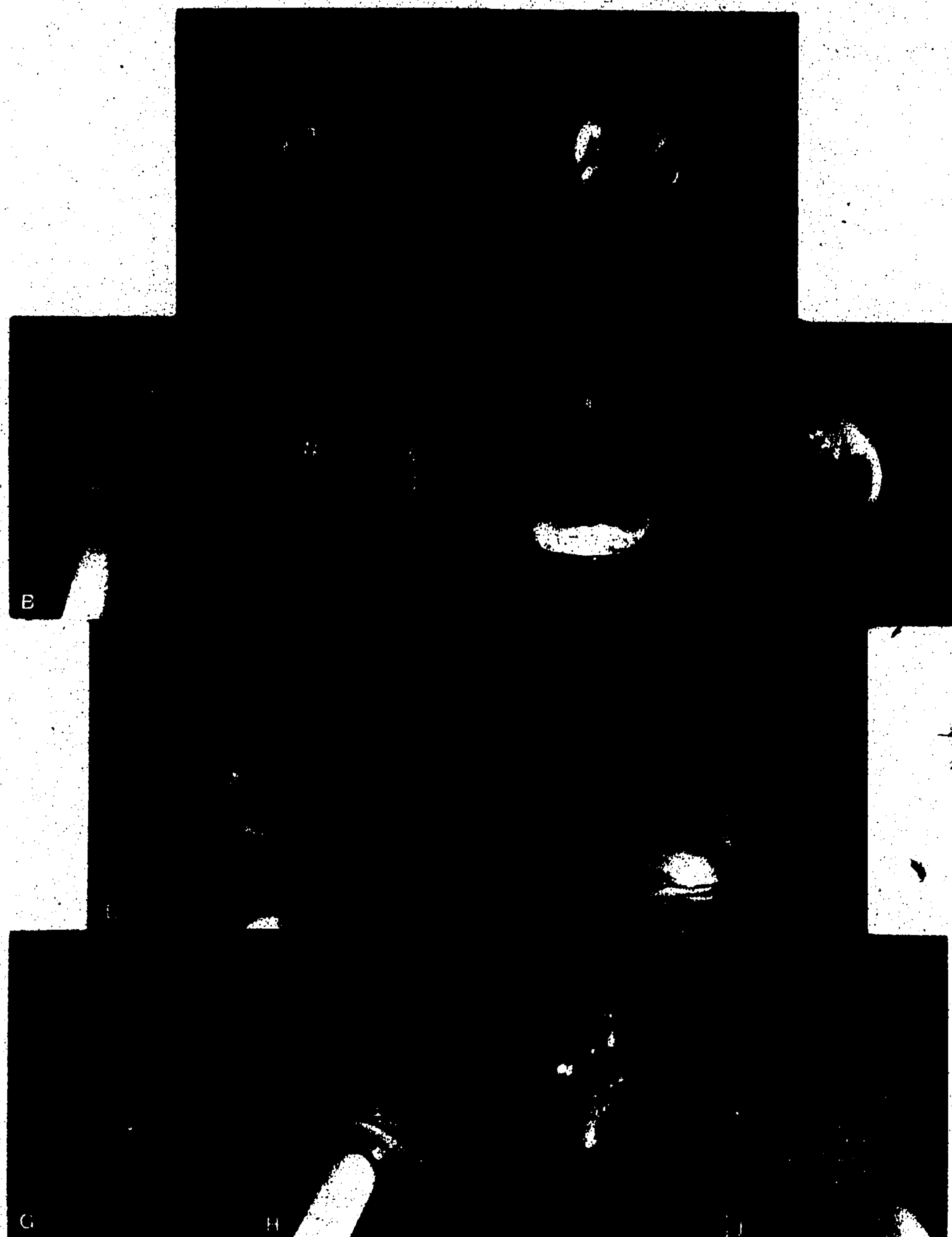

B
G
H

Plate 26. Limaconyssus sp.

A Stereophotographic pair, occlusal view, UALVP 25571, left m1, length 1.1, about x 11.8.

B Stereophotographic pair, labial view, UALVP 25570, left dentary fragment having m2 and alveoli for m1 and m3, length m2, 1.0, about x 13.0.

C Lingual view, UALVP 25570, left dentary fragment having m2 and alveoli for m1 and m3, length m2, 1.0, about x 13.0.

D Stereophotographic pair, occlusal view, UALVP 25570, left dentary fragment having m2 and alveoli for m1 and m3, length m2, 1.0, about x 13.0.

Nyctitheriidae unident. gen. and sp.

E Labial view, UALVP 25572, left p4, width 0.8, about x 11.3.

F Stereophotographic pair, occlusal view, UALVP 25572, left p4, width 0.8, about x 11.3.

G Lingual view, UALVP 25572, left p4, width 0.8, about x 11.3.

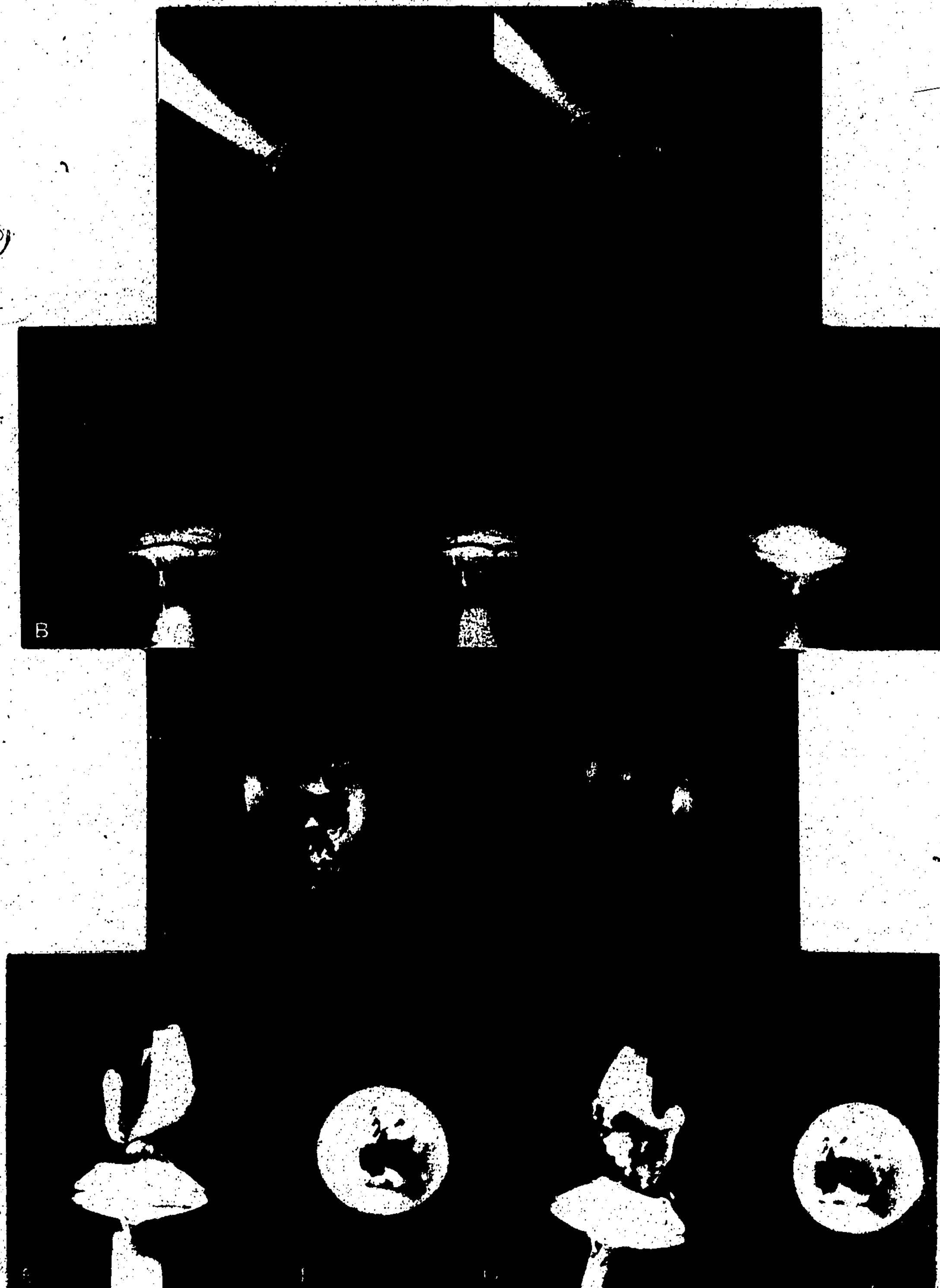

B

Plate 27. Nyctitheriidae unident. gen. and sp.

A Labial view, UALVP 25575, left m2, length 1.3, about x [illegible]

B Lingual view, UALVP 25575, left m2, length 1.3, about x 13.0.

C Stereophotographic pair, occlusal view, UALVP 25575, left m2, length 1.3, about x 12.3.

Lipotyphla incertae sedis unident. gen. and sp.

D Labial view, UALVP 25580, right m2?, length 1.6, about x 11.8.

E Lingual view, UALVP 25580, right m2?, length 1.6, about x 11.8.

F Stereophotographic pair, occlusal view, UALVP 25580, right m2?, length 1.6, about x 11.8.


A
D

Plate 28. *Elpidophorus* cf. *E. elegans*

A Stereophotographic pair, occlusal view, UALVP 18612, right M2, length 4.0, about x 8.0.

B Labial view, UALVP 25582, left dentary fragment having p3—m3 and alveoli for canine and p1, length m3, 4.2, about x 1.8.

C Labial view, UALVP 25582, left dentary fragment having p3—m3 and alveoli for canine and p1, length m3, 4.2, about x 3.1.

D Labial view, UALVP 25581, left p4, length 3.4, about x 8.0.

E Lingual view, UALVP 25581, left p4, length 3.4, about x 8.0.

F Stereophotographic pair, occlusal view, UALVP 25581, left p4, length 3.4, about x 8.0.


A
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Plate 29. ?Palaechthon sp.

A Stereophotographic pair, occlusal view, UALVP 18364, left M3, length 1.7, about x 11.8.

Plesiolestes cf. P. sirokyi

B Stereophotographic pair, occlusal view, UALVP 25590, right M2, length 3.4, about x 9.1.

C Labial view, UALVP 25592, left m1, width 2.8, about x 11.3.

D Lingual view, UALVP 25592, left m1, width 2.8, about x 11.3.

E Stereophotographic pair, occlusal view, UALVP 25592, left m1, width 2.8, about x 11.3.

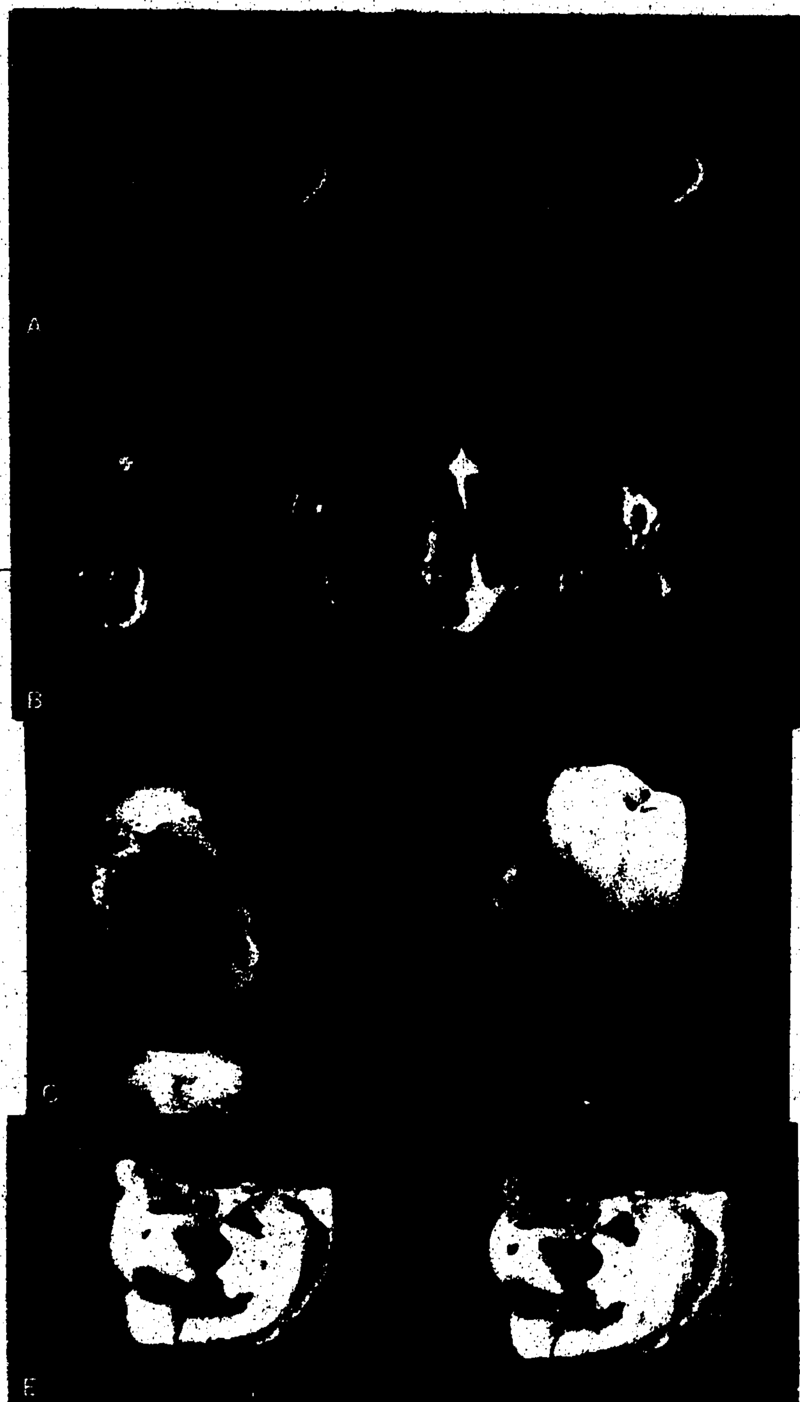

Plate 30. *Ignacius fremontensis*

A Stereophotographic pair, occlusal view, UALVP 24802, right M1, length 1.8, about x 12.8.

B Stereophotographic pair, occlusal view, UALVP 24804, left M2, length 1.9, about x 11.8.

C Stereophotographic pair, occlusal view, UALVP 24800, left M3, length 1.6, about x 10.0.

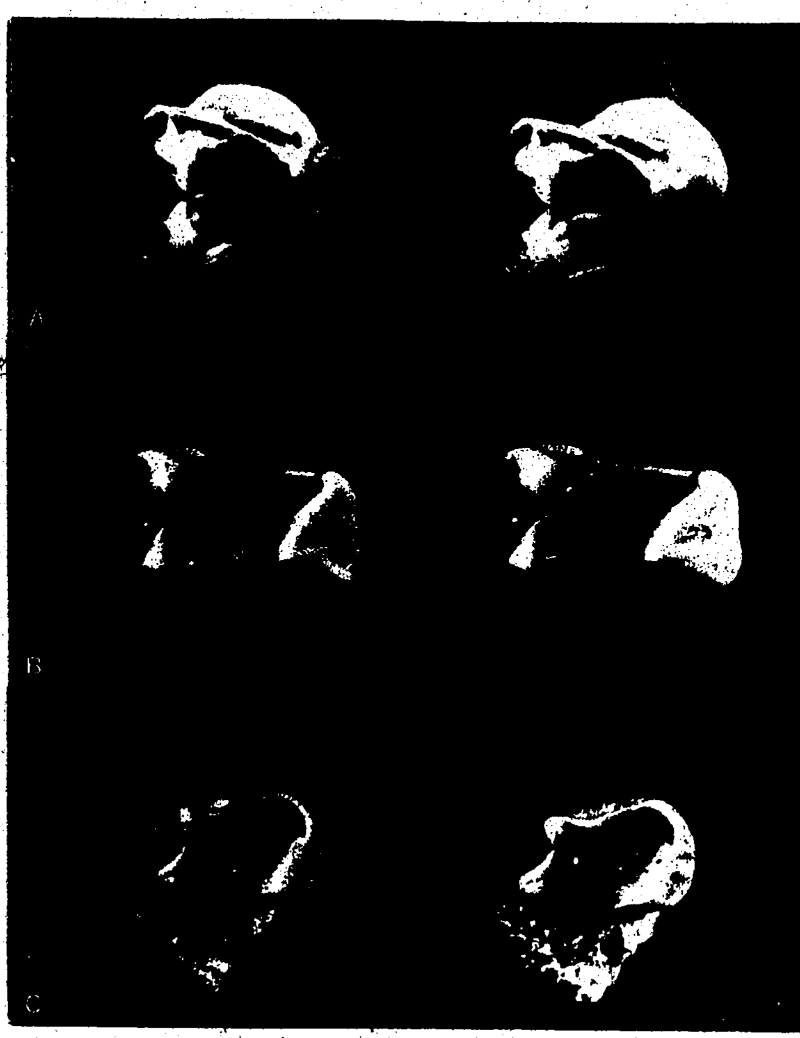
A
B
C

Plate 31. Ignacius fremontensis

A Labial view, UALVP 18366, left m1, length 1.9, about x 11.6.

B Stereophotographic pair, occlusal view, UALVP 18366, left m1, length 1.9, about x 11.6.

C Lingual view, UALVP 18366, left m1, length 1.9, about x 11.6.

D Labial view, UALVP 24803, right m2, length 1.8, about x 12.5.

E Stereophotographic pair, occlusal view, UALVP 24803, right m2, length 1.8, about x 12.5.

F Lingual view, UALVP 24803, right m2, length 1.8, about x 12.5.

G Labial view, UALVP 24801, right m3, length 2.4, about x 11.7.

H Stereophotographic pair, occlusal view, UALVP 24801, right m3, length 2.4, about x 11.7.

I Lingual view, UALVP 24801, right m3, length 2.4, about x 11.7.


A
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Plate 32. *Ignacius* cf. *I. frugivorus*

A Labial view, UALVP 24825, right I1, maximum width 2.2, about x 7.7.

B Stereophotographic pair, occlusal view, UALVP 24825, right I1, maximum width 2.2, about x 7.7.

C Anterior view, UALVP 24825, right I1, maximum width 2.2, about x 7.7.

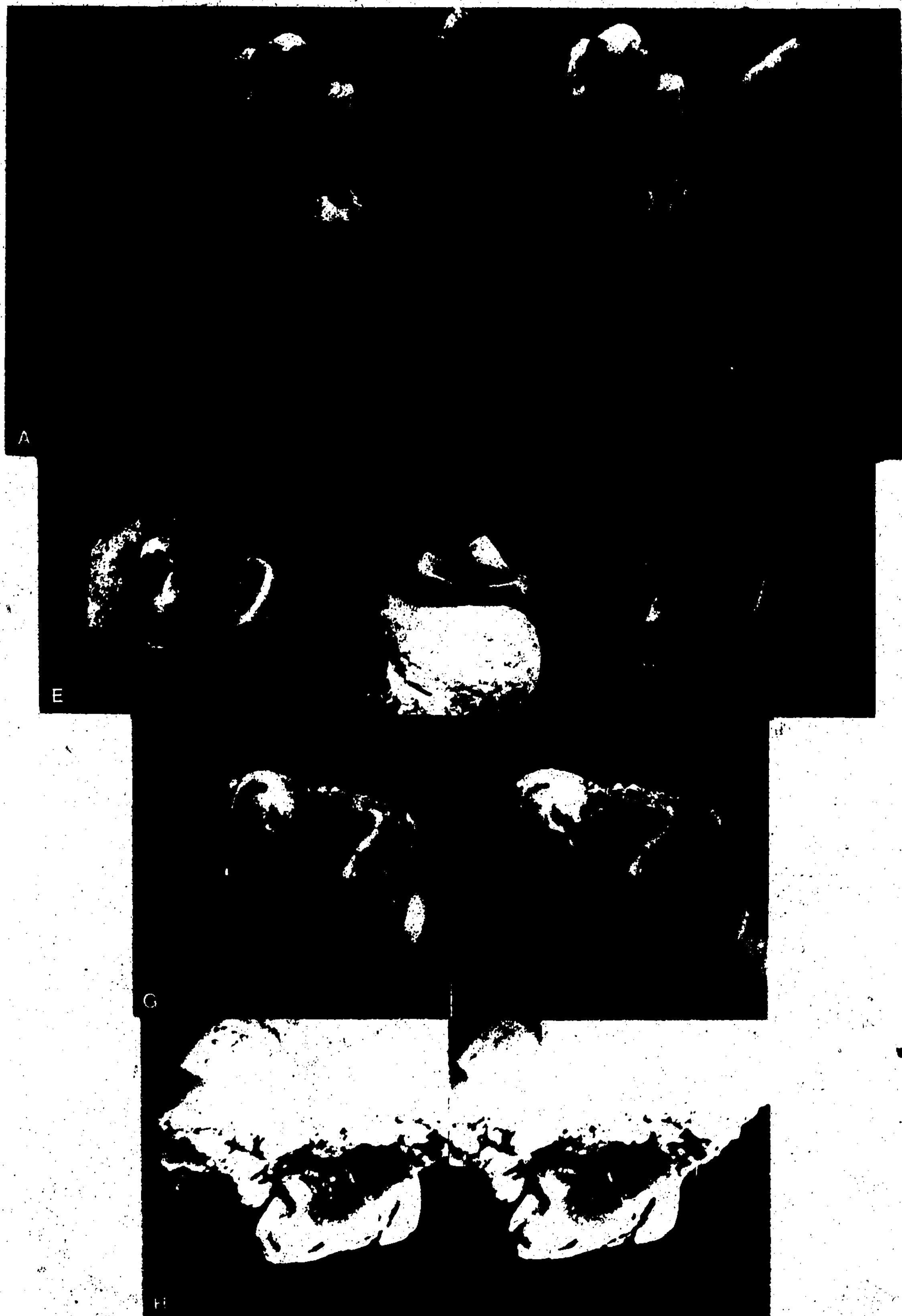
D Medial view, UALVP 24825, right I1, maximum width 2.2, about x 7.7.

E Stereophotographic pair, occlusal view, UALVP 24837, left P4, length 1.7, about x 11.8.

F Labial view, UALVP 24837, left P4, length 1.7, about x 11.8.

G Stereophotographic pair, occlusal view, UALVP 24834, left M1 or M2, width 2.8, about x 11.4.

H Stereophotographic pair, occlusal view, UALVP 24828, left M3, length 1.4, about x 11.4.


A
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G
H

Plate 33. *Ignacius* cf. *I. frugivorus*

A Labial view, UALVP 24827, right p4, length 1.7, about x 12.1.

B Stereophotographic pair, occlusal view, UALVP 24827, right p4, length 1.7, about x 12.1.

C Lingual view, UALVP 24827, right p4, length 1.7, about x 12.1.

D Labial view, UALVP 24830, right m1, length 1.9, about x 11.6.

E Stereophotographic pair, occlusal view, UALVP 24830, right m1, length 1.9, about x 11.6.

F Lingual view, UALVP 24830, right m1, length 1.9, about x 11.6.

G Labial view, UALVP 24836, right m2, length 1.9, about x 12.1.

H Stereophotographic pair, occlusal view, UALVP 24836, right m2, length 1.9, about x 12.1.

I Lingual view, UALVP 24836, right m2, length 1.9, about x 12.1.

J Labial view, UALVP 24832, left m3, length 2.4, about x 12.1.

K Stereophotographic pair, occlusal view, UALVP 24832, left m3, length 2.4, about x 12.1.

L Lingual view, UALVP 24832, left m3, length 2.4, about x 12.1.


A
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G
J
K
L

Plate 34. ?Pronothodectes sp.

A Stereophotographic pair, occlusal view, UALVP 24910, left I1, maximum width 1.8, about x 11.7.

B Medial view, UALVP 24910, left I1, maximum width 1.8, about x 11.7.

C Labial view, UALVP 24911, right p4, length 1.6, about x 11.9.

D Stereophotographic pair, occlusal view, UALVP 24911, right p4, length 1.6, about x 11.9.

E Lingual view, UALVP 24911, right p4, length 1.6, about x 11.9.

Nannodectes intermedius

F Stereophotographic pair, occlusal view, UALVP 24878, right DP4, length 2.2, about x 11.4.

G Stereophotographic pair, occlusal view, UALVP 24860, right P3, length 1.7, about x 11.8.

Plate 35. <u>Nannodectes intermedius</u>

A. Stereophotographic pair, occlusal view, UALVP 24880, right M1, length 2.6, about x 11.5.

B Stereophotographic pair, occlusal view, UALVP 18356, right maxillary fragment having M2, length M2, 2.5, about x 8.0.

C Stereophotographic pair, occlusal view, UALVP 24869, right M3, length 2.5, about x 11.0.

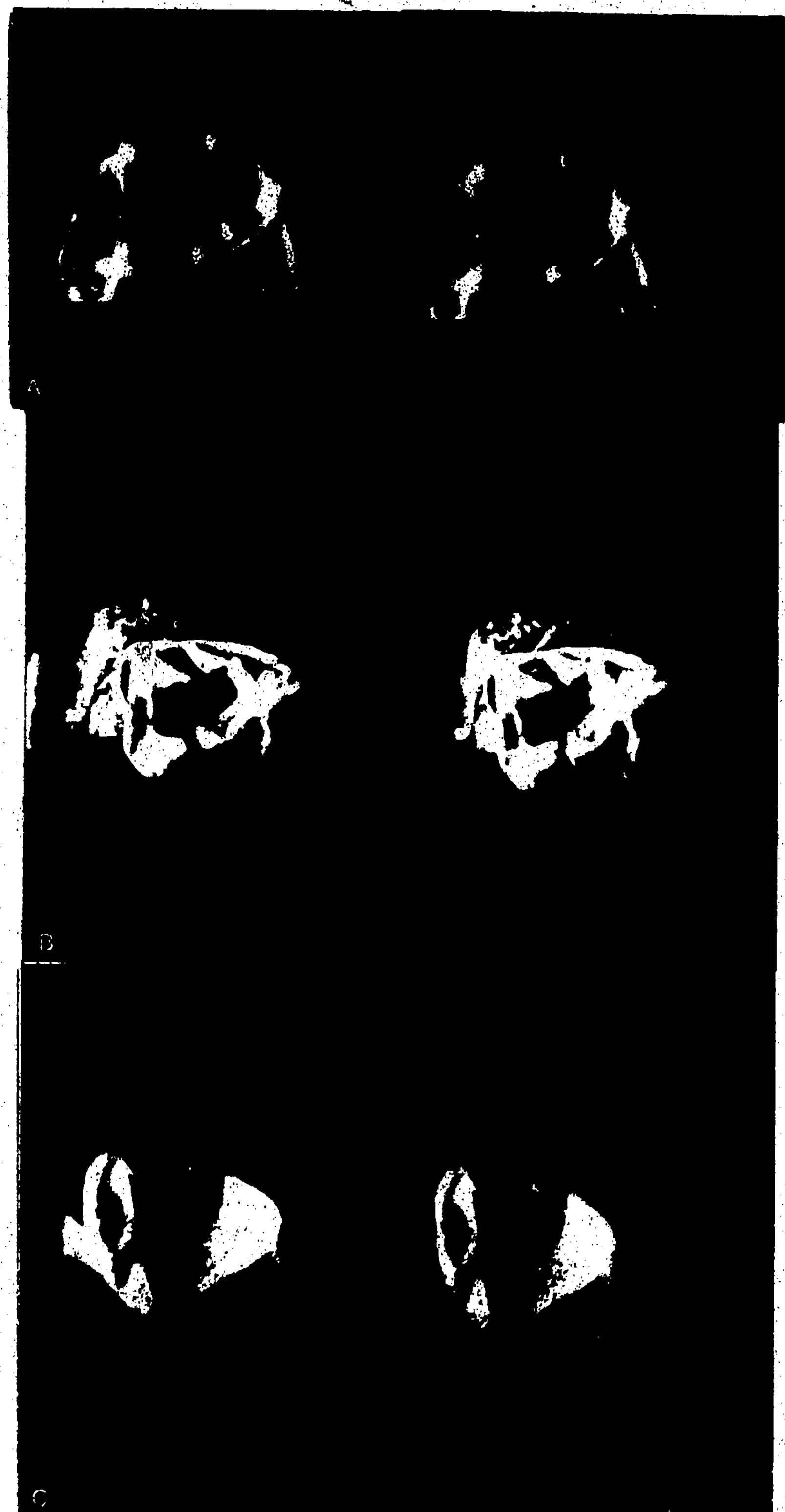


Plate 36. <u>Plesiadapis praecursor</u>

A Labial view, UALVP 24883, right I1, maximum width 2.5, about x 11.8.

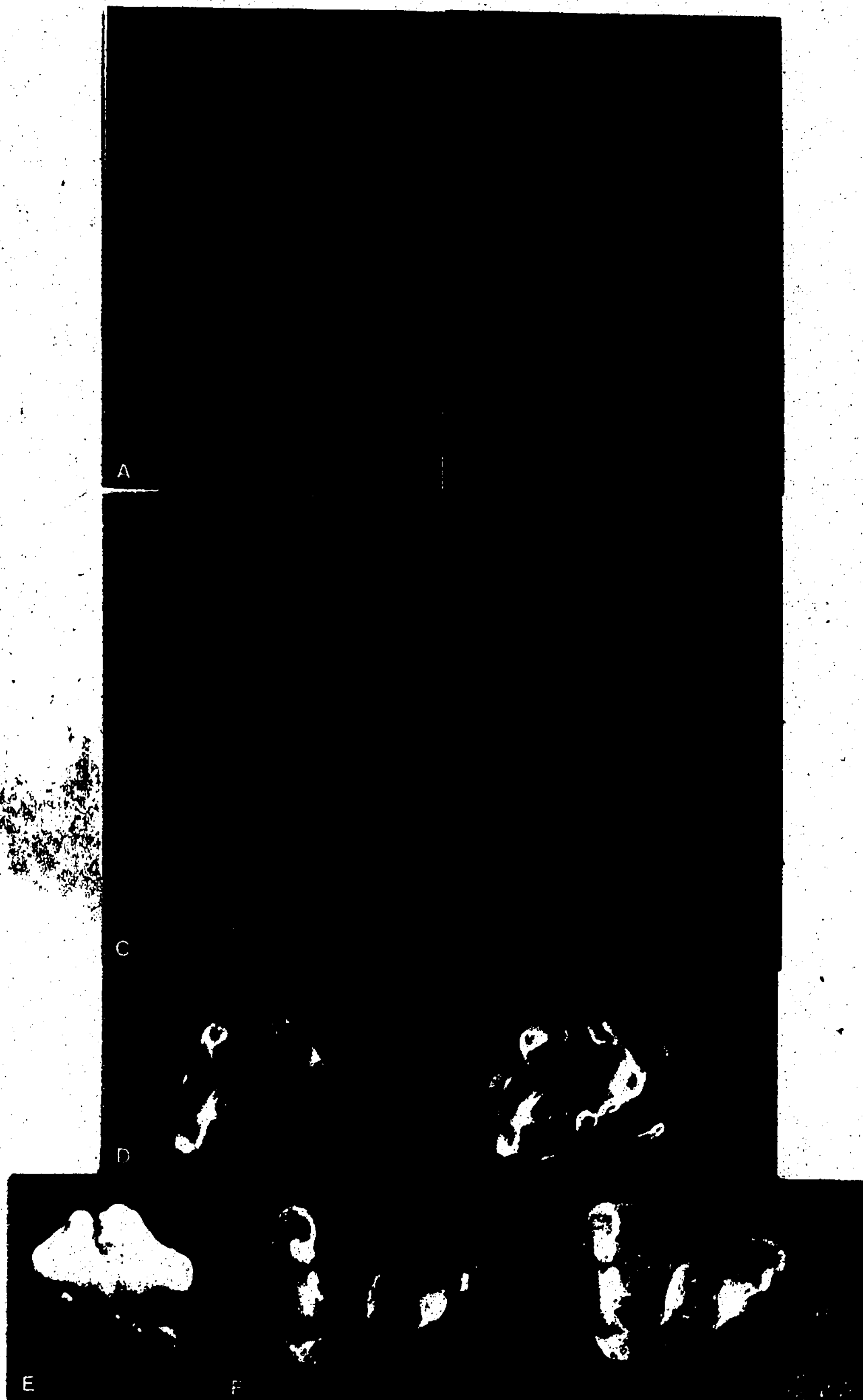
B Medial view, UALVP 24883, right I1, maximum width 2.5, about x 11.8.

C Stereophotographic pair, occlusal view, UALVP 24883, right I1, maximum width 2.5, about x 11.8.

D Stereophotographic pair, occlusal view, UALVP 24884, right DP4, length 2.4, about x 11.8.

E Labial view, UALVP 24889, left P4, length 2.2, about x 11.8.

F Stereophotographic pair, occlusal view, UALVP 24889, left P4, length 2.2, about x 11.8.


A
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F

Plate 37. Plesiadapis praecursor

A Stereophotographic pair, occlusal view, UALVP 24885, left dp4, length 2.6, about x 11.5.

B Labial view, UALVP 24885, left dp4, length 2.6, about x 11.5.

C Labial view, UALVP 24900, right dentary fragment having p4—m3 and alveoli for p2 and p3, length m3, 4.2, about x 3.8.

D Labial view, UALVP 24900, right dentary fragment having p4—m3 and alveoli for p2 and p3, length m3, 4.2, about x 6.4.

Plesiadapis cf. P. anceps

E Stereophotographic pair, occlusal view, UALVP 18361, left DP4, width 3.4, about x 11.5.

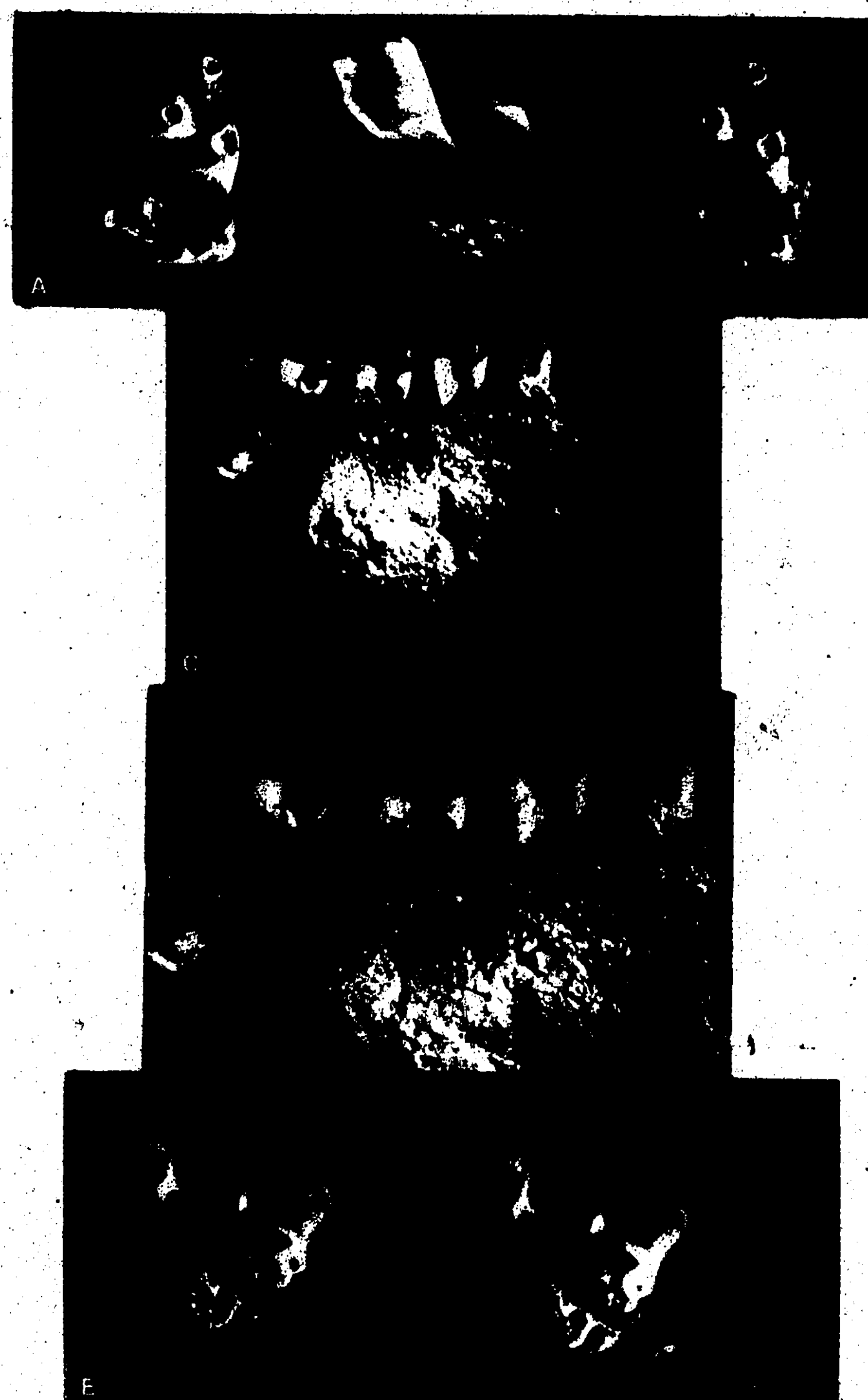
A
C
E

Plate 38. <u>Plesiadapis</u> cf. <u>P.</u> <u>anceps</u>

A Stereophotographic pair, occlusal view, UALVP 24901, left dp4, length 2.7, about x 11.1.

B Labial view, UALVP 24901, left dp4, length 2.7, about x 11.1.

C Stereophotographic pair, occlusal view, UALVP 24902, right p4, length 2.4, about x 11.3.

D Labial view, UALVP 24902, right p4, length 2.4, about x 11.3.

E Labial view, UALVP 24904, left m1, length 3.0, about x 11.3.

F Lingual view, UALVP 24904, left m1, length 3.0, about x 11.3.

G Stereophotographic pair, occlusal view, UALVP 24904, left m1, length 3.0, about x 11.3.


A
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Plate 39. <u>Elphidotarsius russelli</u>

A Labial view, UALVP 18619, right I1, maximum width 1.6, about x 11.0.

B Stereophotographic pair, occlusal view, UALVP 18619, right I1, minimum width 1.0, about x 11.0.

C Medial view, UALVP 18619, right I1, maximum width 1.6, about x 11.0.

D Stereophotographic pair, occlusal view, UALVP 18613, left P3, length 1.6, about x 11.9.

E Labial view, UALVP 18613, left P3, length 1.6, about x 11.9.

F Stereophotographic pair, occlusal view, UALVP 18614, right P4, length 1.7, about x 12.1.

G Labial view, UALVP 18614, right P4, length 1.7, about x 12.1.

H Labial view, UALVP 18616, right m1, length 1.4, about x 12.1.

I Stereophotographic pair, occlusal view, UALVP 18616, right m1, length 1.4, about x 12.1.

J Lingual view, UALVP 18616, right m1, length 1.4, about x 12.1.

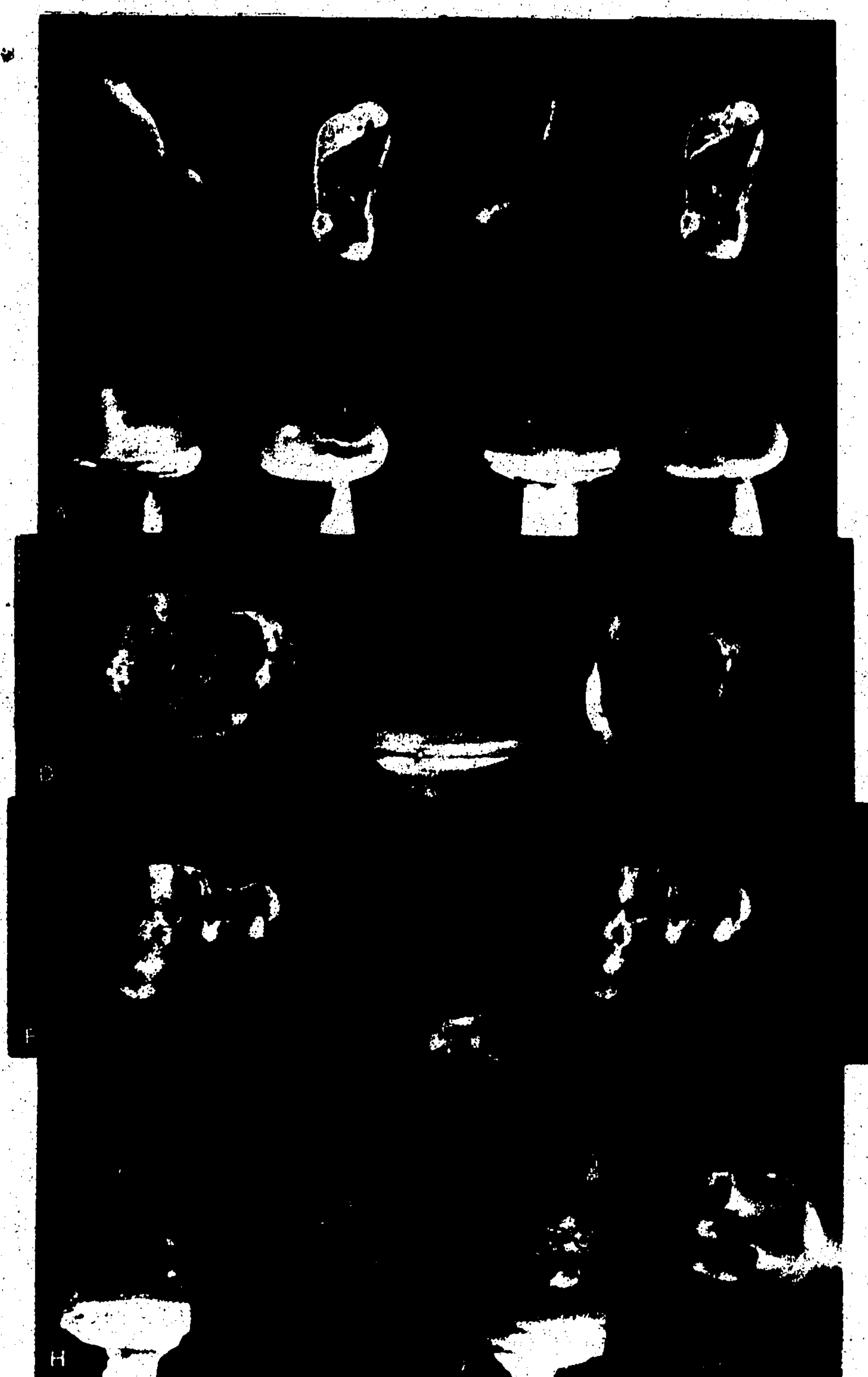

Plate 40. <u>Carpodaptes</u> cf. <u>C. hâzelae</u>

A Stereophotographic pair, occlusal view, UALVP 18618, left P4, length 1.9, about x 11.6.

B Labial view, UALVP 18618, left P4, length 1.9, about x 11.6.

C Stereophotographic pair, occlusal view, UALVP 18615, right M2, length 1.4, about x 11.8.

D Stereophotographic pair, occlusal view, UALVP 24913, right m2, length 1.4, about x 11.8.

E Labial view, UALVP 24913, right m2, length 1.4, about x 12.1.

Plate 41. <u>Picrodus silberlingi</u>

A Stereophotographic pair, occlusal view, UALVP 24918, right maxillary fragment having P4—M1, length M1, 2.6, about x 11.5.

B Labial view, UALVP 24918, right maxillary fragment having P4—M1, length M1 2.6, about x 11.9.

C Anterior view, UALVP 24918, right maxillary fragment having P4—M1, length M1 2.6, about x 11.9.

D Stereophotographic pair, occlusal view, UALVP 24916, left M3, length 1.1, about x 14.5.

?Rodentia unident. gen. and sp.

E Labial view, UALVP 25127, left m1 or m2, length 2.0, about x 11.0.

F Stereophotographic pair, occlusal view, UALVP 25127, left m1 or m2, length 2.0, about x 11.0.

G Lingual view, UALVP 25127, left m1 or m2, length 2.0, about x 11.0.

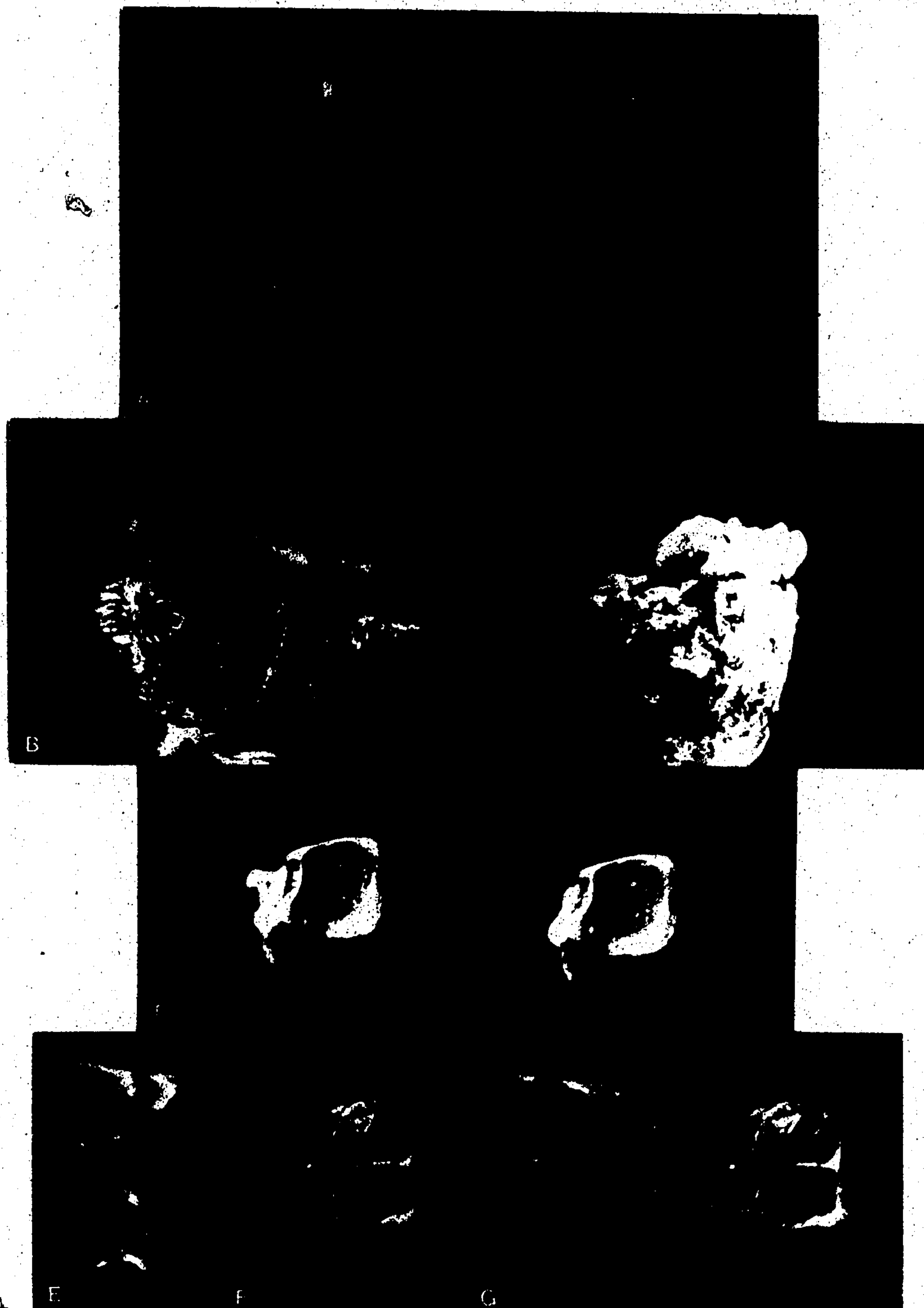
B
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Plate 42. Creodonta unident. gen. and sp.

A Stereophotographic pair, occlusal view, UALVP 24974, left P3, length 5.4, about x 9.3.

B Anterior view, UALVP 24974, left P3, length 5.4, about x 9.3.

C Posterior view, UALVP 24974, left P3, length 5.4, about x 9.3.

D Labial view, UALVP 24974, left P3, length 5.4, about x 9.3.

Pristinictis connatus n. gen. and sp.

E Labial view, UALVP 24947, right P3, length 3.5, about x 10.7.

F Stereophotographic pair, occlusal view, UALVP 24947, right P3, length 3.5, about x 10.3.


A
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Plate 43. Pristinictis connatus n. gen. and sp.

A Stereophotographic pair, occlusal view, UALVP 24949 (type), left maxillary fragment having P4—M2, length P4, 5.0, about x 6.3.

B Labial view, UALVP 24949 (type), left maxillary fragment having P4—M2, length P4, 5.0, about x 6.3.

Simpsonictis cf. S. tenuis

C Labial view, UALVP 24962, right m1, width 1.4, about x 11.4.

D Anterior view, UALVP 24962, right m1, width 1.4, about x 11.4.

E Lingual view, UALVP 24962, right m1, width 1.4, about x 11.4.

F Stereophotographic pair, occlusal view, UALVP 24962, right m1, width 1.4, about x 11.4.

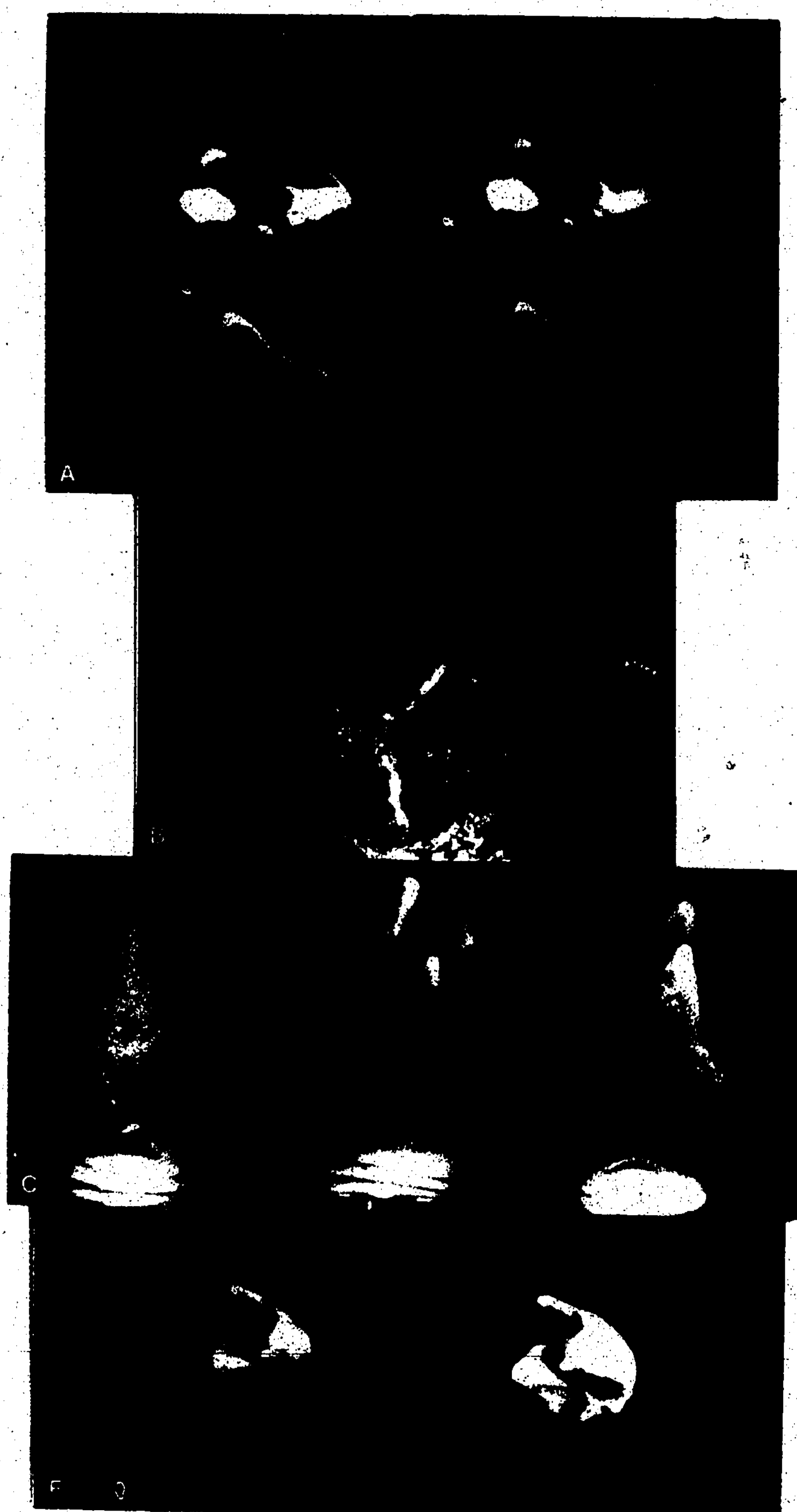

Plate 44. <u>Simpsonictis pegus</u>

A Labial view, UALVP 24955, right P4, length 3.7*, about x 12.4.

B Lingual view, UALVP 24955, right P4, length 3.7*, about x 12.4.

C Stereophotographic pair, occlusal view, UALVP 24955, right P4, length 3.7*, about x 12.4.

D Labial view, UALVP 24957, right p4, length 3.4, about x 11.0.

E Occlusal view, UALVP 24957, right p4, length 3.4, about x 11.5.

F Lingual view, UALVP 24957, right p4, length 3.4, about x 11.0.

G Labial view, UALVP 24952, right m1, width 2.5, about x 10.6.

H Stereophotographic pair, occlusal view, UALVP 24953, right m1, width 2.5, about x 10.6.

I Lingual view, UALVP 24953, right m1, width 2.5, about x 10.6.


A
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G
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Plate 45. ?Oxyclaeninae n. gen. and sp.

A Stereophotographic pair, occlusal view, UALVP 24977, right M1, length 3.3, about x 10.6.

Chriacus pelvidens

B Stereophotographic pair, occlusal view, UALVP 24979, left M1, length 7.3, about x 5.0.

C Labial view, UALVP 24978, left m1, length 7.5, about x 5.0.

D Stereophotographic pair, occlusal view, UALVP 24978, left m1, length 7.5, about x 5.0.

Chriacus cf. C. baldwini

E Labial view, UALVP 24982, left maxillary fragment having M1—M2, length M2, 6.7, about x 3.7.

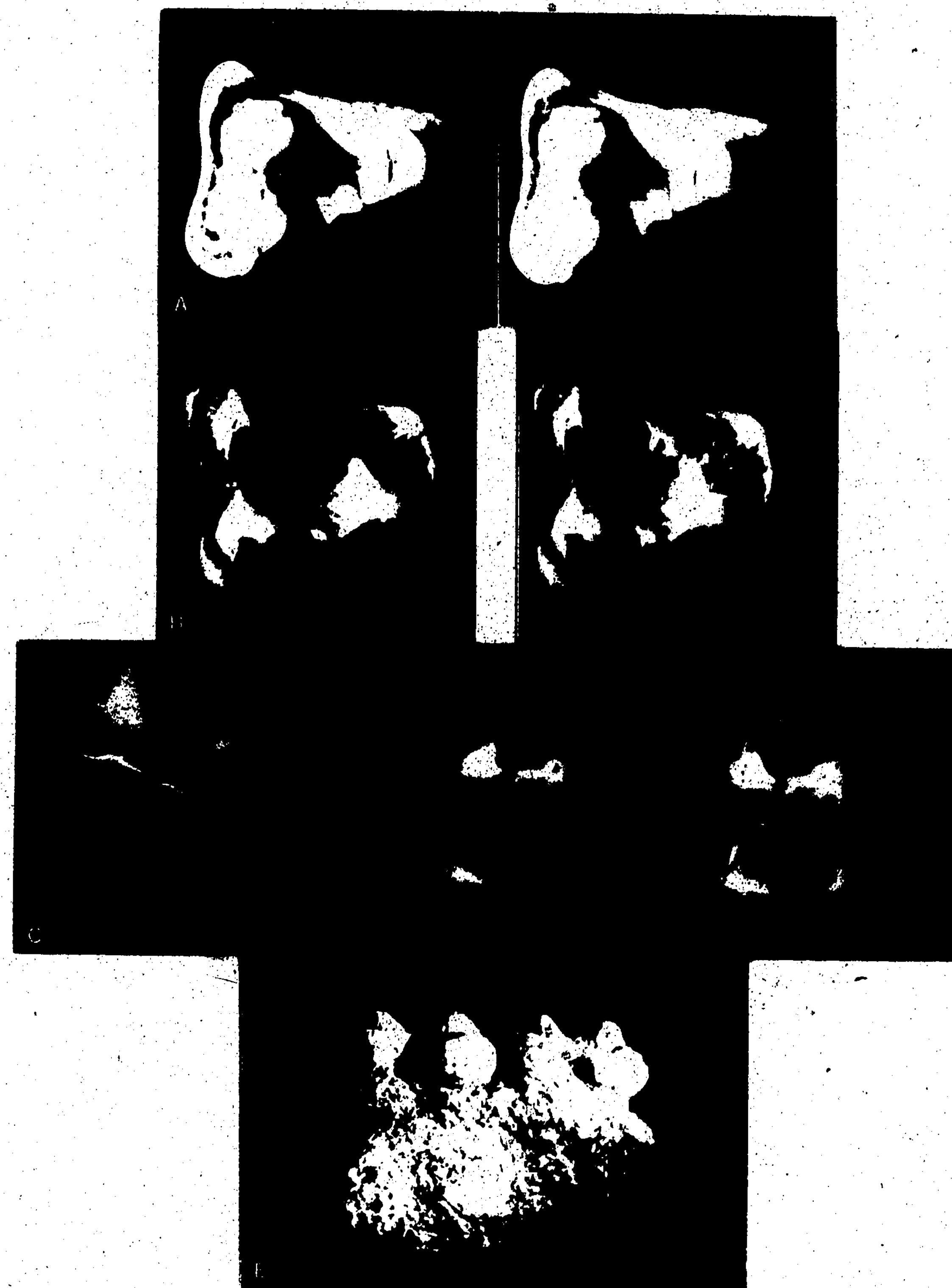

Plate 46. <u>Chriacus</u> cf. <u>C. baldwini</u>

A Stereophotographic pair, occlusal view, UALVP 24982, left maxillary fragment having M1—M2, length M2, 6.7, about x 3.9.

<u>Thryptacodon</u> <u>orthogonius</u> n. comb.

B Labial view, UALVP 24997, right m2, length 6.3, about x 7.3.

C Stereophotographic pair, occlusal view, UALVP 24997, right m2, length, 6.3, about x 7.7.

D Labial view, UALVP 24995, left m3, length 5.9, about x 7.1.

E Stereophotographic pair, occlusal view, UALVP 24995, left m3, length 5.9, about x 7.1.


B
D
E

Plate 47. <u>Colpoclaenus</u> cf. <u>C</u>. <u>keeferi</u>

A Labial view, UALVP 25018, left m1, width 8.2, about x 7.1.

B Stereophotographic pair, occlusal view, UALVP 25018, left m1, width 8.2, about x 7.1.

<u>Claenodon</u> cf. <u>C</u>. <u>montanensis</u>

C Stereophotographic pair, occlusal view, UALVP 25021, left M3, length 6.8, about x 4.3.

?<u>Oxyprimus</u> sp.

D Labial view, UALVP 25026, right m1, length 3.1, about x 11.6.

E Lingual view, UALVP 25026, right m1, length 3.1, about x 11.6.

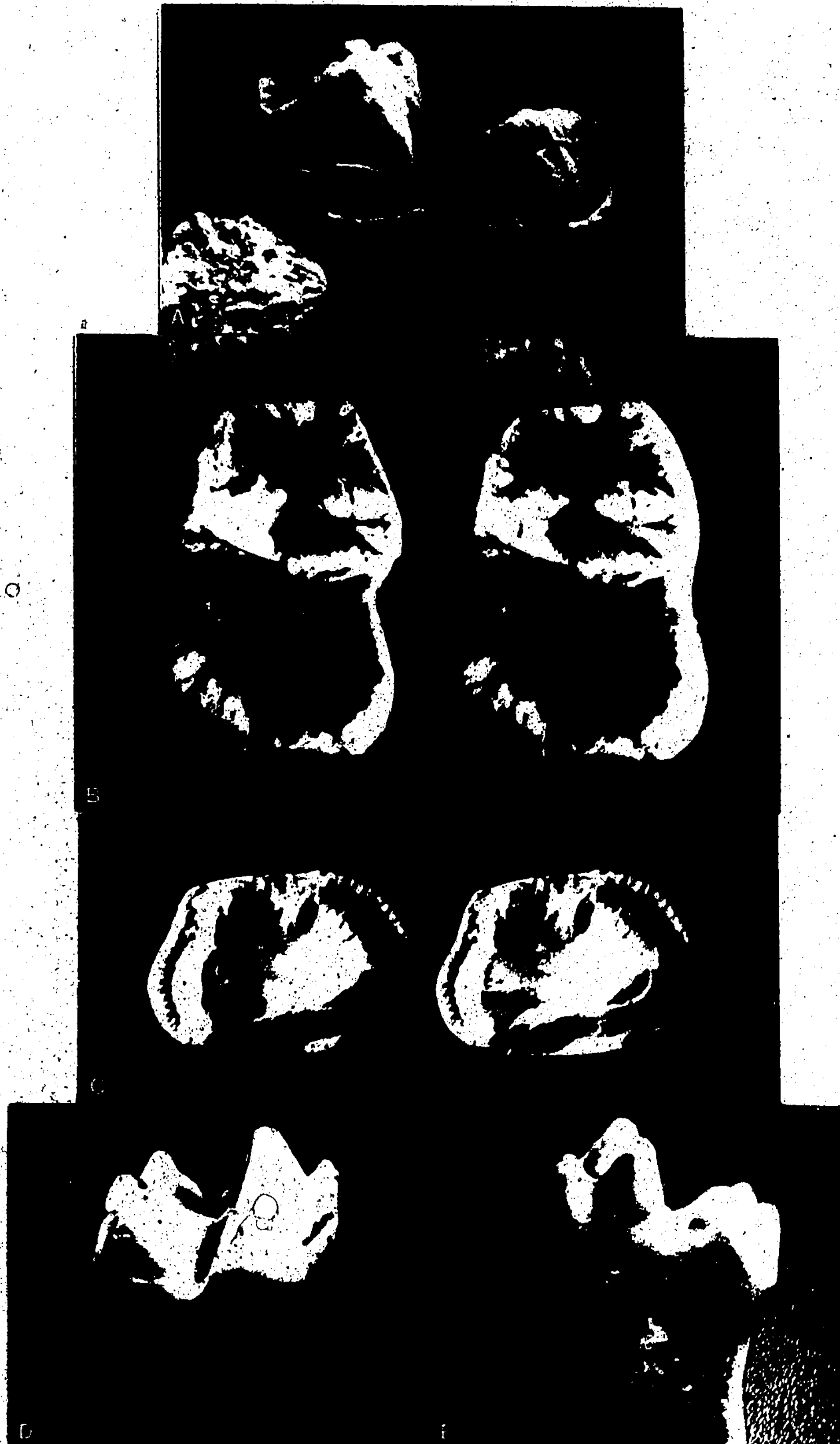
A
B
C
D
E

Plate 48. <u>?Oxyprimus</u> sp.

A Stereophotographic pair, occlusal view, UALVP 25026, right m1, length 3.1, about x 11.6.

<u>Litomylus dissentaneus</u>

B Stereophotographic pair, occlusal view, UALVP 25034, left M1, length 3.3, about x 10.9.

<u>Litomylus grandaletes</u> n. sp.

C Stereophotographic pair, occlusal view, UALVP 25005, left M1, length 4.0, about x 8.0.

D Stereophotographic pair, occlusal view, UALVP 25000 (holotype), right maxillary fragment having M2 and alveoli for M1, length M2, 4.4, about x 5.5.

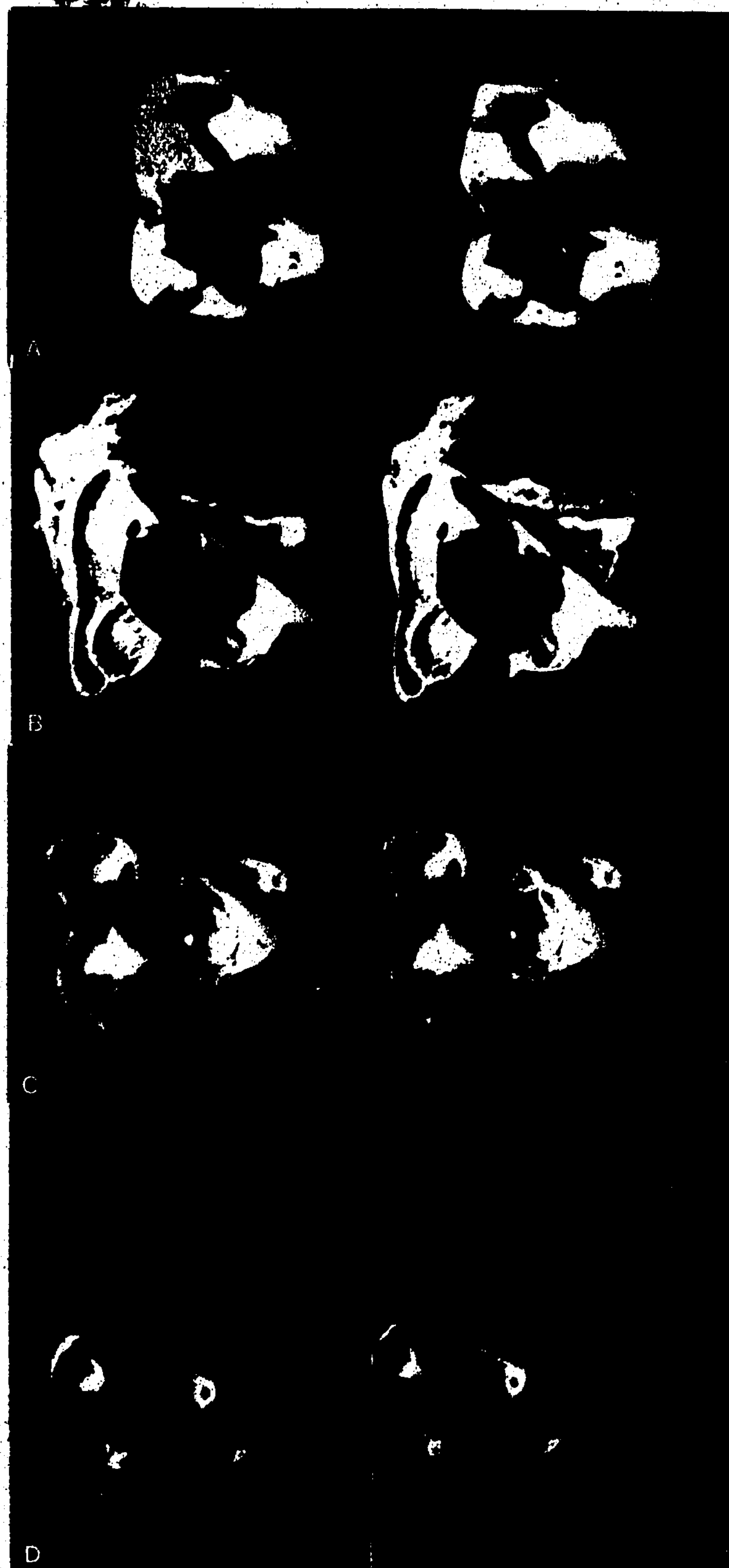

Plate 49. <u>Litomylus grandaletes</u> n. sp.

A Stereophotographic pair, occlusal view, UALVP 25004, left M3, length 3.4, about x 8.5.

B Labial view, UALVP 25015, left m1, length 4.0, about x [illegible].

C Stereophotographic pair, occlusal view, UALVP 25015, left m1, length 4.0, about x 8.0.

D Lingual view, UALVP 25015, left m1, length 4.0, about x 8.0.

E Labial view, UALVP 25013, right m2, length 4.5, about x 8.4.

F Stereophotographic pair, occlusal view, UALVP 25013, right m2, length 4.5, about x 8.6.

G Labial view, UALVP 25014, right m3, length 4.7, about x 8.0.

H Stereophotographic pair, occlusal view, UALVP 25014, right m3, length 4.7, about x 8.4.

I Lingual view, UALVP 25014, right m3, length 4.7, about x 8.0.


A
B
E
G
H
I

Plate 50. Apheliscinae n. gen. and sp.

- A Stereophotographic pair, occlusal view, UALVP 25058, left M1 or M2, length 2.5, about x 10.8.
- B Labial view, UALVP 25053, left p4, length 2.9, about x 10.0.
- C Lingual view, UALVP 25053, left p4, length 2.9, about x 10.0.
- D Labial view, UALVP 25057, right m2, length 2.6, about x 11.1.
- E Lingual view, UALVP 25057, right m2, length 2.6, about x 11.1.
- F Stereophotographic pair, occlusal view, UALVP 25057, right m2, length 2.6, about x 11.3.

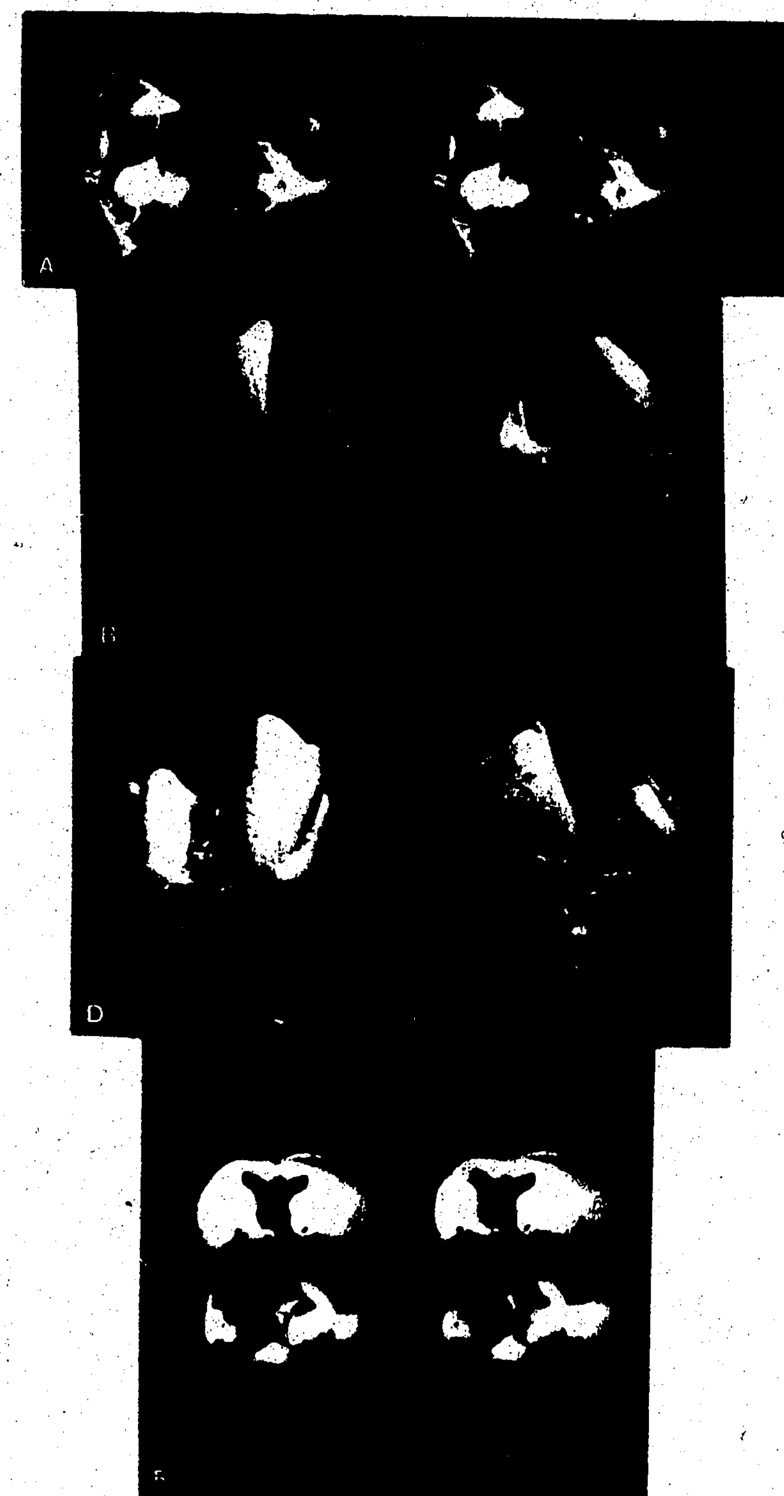
A
B
D
E

Plate 51. Desmatoclaenus cf. D. mearae

A Labial view, UALVP 25079, right m1, length 7.3, about x 8.1.

B Lingual view, UALVP 25079, right m1, length 7.3, about x 8.1.

C Stereophotographic pair, occlusal view, UALVP 25079, right m1, length 7.3, about x 7.8.

Ectocion collinus

D Stereophotographic pair, occlusal view, UALVP 25110, right dentary fragment having p4—m3, length m1, 7.5, about x 2.5.


A
B
C
D

Plate 52. <u>Ectocion collinus</u>

A Labial view, UALVP 25110, right dentary fragment having p4—m3, length m1, 7.5, about x 2.5.

Pantodonta unident. gen. and sp.

B Labial view, UALVP 25113, left C, maximum crown width 11.0, about x 2.0.

C Lingual view, UALVP 25113, left C, maximum crown width 11.0, about x 2.0.

<u>Palaeoryctes</u> cf. <u>P. punctatus</u>

D Stereophotographic pair, occlusal view, UALVP 25189, right M1, length 2.0, about x 11.8.

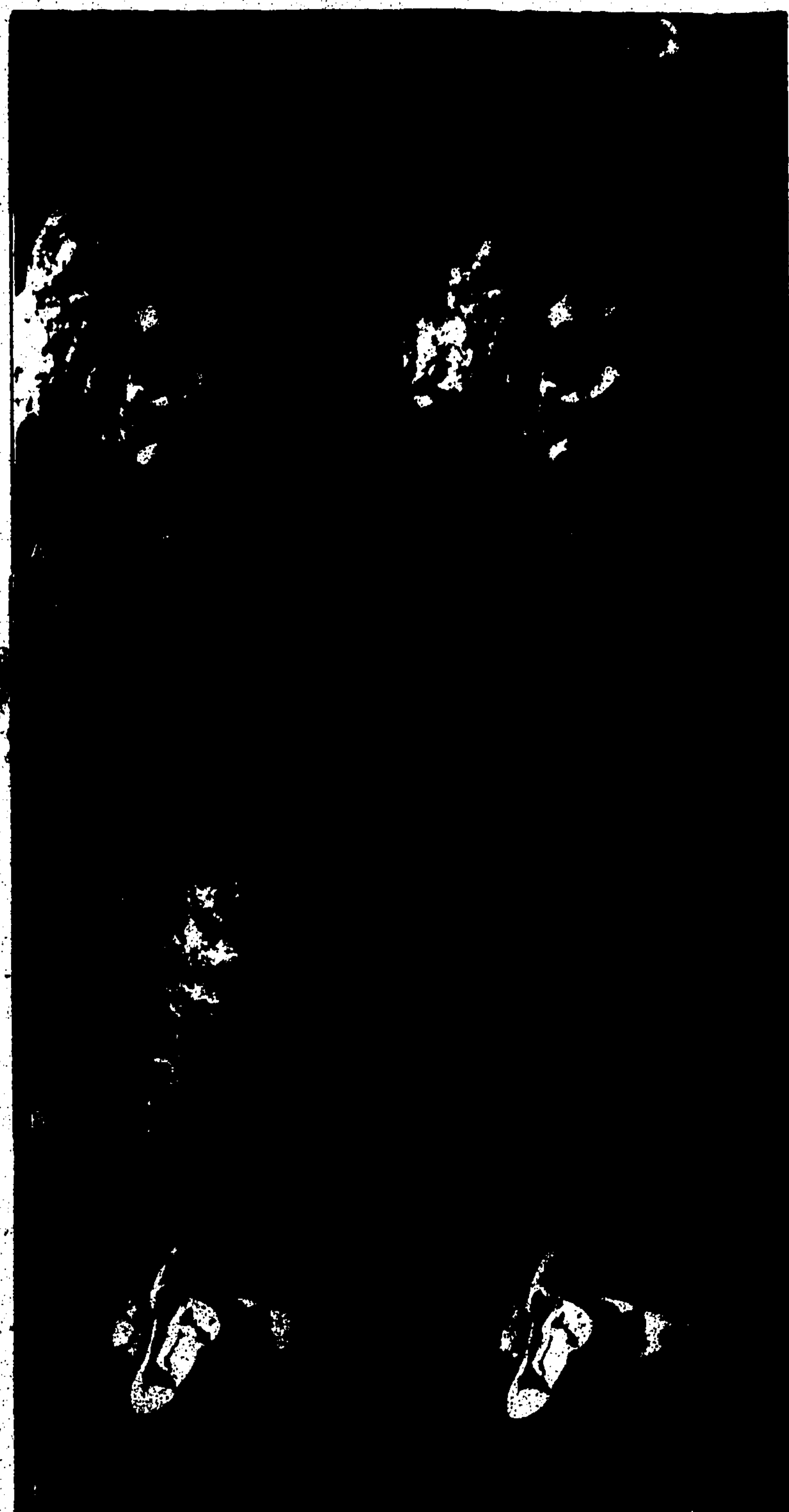

Plate 53. <u>Palaeoryctes</u> cf. <u>P</u>. <u>punctatus</u>

A Labial view, UALVP 25229, left m1, length 1.9, about x 11.8.

B Stereophotographic pair, occlusal view, UALVP 25229, left m1, length 1.9, about x 11.8.

C Lingual view, UALVP 25229, left m1, length 1.9, about x 11.8.

D Labial view, UALVP 25228, right m2, length 1.7, about x 11.8.

E Stereophotographic pair, occlusal view, UALVP 25228, right m2, length 1.7, about x 12.1.

F Lingual view, UALVP 25228, right m2, length 1.7, about x 11.8.

<u>Pararyctes</u> <u>pattersoni</u>

G Stereophotographic pair, occlusal view, UALVP 25232, left M1, length 1.8, about x 12.5.

H Stereophotographic pair, occlusal view, UALVP 25230, left m1, length 1.7, about x 11.5.

<u>Pararyctes</u> <u>rutherfordi</u> n. sp.

I Stereophotographic pair, occlusal view, UALVP 25180 (holotype), left M2, length 2.8, about x 10.4.

Plate 54. Didelphodontinae unident. gen. and sp.

A Stereophotographic pair, occlusal view, UALVP 25187, left M1, length 3.1, about x 9.7.

B Labial view, UALVP 25187, left M1, length 3.1, about x 9.7.

C Anterior view, UALVP 25187, left M1, length 3.1, about x 9.7.

D Posterior view, UALVP 25187, left M1, length 3.1, about x 9.7.

E Stereophotographic pair, occlusal view, UALVP 25186, left M3, width 4.5*, about x 9.7.

Palaeoryctidae unident. gen. and sp. 1

F Labial view, UALVP 25188, right m3, length 1.2, about x 12.1.

G Lingual view, UALVP 25188, right m3, length 1.2, about x 12.1.

H Stereophotographic pair, occlusal view, UALVP 25188, right m3, length 1.2, about x 12.1.

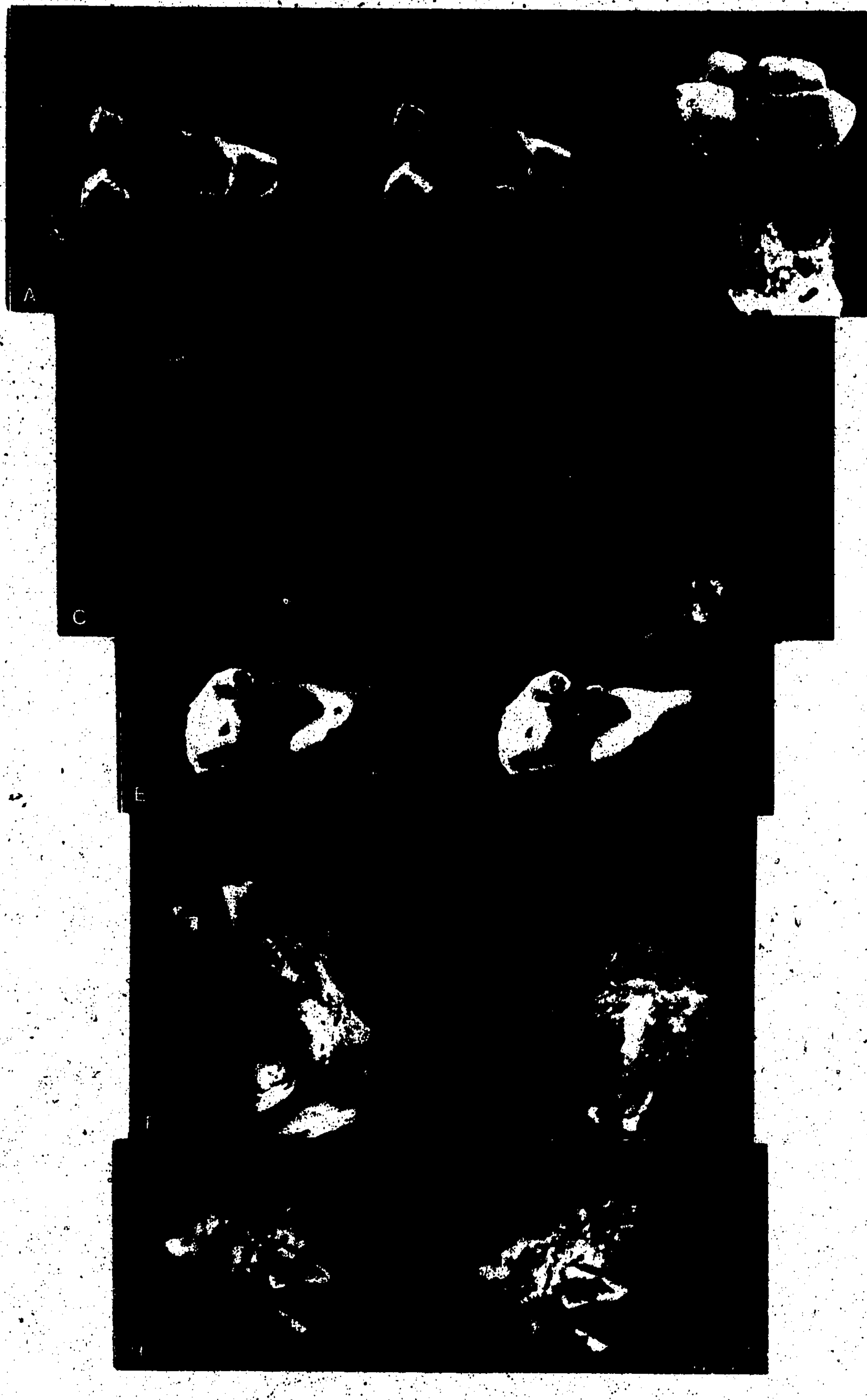
A
C
E

Plate 55. Palaeoryctidae unident. gen. and sp. 2

A Stereophotographic pair, occlusal view, UALVP 25226, left M1, width 3.4, about x 12.0.

B Labial view, UALVP 25219, right m1, length 2.4, about x 11.0.

C Stereophotographic pair, occlusal view, UALVP 25219, right m1, length 2.4, about x 11.0.

D Lingual view, UALVP 25219, right m1, length 2.4, about x 11.0.

E Labial view, UALVP 25227, left m3, length 2.6, about x 11.9.

F Stereophotographic pair, occlusal view, UALVP 25227, left m3, length 2.6, about x 14.5.

G Lingual view, UALVP 25227, left m3, length 2.6, about x 11.9.

Plate 56. Palaeoryctidae unident. gen. and sp. 3

A Labial view, UALVP 25222, right m3, length 3.7, about x 10,5.

B Lingual view, UALVP 25222, right m3, length 3.7, about x 10.5.

C Stereophotographic pair, occlusal view, UALVP 25222, right m3, length 3.7, about x 11.6.

"Palaeoryctoid" n. gen. and sp.

D Labial view, UALVP 25232, right m3, length 3.2, about x 11.0.

E Lingual view, UALVP 25232, right m3, length 3.2, about x 13.1.

F Stereophotographic pair, occlusal view, UALVP 25232, right m3, length 3.2, about x 13.1.

Plate 57. Prodiacodon cf. P. puercensis

A Stereophotographic pair, occlusal view, UALVP 25251, left P4, width 3.5, about x 11.4.

B Stereophotographic pair, occlusal view, UALVP 25234, right M1 or M2, length 2.8, about x 12.1.

C Labial view, UALVP 25236, left p4, length 3.5, about x 12.0.

D Lingual view, UALVP 25236, left p4, length 3.5, about x 12.0.

E Stereophotographic pair, occlusal view, UALVP 25236, left p4, length 3.5, about x 12.0.

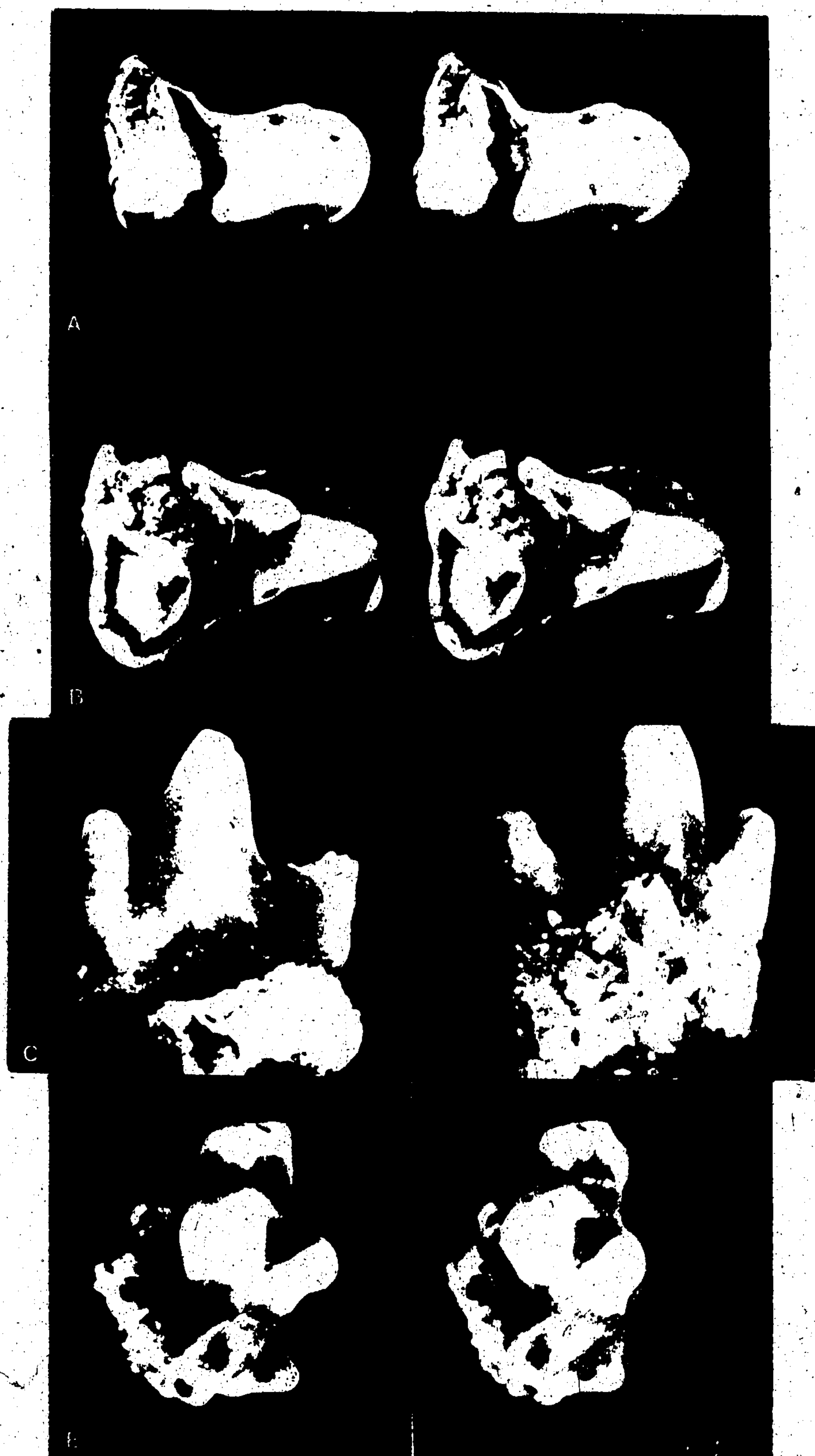
A
B
C
E

Plate 58. Prodiacodon cf. P. puercensis

A Labial view, UALVP 25235, left m1, length 3.0, about x 11.7.

B Lingual view, UALVP 25235, left m1, length 3.0, about x 11.7.

C Stereophotographic pair, occlusal view, UALVP 25235, left m1, length 3.0, about x 11.7.

Prodiacodon concordiarcensis

D Stereophotographic pair, occlusal view, UALVP 25263, left P4, width 2.5, about x 12.0.

E Stereophotographic pair, occlusal view, UALVP 25261, right M1, length 2.0, about x 12.0.

Plate 59. Prodiacodon concordiarcensis

A Labial view, UALVP 25260, right p4, length 2.1, about x 12.9.

B Lingual view, UALVP 25260, right p4, length 2.1, about x 12.9.

C Stereophotographic pair, occlusal view, UALVP 25260, right p4, length 2.1, about x 12.9.

D Labial view, occlusal view, UALVP 25262, left dentary fragment having m1—m3 and alveoli for p4, length m1, 1.9, about x 9.0.

E Stereophotographic pair, occlusal view, UALVP 25262, left dentary fragment having m1—m3 and alveoli for p4, length m1, 1.9, about x 9.0.

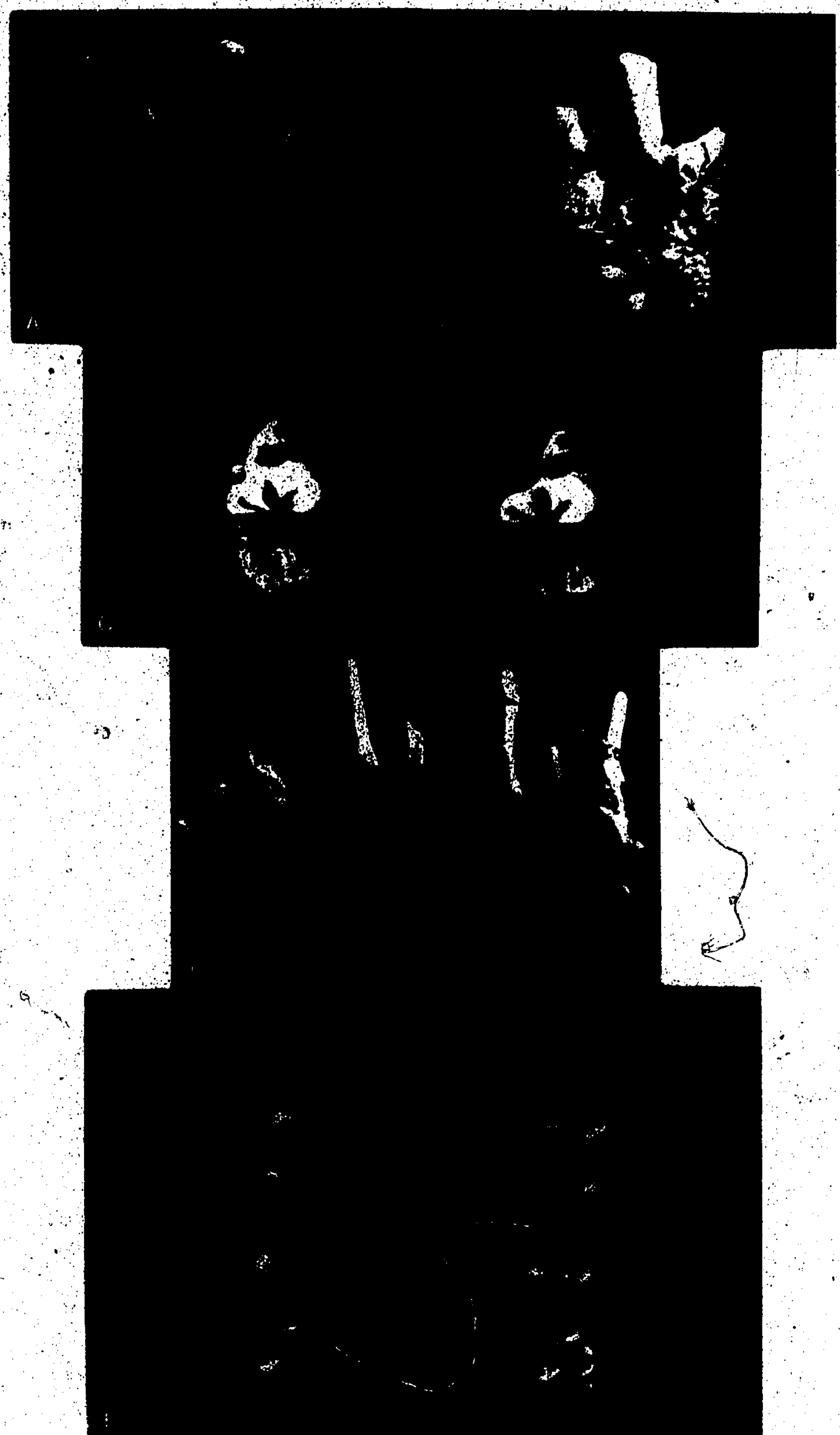

Plate 60. <u>Prodiacodon furor</u>

A Stereophotographic pair, occlusal view, UALVP 25334, right maxillary fragment having P4—M2, length M2 2.2, about x 8.4.

B Labial view, UALVP 25334, right maxillary fragment having P4—M2, length M2 2.2, about x 8.4.

C Labial view, UALVP 25327, right m1 or m2, length 2.0, about x 12.5.

<u>Myrmecoboides montanensis</u>

D Stereophotographic pair, occlusal view, UALVP 25347, right M1, length 2.3, about x 11.5.

E Labial view, UALVP 25346, left m1, length 2.6, about x 11.9.

F Stereophotographic pair, occlusal view, UALVP 25346, left m1, length 2.6, about x 11.9.

G Lingual view, UALVP 25346, left m1, length 2.6, about x 11.9.


G

Plate 61. Bisonalveus browni

A Labial view, UALVP 25352, left maxillary fragment having P4—M2, length M2, 2.5, about x 8.8.

B Stereophotographic pair, occlusal view, UALVP 25352, left maxillary fragment having P4—M2, length M2, 2.5, about x 8.4.

C Labial view, UALVP 18591, left dentary fragment having m1—m3, length m3, 2.6, about x 7.0.

D Stereophotographic pair, occlusal view, UALVP 18591, left dentary fragment having m1—m3, length m3, 2.6, about x 8.0.


A
B
D

Plate 62. Pentacodontidae n. gen. and sp.

A Stereophotographic pair, occlusal view, UALVP 25455, right M1 or M2, lingual length 2.8, about x 11.8.

B Labial view, UALVP 1982, left m1?, width 2.9, about x 11.0.

C Stereophotographic pair, occlusal view, UALVP 1982, left m1?, width 2.9, about x 11.0.

D Labial view, UALVP 18577, right m1?, length 3.4, about x 11.6.

E Lingual view, UALVP 18577, right m1?, length 3.4, about x 11.6.

F Stereophotographic pair, occlusal view, UALVP 18577, right m1?, length 3.4, about x 11.6.

Plate 63. Pentacodontidae n. gen. and sp.

A Labial view, UALVP 18422, left m2?, length 3.0, about x 12.0.

B Lingual view, UALVP 18422, left m2?, length 3.0, about x 12.0.

C Stereophotographic pair, occlusal view, UALVP 18422, left m2?, length 3.0, about x 12.0.

Propalaeosinopa septentrionalis n. comb.

D Labial view, UALVP 25462, right maxillary fragment having P4, width P4 2.2, about x 11.8.

E Stereophotographic pair, occlusal view, UALVP 25462, right maxillary fragment having P4, width P4 2.2, about x 11.8.

F Labial view, UALVP 25463, left dentary fragment having m2, length m2, 2.4, about x 11.7.

G Lingual view, UALVP 25463, left dentary fragment having m2, length m2, 2.4, about x 11.7.


A
D
F
G

Plate 64. <u>Propalaeosinopa septentrionalis</u>, n. comb.

A Stereophotographic pair, occlusal view, UALVP 25463, left dentary fragment having m2, length m2, 2.4, about x 11.7.

B Labial view, UALVP 25499, left m3, length 2.9, about x 11.7.

C Stereophotographic pair, occlusal view, UALVP 25499, left m3, length 2.9, about x 11.7.

D Lingual view, UALVP 25499, left m3, length 2.9, about x 11.7.

<u>Paleotomus senior</u>

E Labial view, UALVP 25603, left m2, length 4.7, about x 8.9.

F Lingual view, UALVP 25603, left m2, length 4.7, about x 8.9.

G Stereophotographic pair, occlusal view, UALVP 25603, left m2, length 4.7, about x 8.5.

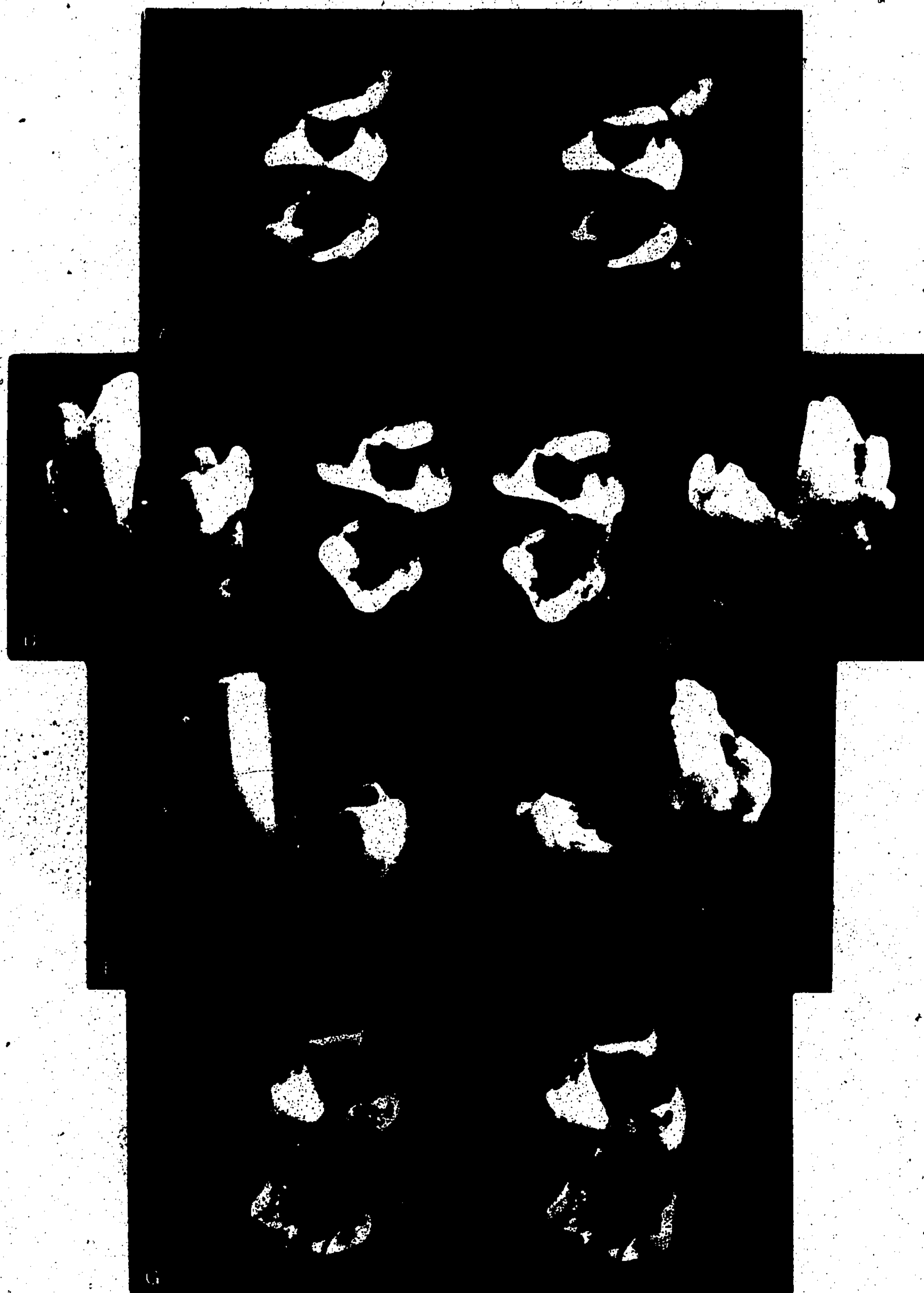

Plate 65. <u>Paleotomus junior</u> n. sp.

A Labial view, UALVP 25604, left M1, length 3.3, about x 11.8.

B Stereophotographic pair, occlusal view, UALVP 25604, left M1, length 3.3, about x 11.8.

C Labial view, UALVP 25607, right p3, length 3.3, about x 11.5.

D Lingual view, UALVP 25607, right p3, length 3.3, about x 11.5.

E Labial view, UALVP 25615, right dp4, length 3.5, about x 12.0.

F Lingual view, UALVP 25615, right dp4, length 3.5, about x 12.0.

G Stereophotographic pair, occlusal view, UALVP 25615, right dp4, length 3.5, about x 12.0.

Plate 66. _Paleotomus junior_ n. sp.

A Labial view, UALVP 25605 (holotype), left m3, length 3.5, about x 12.3.

B Lingual view, UALVP 25605 (holotype), left m3, length 3.5, about x 12.3.

C Stereophotographic pair, occlusal view, UALVP 25605 (holotype), left m3, length 3.5, about x 12.0.

Eudaemonema cf. _E. cuspidata_

D Occlusal view, UALVP 25618, left M1 or M2, width 5.5, about x 7.6.

Plate 67. <u>Jepsenella</u> cf. <u>J. praepropera</u>

A Labial view, UALVP 25620, left I1, maximum width 2.8, about x 10.6.

B Stereophotographic pair, occlusal view, UALVP 25620, left I1, minimum width 1.7, about x 10.6.

C Medial view, UALVP 25620, left I1, maximum width 2.8, about x 10.6.

D Stereophotographic pair, occlusal view, UALVP 25619, left M1, maximum length 1.8, about x 11.9.

Eutheria incertae sedis unident. gen. and sp.

E Stereophotographic pair, occlusal view, UALVP 25627, left M3?, length 1.9, about x 11.6.