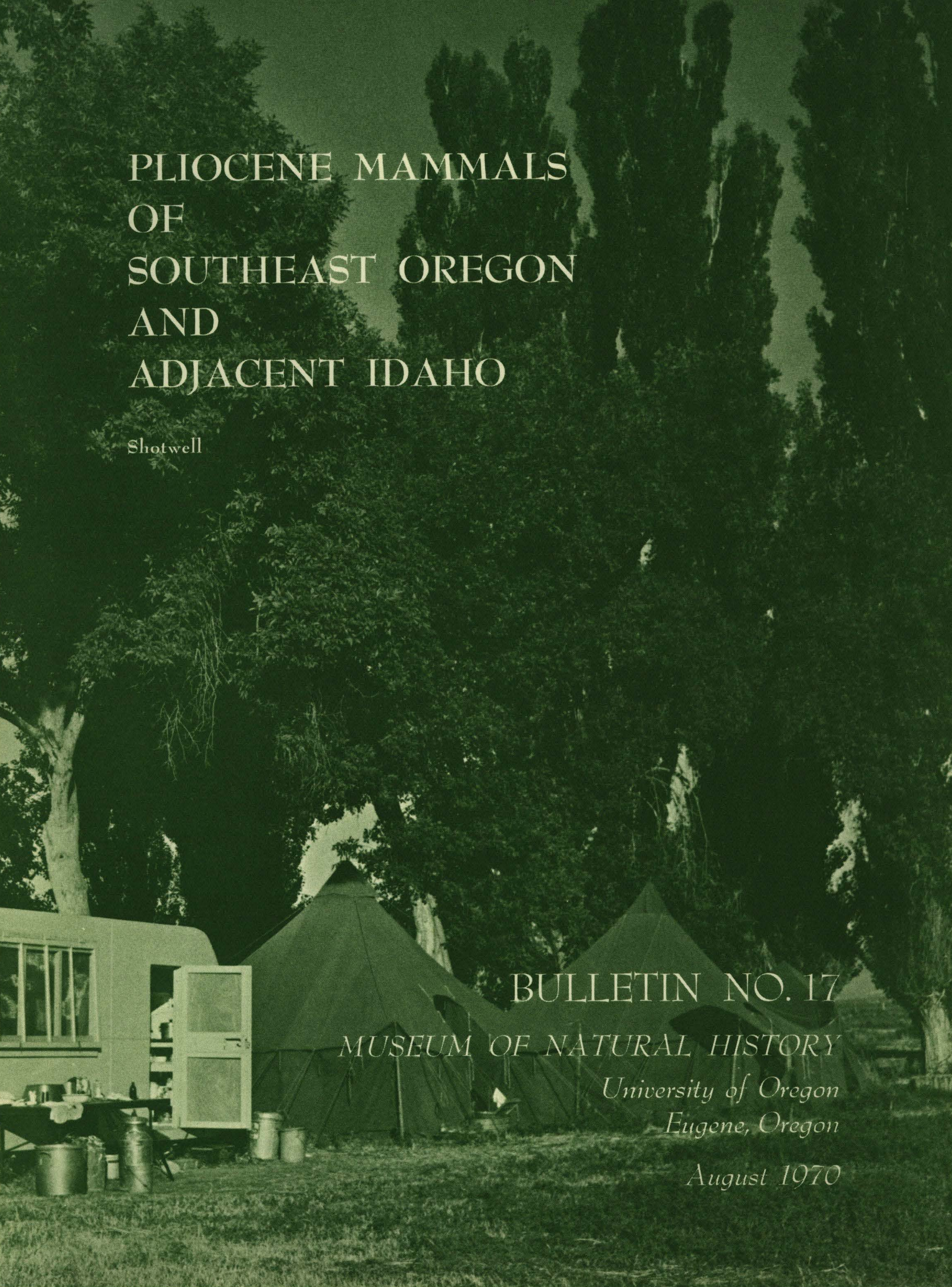

PLIOCENE MAMMALS OF SOUTHEAST OREGON AND ADJACENT IDAHO

Shotwell

BULLETIN NO. 17

MUSEUM OF NATURAL HISTORY

University of Oregon
Eugene, Oregon

August 1970

The *Bulletin* of the Museum of Natural History of the University of Oregon is published to increase the knowledge and understanding of the Natural History of Oregon. Original articles in the fields of Archaeology, Botany, Ethnology, Geology, Paleontology and Zoology appear irregularly in consecutively numbered issues. Contributions arise primarily from the research programs and collections of the Museum of Natural History and the Oregon State Museum of Anthropology. However, in keeping with the basic purpose of the publication, contributions are not restricted to these sources and are both technical and popular in character.

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Museum of Natural History
University of Oregon

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INTRODUCTION

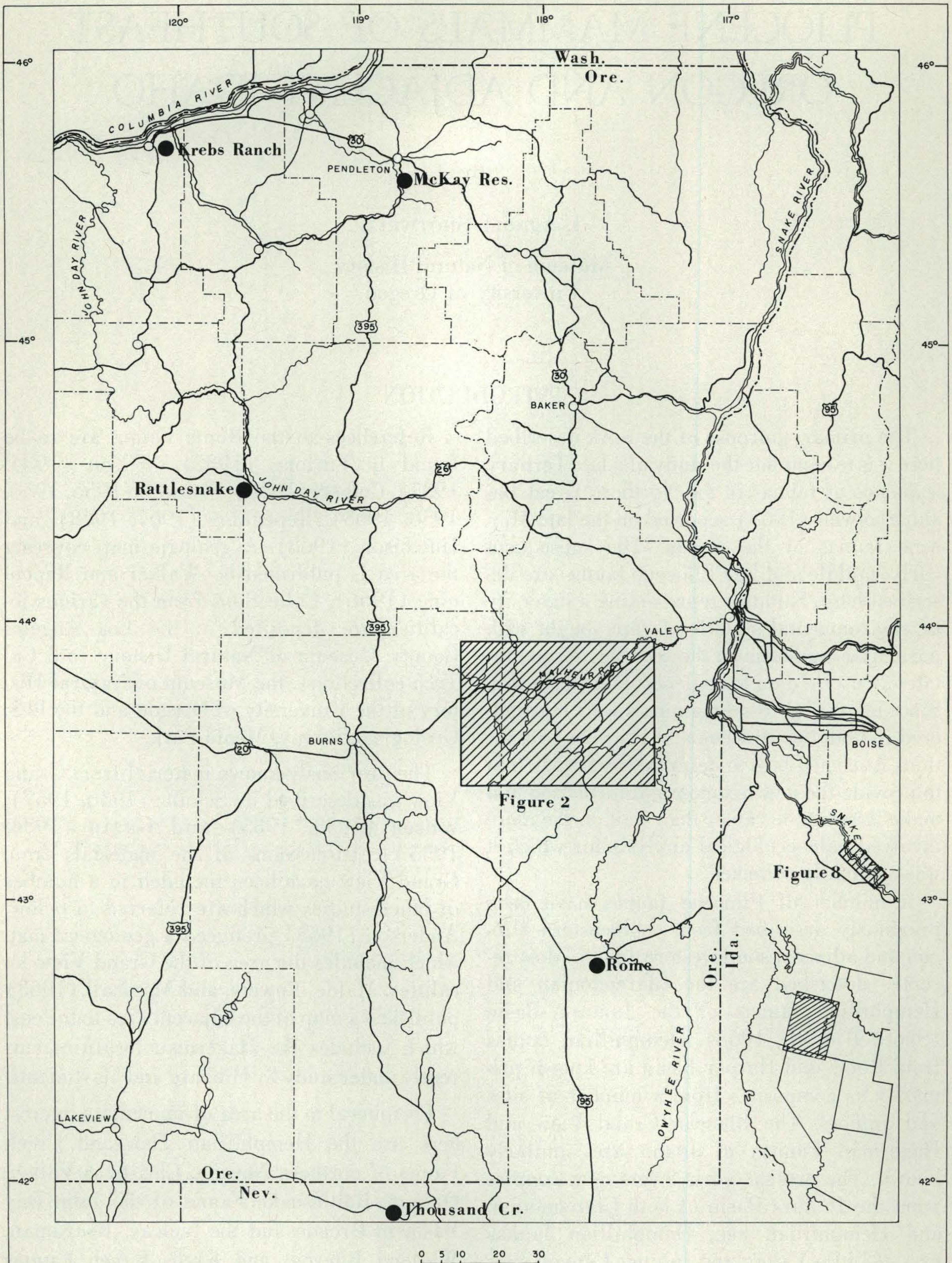
The primary purpose of the work described here was to complete the study of a late Tertiary sequence of faunas in the Northern Great Basin. Shotwell (1968) reported on the late Miocene faunas of the region. The subsequent early, middle and late Pliocene faunas are described here. Samples representing a diversity of environmental situations were sought with particular emphasis on the recovery of quantitatively useful data for paleoecological studies. Since many new fossil mammals were encountered in both the Miocene and Pliocene excavations it seemed best to describe the faunas first to provide the new taxonomic information and make it available rather than wait on the more involved paleoecological analysis for which it was originally collected.

A number of Pliocene faunas have been previously described from southeastern Oregon and adjacent southwestern Idaho. Most recently described are the Clarendonian and Hemphillian faunas of the Juntura Basin (Shotwell *et al.*, 1963). Hemphillian faunas from Rome and Harper Basin are known primarily as composites from a number of sites and authors. The Blancan Grand View and Hagerman Faunas of Idaho are similarly known. The present work covers new samples from the Juntura Basin of both Clarendonian and Hemphillian age, Hemphillian faunas east of Little Valley, the Juniper Canyon sites and the Grand View of Idaho.

References to the Rome Fauna are to be found in Furlong (1932), Wilson (1934, 1937), Colbert (1938), Shotwell (1955, 1956, 1958, 1963), Repenning (1967, 1968), and Hutchison (1968). A geologic map covering the area is published by Walker and Repenning (1966). Collections from the various localities are deposited in the Los Angeles County Museum of Natural History (old Cal Tech collection), the Museum of Natural History of the University of Oregon and the U.S. Geological Survey, Menlo Park.

The previously known material from Grand View was described by Schultz (1936, 1937), Wilson (1933, 1935) and Gazin (1934, 1935A). Discussions of the materials from Grand View have been included in a number of other studies which are referred to below. Anderson (1965) produced a geological map which includes the area of the Grand View localities. Malde, Powers, and Marshall (1963) published a map of the adjacent area to the east which includes the Hagerman localities currently under study by Hibbard and his students.

Peripheral to the area of immediate interest here are the Hemphillian Thousand Creek Fauna of northern Nevada, Christmas Valley, Oregon, Rattlesnake Fauna of the John Day Basin in Oregon and the McKay, Boardman, Westend Blowout and Krebs Ranch Faunas from along the Columbia River in Oregon.


120°
119°
118°
117°
46°
45°
44°
43°
42°
Wash.
Ore.
COLUMBIA RIVER
Krebs Ranch
30
PENDLETON
McKay Res.
JOHN DAY RIVER
SNAKE RIVER
395
30
BAKER
95
26
Rattlesnake
JOHN DAY RIVER
395
VALE
MALHEUR R.
BURNS
20
BOISE
Figure 2
SNAKE
Figure 8
395
Rome
Ore.
Ida.
OWYHEE RIVER
95
LAKEVIEW
Ore.
Nev.
Thousand Cr.
0 5 10 20 30
MILES
120°
119°
118°
117°

ACKNOWLEDGEMENTS

The specimens referred to in this paper were collected in the field seasons of 1958, 1959, 1960, 1963, 1964, and 1965. I wish to express my gratitude to the students who assisted in the excavation and preparation of these specimens. They include; Fred Crafts, Ron Bigelow, Stuart Shininger, Jon Jacklet, Richard Wilson, Dale Russell, David Brown, Huntley Alvey, George Howe, Howard Hutchison, Fred Cole, Jim Haight, Gary Millhollen, and Janet Mack. A number of them were involved in more than one season. Mrs. Lillian Wells was cook 1958, 1960 assisted by Charlene Wells. Mr. Charles Steiner provided a camp site for our work in Idaho. Jean Morcom allowed us to use his property at the Page Ranch for our 1960 camp. Our 1963 site was on the property of Drex Williams. I am indebted to these men for their assistance.

National Science Foundation Grants G-3935, G-10684, and G-21820 provided funds for the field and laboratory work. The illustrations in this report are by Mildred Detling.

CLARENDONIAN

Black Butte

The Clarendonian Black Butte Fauna of the Juntura Basin was described previously (Shotwell and Russell, 1963). However, the sample attributed to a stream-bank association (UOloc 2337) contained a very small number of mammals. After the diversity of forms present in the older (Barstovian) Quartz Basin Fauna was revealed it was obvious that the existing sample from the Juntura Basin (UOloc 2337) did not adequately represent the members of the association to be expected both quantitatively and qualitatively. At UOloc 2337 only a hilltop remnant had been available for our sample so that no future excavation was possible. In the spring of 1963 we were successful in establishing a new site at approximately the same stratigraphic level and about one-fourth mile north of UOloc 2337. With the advantage of a better disaggregation technique than was available earlier and small mesh screen (see Wilson 1965) a large sample was recovered during the spring and summer of 1963. The sample was taken from a narrow band, less than a foot in thickness, as a large number of subsamples each an approximately equal volume of sediment. Throughout the disaggregation, preparation and study these subsamples were maintained as segregates to allow a broader range of analytical techniques in the paleoecological work for which they were ultimately intended.

Figure 1. *Map of Eastern Oregon and adjacent states indicating location of major Pliocene faunas with index to detail maps.*

The geomyoid and cricetid rodents have been previously described by Shotwell (1967A, 1967B). The talpids have been described by Hutchison (1968). He is presently studying the soricids. Included in the systematic section of this report are additions to the known fauna beyond the above papers and Shotwell and Russell (1963) with further descriptions of previously known forms where the new material provided additional information. Additions to the avian fauna and description of the lower vertebrates will appear at a later date. The composite mammalian fauna of the Juntura Formation is presented in Table 1.

Kittleman *et al.* (1965, 1967) have shown the Juntura Formation to overlie the Tims Peak Basalt which in turn overlies the Butte Creek Volcanic Sandstone. The Butte Creek Volcanic Sandstone has produced the Skull Springs (Red Basin) Fauna thus establishing the superpositional relationship of the two faunas.

HEMPHILLIAN

Drewsey (Bartlett Mountain and Otis Basin)

The fauna of the Hemphillian Drewsey Formation was originally described (Shotwell 1963) as three local faunas, Bartlett Mountain, Drinkwater and Otis Basin. Surface materials were the primary source of the faunal lists ascribed to these local faunas. In 1963 we

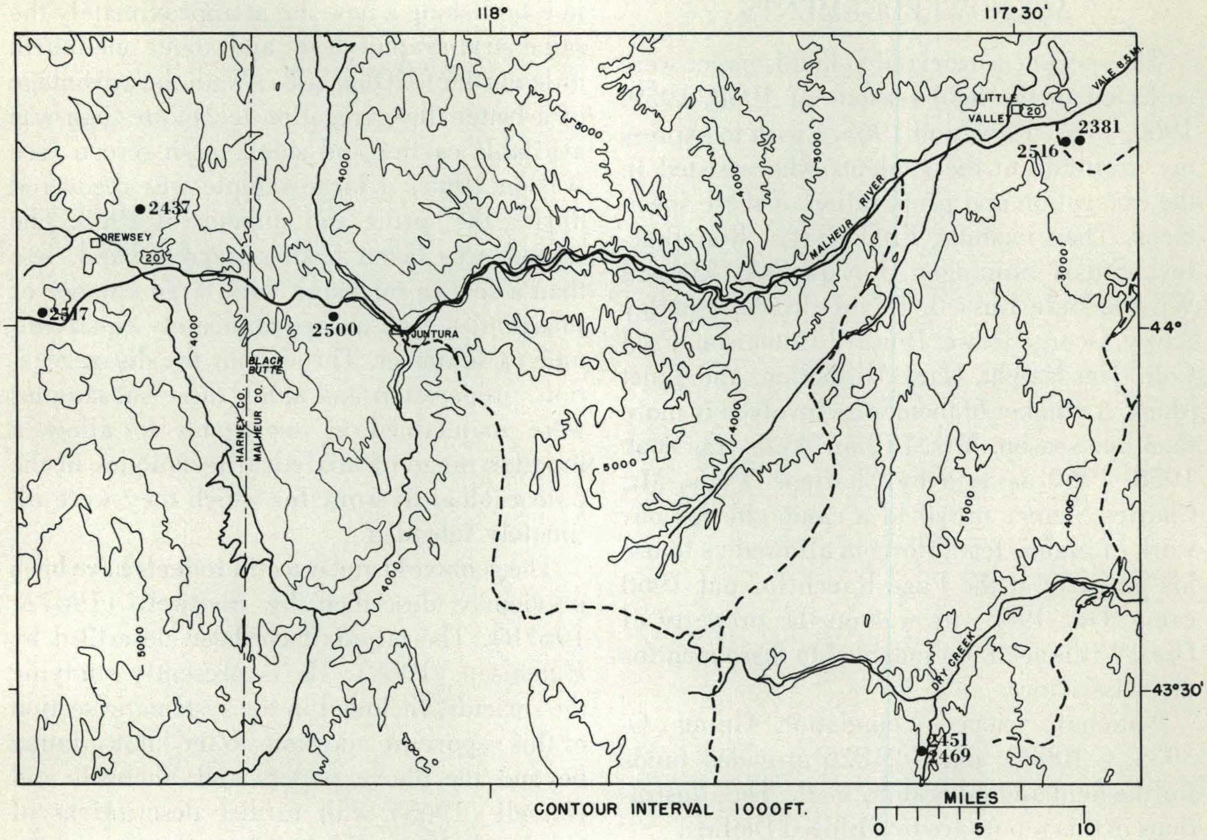


Figure 2. *Locality map. UOloc 2381, Little Valley Hemphillian, UOloc 2437, Otis Basin Hemphillian, UOloc 2451, Juniper Creek Canyon Hemphillian, UOloc 2469, Juniper Creek Canyon Hemphillian, UOloc 2500, Black Butte Clarendonian, UOloc 2516, Little Valley Hemphillian, UOloc 2517, Bartlett Mountain Hemphillian.*

established a screening site (UOloc 2517) in the area of the surface locality 2339 near Bartlett Mountain. The excavation and preparation of the specimens was carried out in the same manner as those from Black Butte (UOloc 2500) with subsamples maintained. In addition further searching was carried on in Otis Basin with additional elements of that fauna recovered. Table 2 presents a composite list of the fauna of the Drewsey Formation broken down by local faunas with the new screening site results segregated in the listing.

The Drewsey Formation overlies the Juntura Formation in the eastern half of the Juntura Basin thus the superpositional relationship of the faunas is well established (Bowen, Gray and Gregory 1963).

JUNIPER CREEK CANYON

Juniper Creek Canyon is a small branch canyon entering Dry Creek from the south in central Malheur County. The sediments containing the Hemphillian fossils are faulted against the Deer Butte Formation. As a result some exposures produce both Hemphillian and Barstovian fossils (UOloc 2450). It is not possible at the present time to assign a formational name to these beds. The nearest known Grassy Mountain exposures are nine miles to the north. The Juniper Creek Canyon sediments may represent an outlier of the Grassy Mountain Formation. Scattered discontinuous exposures of Hemphillian beds to the south, however, may represent a correlate of the Grassy Mountain

TABLE 1

BLACK BUTTE FAUNA

	2500	2448	2332	Other
		Q3	Q2	
INSECTIVORA				
Meterix sp.	X			
Shrew	X			
Shrew	X			
Mystipterus (M) sp.	X			
Scalopoides sp. A	X			
Scalopoides sp. B	X			
Scapanus (X) cf. *schultzi*	X			
CHIROPTERA				
Bat	X			
LAGOMORPHA				
Hesperolagomys cf. *galbreathi*	X			
Hypolagus cf. fontinalis	X			
RODENTIA				
Tardontia cf. *occidentale*	X			
Mylagaulus sp.				X
Epigaulus minor				X
Spermophilus junturensis	X			
Spermophilus sp.				X
Eutamias sp.	X			
Hystricops sp.			X	
Eucastor malheurensis	X			X
Microtoscoptes sp.	X			
Peromyscus dentalis	X			
Peromyscus sp.	X			
Peromyscus cf. *esmeraldensis*	X			
Leptodontomys sp.	X			
Perognathus sp.	X			
Diprionomys sp.	X			
Pliosaccomys sp.	X			
Macrognathomys nanus	X			
CARNIVORA				
Osteoborus sp.				X
Aelurodon sp.			X	
Vulpes sp.				X
Martes sp.	?			X
Eomelivora sp.				X
Sthenictis junturensis	?			X
Pseudaelurus sp.				X
PROBOSCIDEA				
Platybelodon (T) cf. *barnumbrowni*				X
Mammut (P) furlongi		X		
Mammut (M) sp.				X
PERISSODACTYLA				
Hipparion condoni		X	X	
Tapirid				X
Aphelops sp.		X	X	
ARTIODACTYLA				
Prosthennops sp.				X
Ustatochoerus sp.				X
Procamelus cf. *grandis*		X	X	
Megatylopus sp.		X		

Formation which in reality is a distinct mapable unit including the Juniper Creek Canyon exposures. Neither of the small quarries worked in these beds provides good quantitative data. UOloc 2451 is apparently a concentration of fossils either locally redeposited or in some other way highly selected in such a way that primarily teeth have survived. Thus although a large number of specimens were recovered they apparently are not useful as a quantitative sample. UOloc 2469, just to the west, occurred in a poorly sorted volcanic sandstone. It was not susceptible to the older disaggregation techniques available at that time (1960) nor to subsequent tests using later techniques. Material was retrieved from excavated blocks by crumbling them with hammers and screening the resultant rock fragments. The representation of small specimens (although many were recovered) may be proportionately low. Considering the small size of the sample and the means of excavation its value as a quantitative sample is questionable. Qualitatively it is of value because of its geographic position. Table 3 includes the taxonomic groups found at these two localities.

LITTLE VALLEY

The Little Valley localities are within the Chalk Butte Formation as proposed and mapped by Corcoran *et al.* (1962). This unit apparently includes beds ranging in age from Hemphillian to Pleistocene including several disconformities. In order for it to be a more useful name it will probably have to be revised

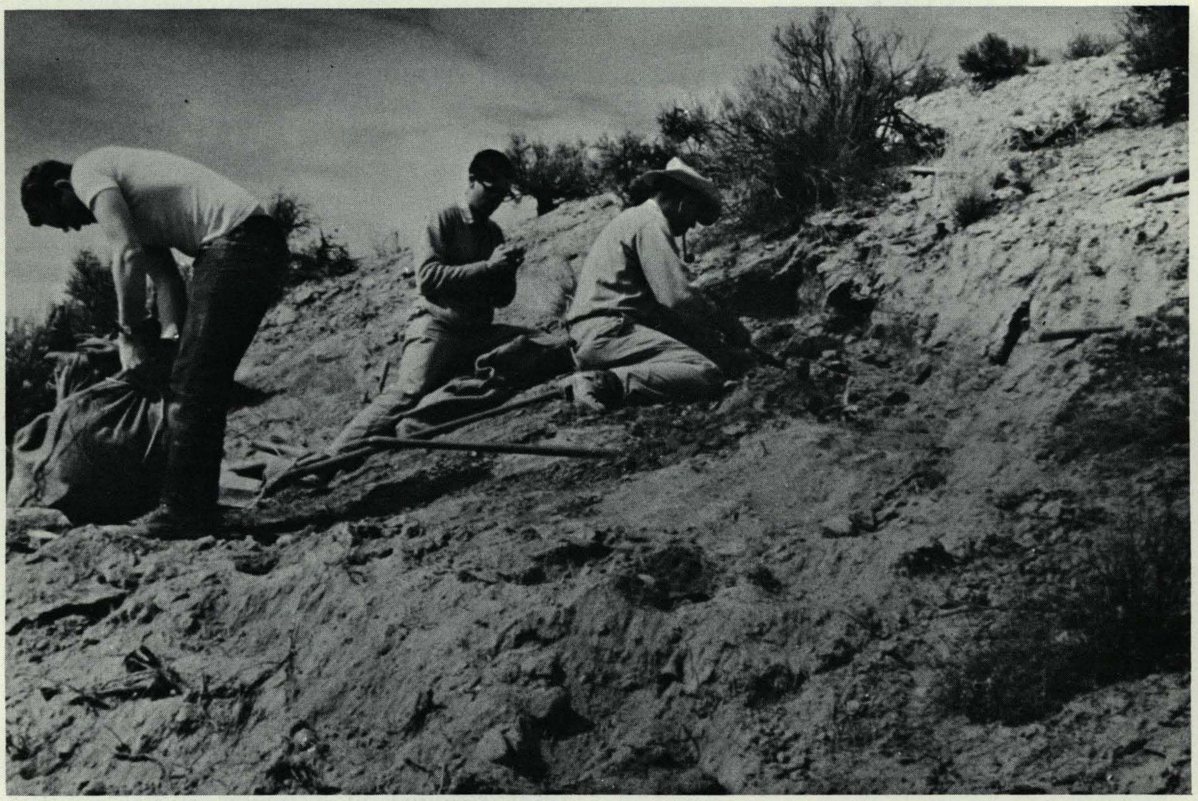


Figure 3. *UOloc 2500, Black Butte Fauna, Juntura Basin.*

or at least restricted in its extent. No other name has been proposed for these beds. The beds, in which the Little Valley localities occur overlie unconformably the Grassy Mountain Formation which also includes Hemphillian and possibly Clarendonian mammals. The Grassy Mountain Formation in turn unconformably overlies the Barstovian Deer Butte Formation (see Kittleman 1962, Kittleman *et al.* 1965, 1967). The section in this area is thus parallel to that immediately to the west which includes the localities in the Juntura Basin. Stratigraphic information is not available to determine the exact relationships of the beds containing the Bartlett Mountain Fauna (Drewsey Formation) to those in which the Little Valley localities occur. Direct superpositional relationships cannot be presently recognized. Paleontological comparisons are not feasible for the purpose of the research program which produced this material since it would lead to circuitous reasoning, however, they may be useful for other applications of the faunas described here.

Little Valley locality 2380 includes a small pocket which consists of rock fragments and fossils redeposited from their original source of deposition, possibly the underlying Grassy Mountain Formation. Several characteristics of this pocket suggest such an origin. The lithology is unconsolidated poorly sorted rock fragments with little or no clays or sands in fact with almost no matrix. The fossils and rock fragments are in many cases abraded and often encrusted. Some of the species recognized do not occur in the undisturbed sites nearby. *Dipoides* is represented in both types of sites. In the apparently redeposited pocket *Dipoides stirtoni* is present. At UOloc 2516, one of the adjacent sites, a small species of *Dipoides* is present similar to those usually associated with later Hemphillian faunas. Locali-

TABLE 2

DREWSEY FORMATION FAUNA

	Bartlett Mt. 2517	Bartlett Mt.	Drinkwater	Otis Basin
EDENTATA				
Sloth				X
INSECTIVORA				
Scalopoides sp.	X			
Scapanus (*S*) sp.	X			
Scapanus (*X*) cf. *proceridens*				X
Shrew	X			
Shrew	X			
Shrew	X			
LAGOMORPHA				
Hypolagus sp.	X	X		X
RODENTIA				
Tardontia sp.	X			
Liodontia furlongi		X		X
Mylagaulus sp.		X		X
Spermophilus sp.	X			X
Spermophilus cf. *wilsoni*	X			
Eutamias sp.	X			
Hystricops browni		X		
Dipoides stirtoni	X	X		
Oryzomys sp.	X			
Microtoscoptes disjunctus	X	X		
Peromyscus valensis	X			
Peromyscus antiquus	X			
Peromyscus cf. *esmeraldensis*	X			
Leptodontomys sp.	X			
Perognathus sp.	X			
Diprionomys cf. *parvus*	X			
Pliosaccomys magnus	X			
Pliosaccomys sp.				X
Dipodomys sp.	X			
Macrognathomys cf. *nanus*	X			
CARNIVORA				
Osteoborus sp.				
Ursid		X		
Pliotaxidea nevadensis		X		
PROBOSCIDEA				
Ambelodon sp.		X		
Mammut sp.		X		X
PERISSODACTYLA				
Hipparion cf *condoni*		X		
Pliohippus spectans		X		X
Teleoceras sp.	X	X	X	?
ARTIODACTYLA				
Prosthennops sp.				X
Procamelus sp.	X	X	X	X
Megatylopus sp.		X	X	
Sphenophalos sp.		X		

ties in the Grassy Mountain Formation have thus far not produced any large samples. *Dipoides stirtoni*, however, does occur in those localities known. This beaver is also present in the Bartlett Mountain Fauna of the Drewsey Formation. The suggestion is that the Grassy Mountain Formation (at least in part) is equivalent to the Drewsey and that the beds containing the undisturbed Little Valley localities are slightly younger. There can be no question that they are younger than the Grassy Mountain Formation at that point but the correlation with the Drewsey is certainly tentative. Probable stratigraphic relationships with the section to the east of Little Valley are discussed under the heading of the Idaho localities.

All of the matrix from Little Valley locality 2516 was disaggregated and passed through 24 mesh screen. Equal volumes of matrix were handled as subsamples in the same way as those from Black Butte and Bartlett Mountain (UOloc 2500 and 2517) described above and in Wilson (1965). Table 3 includes a list of the taxa present at the Little Valley localities. UOloc 2516 is the quantitative sample.

BLANCAN

GRAND VIEW

One of the basic elements of the original design of the program of research, of which this report is a part, was the maintenance of stratigraphic and time controls independent of the paleontological data. Stratigraphic super-

TABLE 3

LITTLE VALLEY—JUNIPER CREEK

	2516 Little Valley	2380 Little Valley	2451 Juniper Cr.	2469 Juniper Cr.
INSECTIVORA				
Shrew	X			
Shrew	X			
Scapanus (X) proceridens	X	X		
LAGOMORPHA				
Hypolagus vetus	X	X	X	X
RODENTIA				
Spermophilus cf. *wilsoni*			X	X
Spermophilus sp. A.	X			
Spermophilus sp. B.	X			
Dipoides vallicula	X			
Dipoides stirtoni		X	X	X
Peromyscus cf. *pliocenicus*	X			X
Peromyscus cf. *esmeraldensis*	X			
Peromyscus antiquus	X			
Peromyscus valensis	X			
Microtoscoptes disjunctus			X	
Perognathus sp.	X			
Diprionomys parvus	X			X
Pliosaccomys cf. *magnus*	X			
CARNIVORA				
Canis davisi	X	X		X
Indarctos oregonensis			X	X
Martes (*Plionictus*) *oregonensis*	X			
Pseudaelurus sp.			X	
Machairodont				X
PERISSODACTYLA				
Pliohippus spectans		X	X	X
Teleoceras or *Aphelops*			X	
ARTIODACTYLA				
Prosthennops sp.			X	
Procamelus sp.			X	
Megatylopus sp.		X	X	X
Sphenophalus sp.			X	X

position of the steps in the sequence was thus a goal. In searching for sites representing a post-Hemphillian step within the Pliocene, several areas within or contiguous to the geographic region of the earlier sites were examined. Two of these were within the area and were thus most attractive for the reasons noted above. In both of these areas field examination and small collections of fossils revealed what appeared to be typical late Pleistocene beds immediately overlying Hemphillian deposits. Thus the desired late Pliocene segment of the record was apparently missing. Because of this a third area, contiguous to our area of study was examined. Previously published work indicated that the type of samples required could be obtained there. This area consisted of the western portion of the Snake River Plain in Idaho, just east of our controlled region. Dr. Norman Anderson of the University of Puget Sound was then preparing a geologic map in the western portion of the area which included most of the known occurrences of the Grand View Fauna. Drs. Harold Malde and Howard Powers were carrying on a large scale detailed mapping program on to the east so that the major problem of extending into this area was significantly reduced by this geologic work. Thus in 1958 we turned our attention to the Snake River region and set up a field camp near Castle Creek just north of state highway 45. From this base camp sites at Castle Butte, Wild Horse Butte and Jackass Butte were established and excavated. During the course of this work David Tillson of the University of Utah brought to our attention several sites southeast of this area.

The oldest sediments exposed locally are those of the Clarendonian Poison Creek Formation. They are overlain by the Hemphillian Chalk Hills Formation which is in turn overlain by the late Pliocene Glenns Ferry Formation in which our sites were established. This sequence parallels that to the west in Oregon where our previous and subsequent work has been done. The Poison Creek Formation may in fact represent the uppermost part of the Deer Butte Formation from which earlier samples in the sequence were collected (Shotwell 1968, Kittleman *et al.* 1965, 1967). Small collections from the Poison Creek Formation appear close to those from the Clarendonian

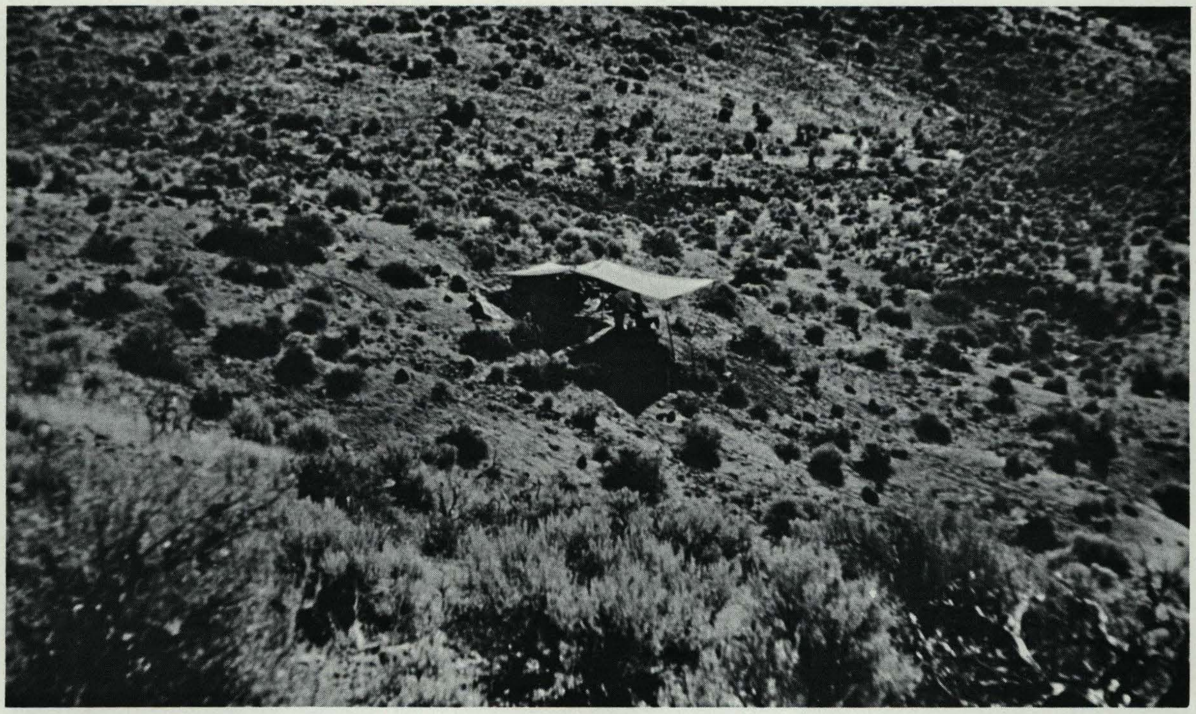


Figure 4. *UOloc 2469, Juniper Creek Canyon.*

Juntura Formation and those from the Chalk Hills Formation close to those from the Hemphillian Drewsey Formation also in the Juntura Basin. There seems little doubt that the Glenns Ferry Formation represents a subsequent step to our earlier portion of the sequence, both on geologic and paleontologic grounds even though our strict superpositional requirements are not clearly met.

Dr. Anderson's work and map have not been published. His preliminary map, which he made available to us, was of considerable help since it allowed us to restrict the area of our investigations thus saving considerable time and effort. His formational terms are, however, not available. Drs. Malde and Powers visited our field camp and discussed many of the local problems of the area in terms of their knowledge of them during the early stages of their work. Dr. Malde has also been of assistance in later conversations. Their detailed work was, however, east of the immediate area of our interest although the formational names they used are applicable. Our localities were all within the Glenns Ferry Formation (Jackass Butte Formation of Anderson).

At this point the Snake River flows northwesterly. The Glenns Ferry Formation is exposed in a relatively narrow strip along both sides of the river. Our investigations were restricted for the most part to the exposures available from Jackass Butte northwest to Wild Horse Butte, a distance of about eight miles. Castle Butte is about midway between these two features. Less extensive work was carried on in the areas of Shoofly Creek, Sand Point and Hagerman to the east and Sands to the west.

UOloc 2393 was established on a small hill about one mile southeast of Castle Butte. The sediment here was a clay, probably bentonitic considering its reaction in water. Bags of sediment were removed and washed using fifty screens of 14 x 18 mesh wire. Disaggregation was rapid and complete. A very large sample was obtained in a week. Several other sites were investigated on the eastern slope of Castle Butte. These did not show promise of providing useful quantitative samples. Our efforts were then directed towards the location of a

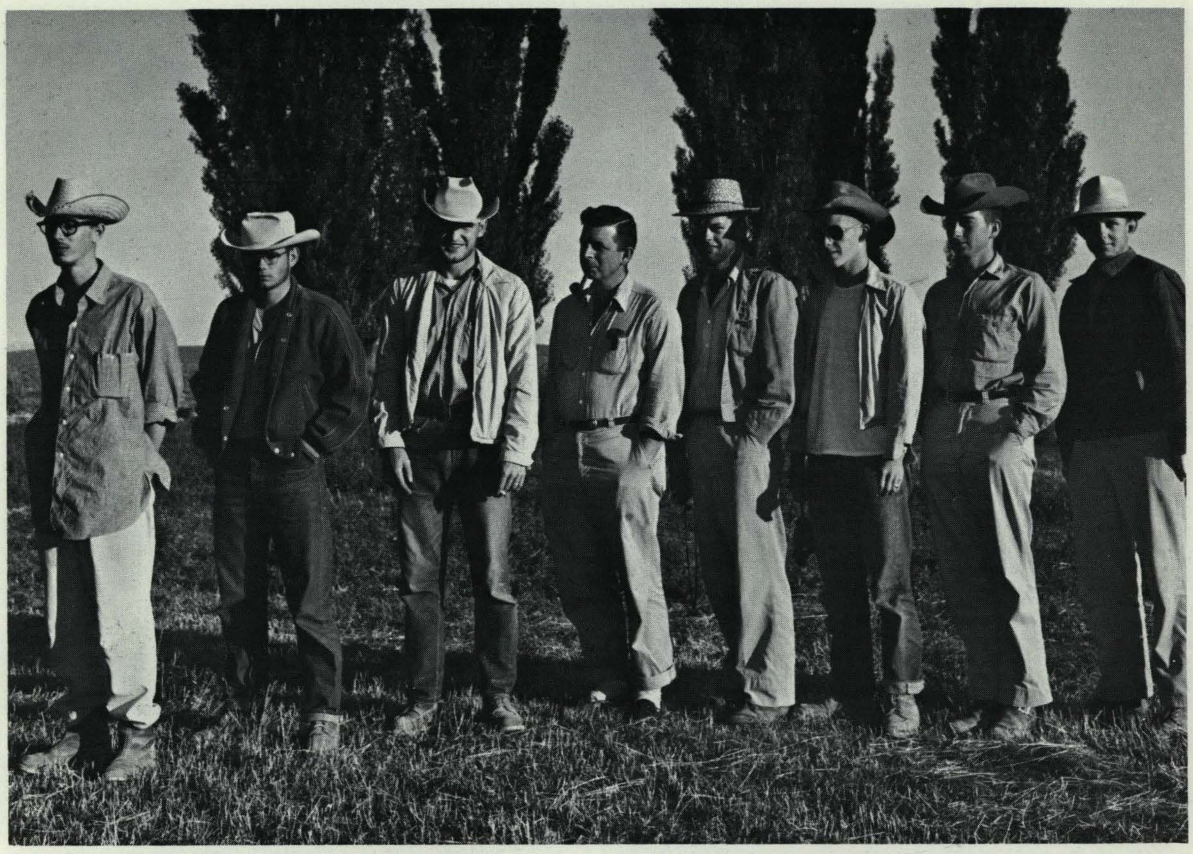


Figure 5. *Idaho crew 1958. Left to right: Crafts, Bigelow, Shininger, Shotwell, Jacklet, Wilson, Russell, Brown.*

site which would provide a sample representing the more terrestrial aspects of the fauna particularly the horses. A quarry was started on the south side of Wild Horse Butte (UOloc 2396) which at its early stages appeared to be producing the type of sample sought. However, after considerable work had been put into it several observations suggested that it might not be useful. Many of the specimens appeared to be water-worn, or to have been preserved in more than one sedimentary environment. Fragments of sediment from some other source were also present. These points suggested that the concentration had in part accumulated from secondary deposition of material exhumed from some nearby site by erosion. There was no reason to believe that materials from more than one geologic age were involved but it was clear that very possibly several depositional environments might be represented. With no apparent means of segregating these elements the quarry was abandoned. At this point the face was fifty-two feet across and about six feet high. Although it was felt that the quarry could not provide a useful quantitative sample the specimens were retained for their morphological value. Several other nearby sites were tested but discarded.

At this point we turned our attention to Jackass Butte. Searching and testing began at the southerly tip and carried around the western side of the butte to less than a quarter mile of of the northern edge. Six localities were tested. Only UOloc 2404 appeared to have potential although UOloc 2403 nearby was also excavated. Locality 2404 was in a poorly sorted and highly cross-bedded sand. A large quarry was excavated, ninety-five feet across the face and eleven feet deep. It was not practical to screen the entire tailings from this site, how-

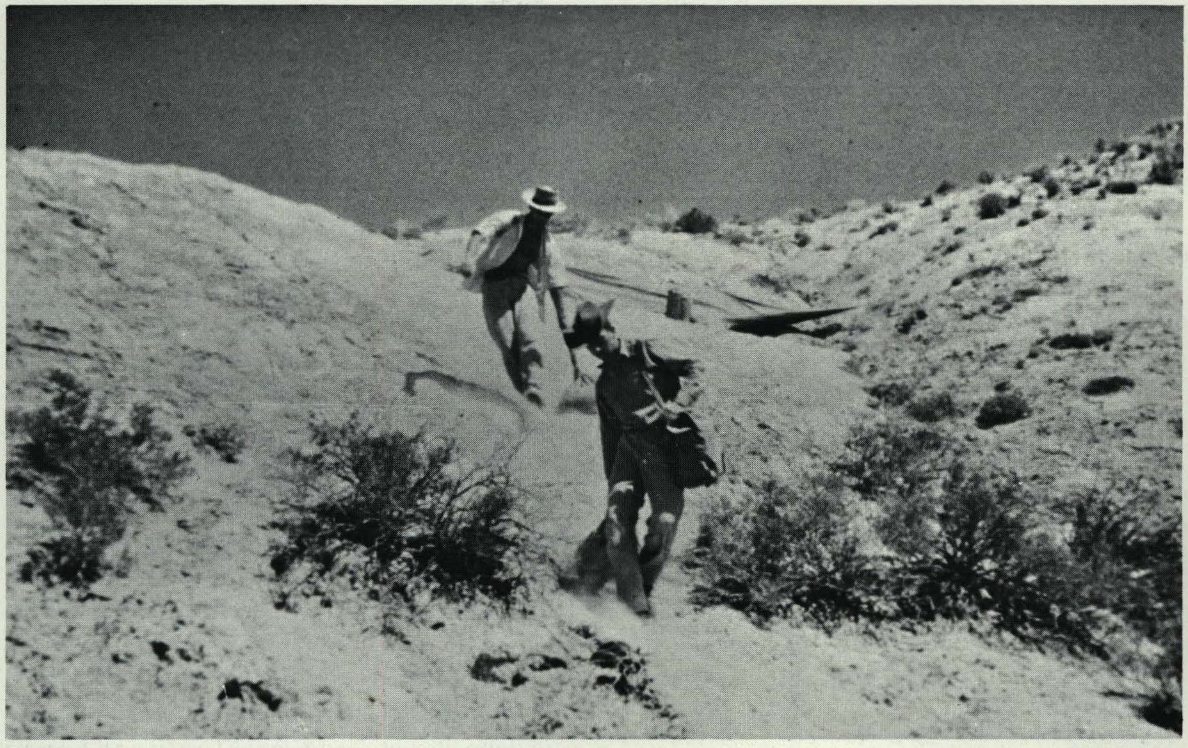


Figure 6. *UOloc 2393, Castle Butte, Grand View Fauna.*

ever, a significant portion was entirely dry screened to provide a quantitative sample and kept separate from the remainder of the material from the site. Dry screening was conducted using a series of screen sizes in order to simplify picking. The tailings were passed through 4 mesh, then 8 mesh, then 16 mesh screen which expedites a tedious job.

Two large quantitative samples were thus obtained, Castle Butte 2393, and Jackass Butte 2404. One additional large sample was obtained from Wild Horse Butte 2396, but was not considered reliable as a quantitative sample. A number of lesser sites were established in all three areas.

A faunal list of the Grand View Fauna as represented by these localities is presented (Table 4). The two large samples are shown as different aspects of the same fauna. Discussion of the quantitative characteristics of the samples will be presented separately, and in a more appropriate context.

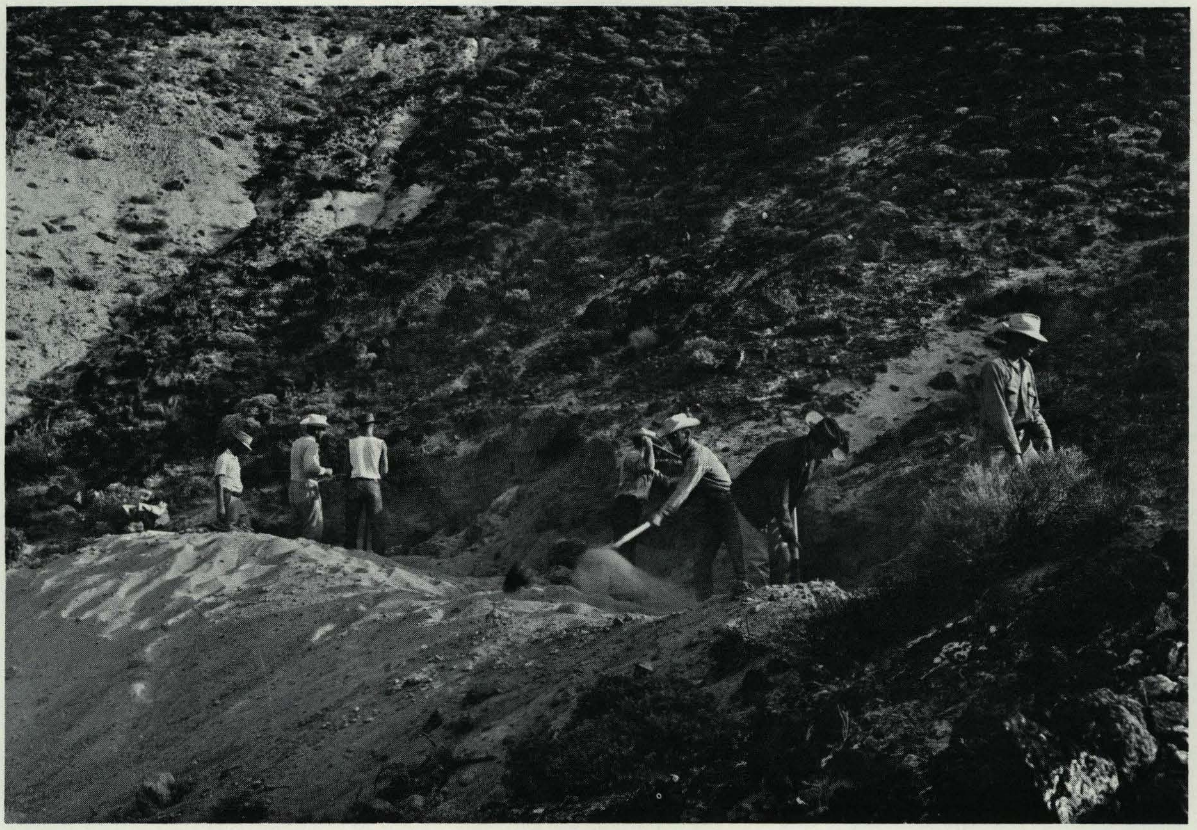
The Grand View Fauna provides a useful last step in our late Tertiary sequence. Although it is not within the limited geographic area set aside for our studies it is close by and stratigraphic controls are present even though they are not as rigorous as is desirable for the purposes of this work. Future work may well indicate that the controls are more direct than I have indicated here. The presence of *Plesippus, Stegomastodon, Procastoroides, Borophagus, Hypolagus* and *Titanotylopus* indicate that its age should be considered Blancan. However, for the purposes of this project it does not matter what the age designation is as long as the superpositional relationship of the faunas used is assured. Many statements have long been present in the literature as well as more recent statements which lead me to believe that it would be useful to briefly discuss the nature and chronologic position of the Grand View Fauna. We now have available a much more complete picture of this fauna which allows a better basis for such comparisons.

TABLE 4
GRAND VIEW FAUNA

	Castle Butte 2393	Wild Horse Butte 2396	Jack-ass Butte 2404	Other
EDENTATA				
Megalonyx leptonyx		X	X	
INSECTIVORA				
Shrew	X		X	
Scapanus sp.	X			
LAGOMORPHA				
Hypolagus furlongi	X	X	X	
RODENTIA				
Procastoroides idahoensis	X			X
Castor accessor		X	X	
Spermophilus sp.			X	
Thomomys		X		
Dipodomys	X			
Synaptomys vetus	X	X	X	
Ophiomys parvus	X	X	X	
Pliopotomys idahoensis	X	X	X	
Erethizon bathygnathus			X	
CARNIVORA				
Canis sp.			X	
Borophagus sp.			X	
Trigonictis cooki	?		X	
Trigonictis idahoensis			X	
Lutra (S) ingens			X	
Felis lacustris			X	
? Ischyrosmilus idahoensis		X	X	
PROBOSCIDEA				
Stegomastodon mirificus		X	X	
Mammut sp.				X
PERISSODACTYLA				
Plesippus idahoensis		X	X	
ARTIODACTYLA				
Platygonus sp.		X	X	
Tanupolama sp.		X	X	
Titanotylopus sp.			X	
Cervus sp.		X	X	
Antilocaprid sp.				X

The Grand View Fauna has been most frequently compared with the Hagerman Fauna which occurs seventy miles to the east. The recent work of Malde and Powers (1962) places the localities for both faunas within the Glenns Ferry Formation. The proximity of the Hagerman suggests that the relative stratigraphic occurrences of the two faunas may be determined as well as taxonomic comparisons free of biogeographic differences.

Hibbard and Zakrewski (1967), in attempting to establish a time sequence for occurrences of *Ophiomys* within the Glenns Ferry Formation, state that Malde and Powers (1962) ". . . were able to show that the deposits containing the lower 400 feet of floodplain facies in the area of the Hagerman Horse Quarry were lower in the stratigraphic section than the deposits at Sand Point from which the fossils were recovered." Malde and Powers (1962, p. 1207) statement was "The lower 400 feet of flood plain facies at Hagerman grades westward into a lacustrine facies at Deer Gulch 8 miles southeast of Glenns Ferry and into arkosic deposits between Clover Creek and Glenns Ferry. These arkosic deposits are overlain by 650 feet of lacustrine facies at Glenns Ferry. A floodplain facies in the upper part of the northern canyon wall at Glenns Ferry grades southwestward into the fluviatile facies at Hammett." The Sand Point localities, USGS 19128 (DWT 406). USGS 19129 (DWT 407) and UOloc 2405 are south of Hammett across the Snake River in this upper fluviatile facies. Malde and Powers (1962, p. 1209) also state that "A few vertebrates have been found at Hagerman in the lower exposures that are laterally equivalent to the lacustrine facies at Deer Gulch (Hibbard, 1959, locs. 19217 and 20765) but the principal collections are from the 'Hagerman horse quarry' in beds stratigraphically high." The localities referred to by Hibbard and Zakrzewski (1967, p. 268) in their Table 1 (USGS 19216 and UM-Ida.la-65) are in these upper beds which include the horse quarry. It appears then that the horse quarry, Hagerman localities (USGS 19216 (DWT 431) = UO 2437 = UCV5523 and UM-Ida.la-65 and the San Point localities previously listed are all stratigraphically above the



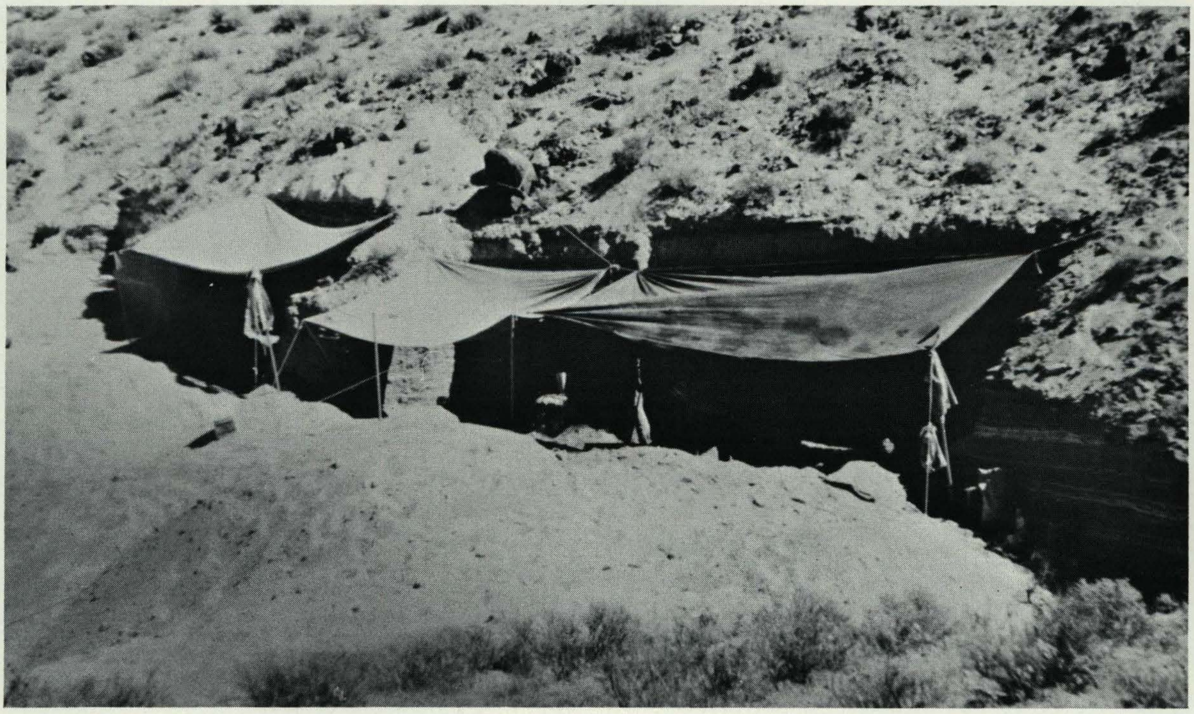


Figure 7. *Upper UOloc 2396, Wild Horse Butte, lower UOloc 2404, Jackass Butte. Both Grand View Fauna.*

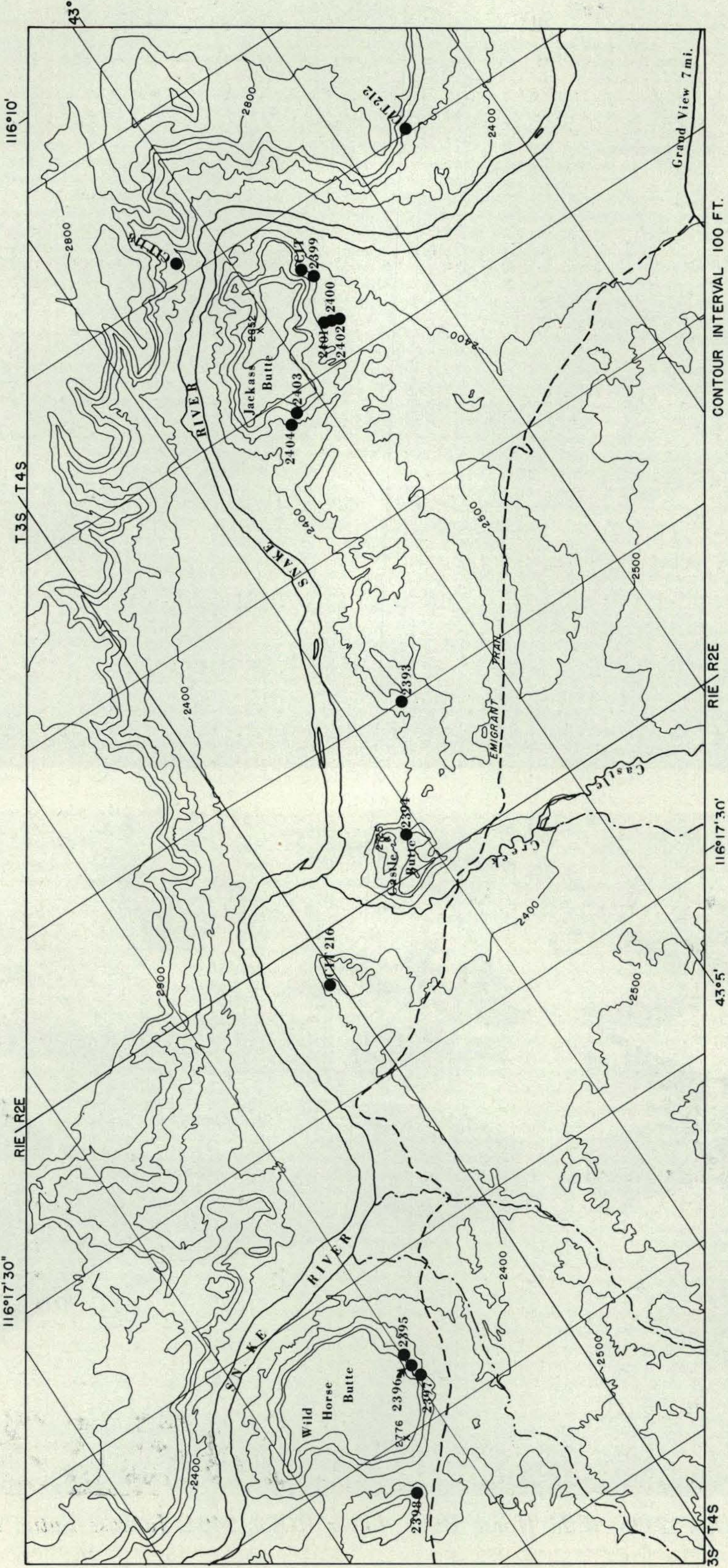


Figure 8. *Locality Map, Grand View Fauna localities. CIT localities approximated from field notes.*

lower beds traced by Malde and Powers. There is apparently no demonstrable stratigraphic difference in their occurrence. The Sand Point localities may be slightly older, slightly younger or equivalent to those adjacent to the Hagerman horse quarry. Although the Grand View Fauna localities are also in the Glenns Ferry Formation their relative position stratigraphically to those at Sand Point and Hagerman has not been established. The distance between the Sand Point exposures and Jackass Butte is over thirty miles. Malde and Powers (1962, p. 1207) describe the nature of the facies of the Glenns Ferry Formation in the Grand View-Castle Creek area but do not attempt to relate them to similar facies at Hammett and Hagerman. Their more detailed map (Malde, Powers and Marshall 1963) does not extend as far west as Grand View. One might conclude from Malde and Powers (1962, p. 1206) that the fluviatile facies northwest of Grand View is the same as that at Hammett, thus equating beds in the Sand Point and Jackass Butte areas, however, it is not clear that this is the intent in their remarks.

The presently available published geologic evidence indicates that the main Hagerman localities and the Sand Point localities are both above a lower unit which has been traced between the two areas. The relative stratigraphic position of the Grand View localities within the same Glenns Ferry Formation has not been definitely established but could be close to that of the Sand Point and the major Hagerman sites. Malde and Powers (1962, p. 1209) assigned to Glenns Ferry Formation to the late Pliocene and early Pleistocene simply to reflect the diversity of opinion among paleontologists not as a conclusion based on their own work. Although the available evidence does not allow a conclusion as to the relative stratigraphic positions of the Grand View, Sand Point and majority of the Hagerman localities within the Glenns Ferry Formation, it appears that no matter what these relative positions are they are close and the time differences represented between them must be very small.

Faunal comparisons between the two major areas are also inconclusive. At this stage of our knowledge it appears that over seventy-five percent of the genera found in the Grand View Fauna also occur in the Hagerman. When recent work in the Hagerman is available the percentage will probably be even higher. *Procastoroides, Synaptomys, Erethizon, Stegomastodon* and *Titantylopus* of the Grand View Fauna have not yet been reported from the Grand View.Hagerman. Conversely *Blarina, Ailepus, Peromyscus* and *Cosomys,* previously reported from the Hagerman, do not appear in our samples from Grand View. Although additional genera may be added to these lists it is likely that the size of the lists will be reduced through new information since a number of the genera represent relatively rare or ecologically restricted forms. The taxonomic differences between the two faunas will thus be largely at the species and subspecies level.

Previous estimates of the relative ages of the Grand View and Hagerman faunas have been dependent on the presumed relationships of the horses from those sites. Even here there has been a certain amount of confusion which I have attempted to clear up under the appropriate heading in the systematics section of this paper. The conclusion expressed there indicates that the chief difference is in relative body to head size and does not provide a basis for concluding any age difference in the two species. Comparisons have also been made previously between the species of *Ophiomys, Pliopotamys* and some of the carnivore genera common to the two faunas. The nature of these is described and discussed in detail in the systematics section. The evaluation of the minute differences between the species or subspecies involved is indirectly dependent on the presumption that the horses demand an age difference and thus tend to be circuitous. The differences that do exist between these species are of the nature of the frequency of occurrence of minute characteristics and suggest close approximation to the type of differences seen in contemporaneous species occupying a variety of local habitats. Relative abundance figures are not available for the Hagerman Fauna but it appears that such forms as the antelopes and peccaries are much more common there than in the Grand View Fauna where they are relatively rare. If in addition the lack of *Procastoroides, Synaptomys* and *Erethizon* in the Hagerman Fauna are real than it is suggested that significant habitat difference were present.

My conclusion is that if there is an age difference between the Hagerman and Grand View Faunas it must be small and that the primary source of the difference that can be demonstrated between these two faunas reflects local environmental variations.

TABLE 5

MEASUREMENTS OF THE DENTITION OF *Hesperolagomys* cf. *galbreathi*

BLACK BUTTE FAUNA

		AP	Tr
P_4	UO25685	1.80	1.42
$M_{1 \text{ or } 2}$	UO24726	2.25	2.52
$M_{1 \text{ or } 2}$	UO25727	2.15	2.47
$M^{1 \text{ or } 2}$	UO25728	3.24	1.58
P^2	UO25730	1.68	1.05

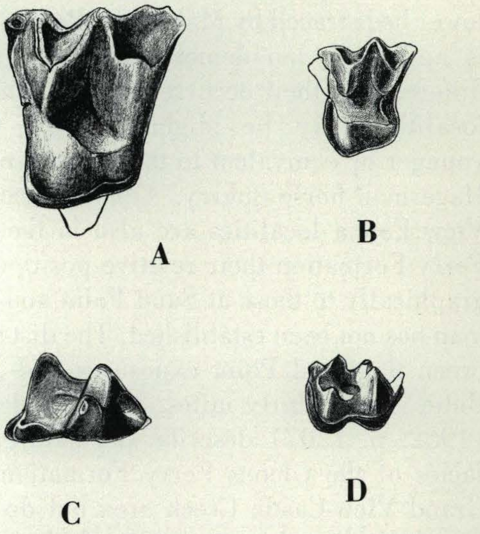


Figure 9. ?Vespertilionidae, **A** sp.B UO26203 $M^{1 \text{ or } 2}$ occlusal view Little Valley UOloc 2516, **B** sp.A UO26206 $M^{1 \text{ or } 2}$ occlusal view Little Valley UOloc 2516, **C** sp.B UO26204 $M_{1 \text{ or } 2}$ occlusal view Little Valley UOloc 2516, **D** UO25293 $M_{1 \text{ or } 2}$ occlusal view Black Butte UOloc 2500, all x 10.

SYSTEMATICS

ORDER CHIROPTERA

SUBORDER MICROCHIROPTERA

FAMILY ?VESPERTILIONIDAE

Genera and species indet.

A lower first or second molar (UO25293) from Black Butte locality 2500 represents a bat similar but smaller than the brown bat *Eptesicus fucus bernardinus.*

Genus and species indet. A

A mandible fragment (UO27533), a lower first or second molar (UO26345) and an upper first or second molar from Little Valley locality 2516 all represent a small bat similar to that found at Black Butte locality 2500.

Genus and species indet. B

A lower first or second molar (UO26204) and an upper first or second molar (UO26203) from Little Valley locality 2516 represent a bat slightly larger than the brown bat *Eptesicus fucus bernardinus.* It is similar in those characteristics available in the molars.

ORDER EDENTATA

SUBORDER XENARTHRA

FAMILY MEGALONYCHIDAE

Genus and species indeterminate

A first phalanx of a small sloth (UO23275) was recovered from the Hemphillian Otis Basin locality 2347. Similar foot elements are known from a number of Hemphillian localities in Oregon including; Rattlesnake, Westend Blowout, Boardman and Krebs Ranch.

MEGALONYX LEPTONYX ? (Marsh)

A palate fragment (UO17842) from Wild Horse Butte (UOLoc 2396) and an upper cheek tooth (UO16295) from Jackass Butte (UOLoc 2404) apparently represent *Megalonyx leptonyx.* This species was originally described from a claw presumed to have come from Castle Creek within the area of the localities producing the Grand View fauna. Since direct comparisons are not possible the assignment is tentative.

Gazin (1935) assigned a partial lower jaw from the Hagerman locality to *Megalonyx leptonyx?* and reviewed the occurence of the type specimen.

ORDER LAGOMORPHA

FAMILY OCHOTONIDAE

HESPEROLAGOMYS cf. *GALBREATHI*

Three lower molars and an upper fourth premolar, all rooted teeth, represent a large ochotonid in the Black Bute sample from locality 2500. The specimens compare closely with *Hesperolagomys galbreathi* Dawson (Clark, Dawson, and Wood 1964) but appear to be somewhat larger. In the lower molars the posterior loph is considerably smaller than the anterior loph. Enamel failure is present on the anterior face of two specimens (UO25727, UO25726) the third specimen, UO25685, may possibly be a deciduous tooth since the roots are well separated and divergent. The two roots of the other molars are partially fused through much of their length. The upper premolar, UO25728, is well worn. It has one large root and a very small internal root. As in *Hesperolagomys* from Fish Lake Valley of Nevada there is a chevron-shaped fossette. The hypostria has been worn away leaving a small fossette situated just anterior and labial to the larger fossette. Measurements of the dentition are presented in Table 5.

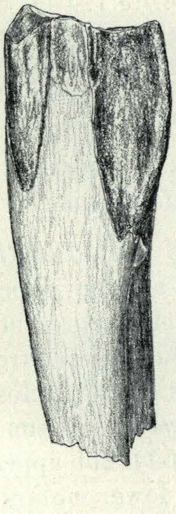
FAMILY LEPORIDAE

HYPOLAGUS cf. *FONTINALIS*

Isolated teeth and skeletal elements of a species similar in size to *H. fontinalis* occur in the sample from Black Butte UOLoc 2500. The lack of a mandible or P_3 does not allow closer assignment.

HYPOLAGUS VETUS

The most abundant mammal in the Little Valley sample from locality 2516 is *Hypolagus vetus.* All elements of the dentition and skeleton are represented. Dawson (1958) has described the skeleton of this species. She, however, did not have available complete enough



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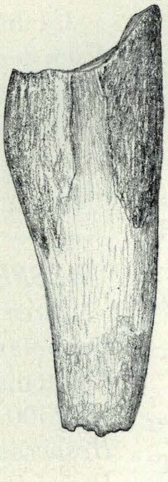

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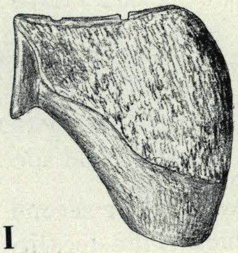

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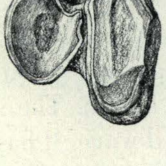

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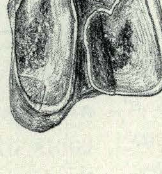

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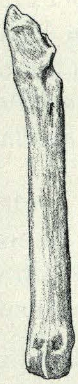

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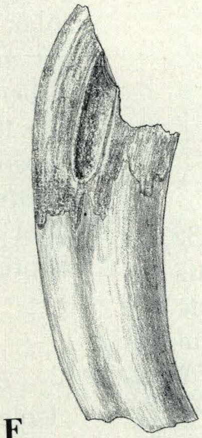

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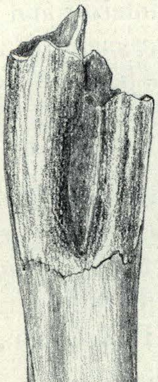

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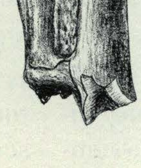

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metatarsals or metacarpals to determine the relative lengths of these elements. The Little Valley sample (UOLoc 2516) includes a complete first metatarsal and specimens of all the other metatarsals and metacarpals lacking only the distal articular surface. When compared with *Lepus californicus* the metapodials are all proportionately shorted in *Hypolagus vetus*. Dawson found the tarsals and carpals of *Hypolagus vetus* to be short proximodistally. This strengthens Dawson's conclusion that "*H. vetus* was less cursorially adapted than *Sylvilagus* but probably had a somewhat similar bounding mode of locomotion."

HYPOLAGUS VETUS

A P_3-P_4 in a mandible fragment, isolated teeth and skeletal elements represent this species in the samples from Juniper Creek Canyon (UOLoc 2451 and 2469).

HYPOLAGUS sp.

A number of isolated teeth, tooth fragments, and fragmental skeletal elements are present in the Bartlett Mountain sample from locality 2517. Possibly two species are represented as indicated by size but no definite assignments can be made.

HYPOLAGUS FURLONGI

This well known species is well represented in the collections from the Grand View Fauna, Jackass Butte locality 2404, and Wild Horse Butte locality 2396. It also occurs at Castle Butte locality 2393.

Figure 10. **A-J** *Hesperolagomys* cf. *galbreathi* Black Butte UOlocl 2500 **A** UO25727 lower molar anterior view **B** occlusal view, **C** lateral view, **D** UO25726 lower molar anterior view, **E** occlusal view, **F** medial view, **G** UO23685 lower deciduous tooth lateral view, **H** occlusal view, **I** UO25728 P^4 posterior view, **J** occlusal view, all x 7.5, **K** *Lepus californicus* UO 8271 MT I x 1.4, **L** *Hypolagus vetus* UO27619 MT I Little Valley UOloc 2516 x 1.4.

ORDER RODENTIA

SUBORDER PROTROGOMORPHA

SUPERFAMILY ALPLODONTOIDEA

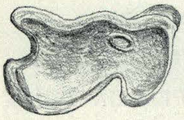
FAMILY APLODONTIDAE

TARDONTIA cf. *OCCIDENTALE*

This species is poorly represented at locality 2500 of the Black Butte fauna. A fragmental lower fourth premolar, UO25264, consists of the anterior moiety only. There is an anteroflexid present the full length of the enamel on the anterior face of the tooth. A lower third molar, UO25265, is complete. There is an open metaflexid the full length of the posterior border of the tooth. A metafossetid is present. There is in addition a very small pit near the anterior border of the tooth but I cannot determine if it is surrounded by enamel. The enamel is entire at the occlusal surface of the tooth. A wedge of enamel failure is present on the anterior face of the tooth extending within a short distance of the occlusal surface. The stylids are not strongly developed as in *Aplodontia* but appear as local waves in the enamel. The tooth has two roots, the posterior one is much the larger. An upper third molar, UO-25266, has the assymetric occlusal outline seen in *Liodontia*. There is a small anterofossette present at the stage of wear of this specimen. There is also a well developed mesostyle. Enamel failure is evident on the anterior face of the tooth. Two roots are present. The anterior one is larger.

Upper teeth have not previously been assigned to *T. occidentale*. The presence of fossettes and fossettids on the upper and lower third molars accompanying only a moderate crown height suggests that the Black Butte species might be somewhat lower crowned than *T. occidentale*. However, third molars are typically lower crowned in rodents and this may account for the apparent difference.

In *Pseudaplodon* the metaflexid of the lower third molar is not as deep or persistent as in *T. occidentale*. The molars are also much broader for their length than in *T. occidentale*.



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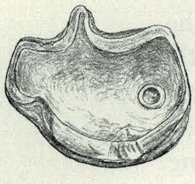

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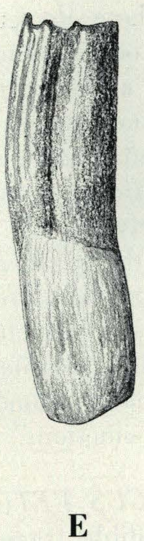

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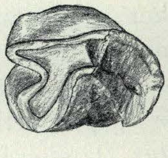

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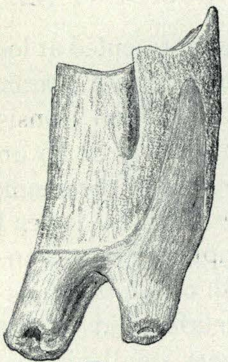

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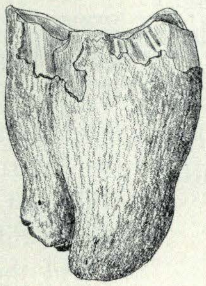

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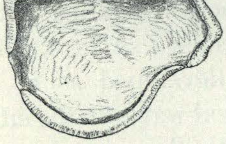

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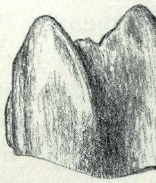

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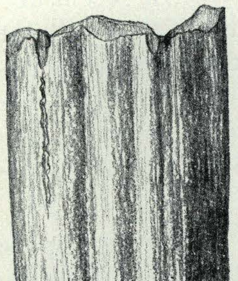

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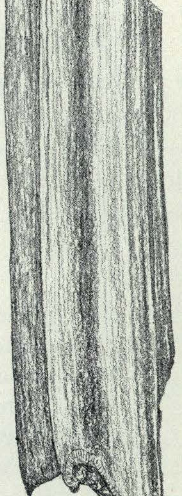

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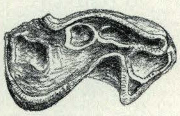

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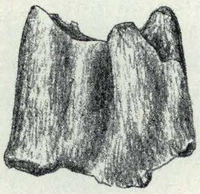

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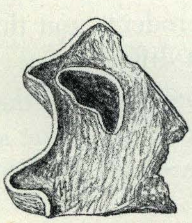

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TARDONTIA sp.

At Bartlett Mountain, UOLoc 2517, *Tardontia* is first known in a Hemphillian species. A number of isolated specimens are present which reveal many of the details of the dentition. However, a new name should wait on more nearly complete material.

LOWER DENTITION: Three deciduous lower fourth premolars are present and represent three stages of wear. One, UO24951 is well worn, another, UO27534, is an unerupted tooth while the last, UO25188 is a moderately worn specimen. The paraconid and protoconid are opposite each other and the most prominent cusps of the tooth. They are well separated anteriorly by a well developed anteroflexid, and join only at their posterior borders. The anteroflexid extends well down the anterior face of the tooth at which point it is blocked by an anteroconid extending from the protoconid. A similar development is present in the deciduous lower fourth premolar of *Aplodontia.* A small basin is formed by the blockage. On the well worn speciment there is no evidence of the anteroflexid but there is an anterofossetid which represents its lower closed off extension. The paraconid and protoconid are thus completely joined and cannot be identified in late wear. Three antero-posteriorly aligned fossetids are present in the posterior moiety of the moderately worn tooth. They apparently represent the remaining segments of the meso and metafossetids. A distinct hypofossettid is not present on the unworn specimen. There is no evidence of fossetids on the posterior moiety of the well worn specimen. The lower deciduous fourth premolar is elongate antero-posteriorly.

Figure 11. **A-F** *Tardontia* cf. *occidentale* Black Butte UOloc 2500, **A** UO25265 M_3 occlusal view, **B** lateral view, **C** UO25266 M^3 occlusal view, **D** medial view, **E** UO25264 anterior half P_4 anterior view, **F** occlusal view, **G-O** *Tardontia* sp. Bartlett Mountain UOloc 2517, **G** UO 25190 P^4 occlusal view, **H** medial view, **I** UO25186 DP^4 occlusal view, **J** UO25189 P_4 occlusal view, **K** lateral view, **L** UO25188 DP_4 occlusal view, **M** lateral view, **N** UO27536 $M^{1 \text{ or } 2}$ occlusal view, **O** anterior view, all x 7.5.

The lower fourth premolar is represented by a single unworn specimen, UO25189. The tooth column is broken so that the total height of crown cannot be determined. The paraconid and protoconid are well separated by an anteroflexid which extends to at least the broken point on the column. There is a well isolated mesoflexid. The remainder of the posterior moiety of the tooth is a large basin, only partially subdivided by two short lophids eminating from the lingual side. The hypoconid and entostylid appear as local elevations in the outer tooth enamel. The entostylid appears on the entire tooth column as a prominent posteriorly directed feature. A narrow wedge of enamel failure extends up the posterior face of the tooth but does not reach the occlusal surface at the existing stage of wear.

The lower molars are represented by labial and lingual tooth column fragments. They indicate that enamel failure is well developed on both anterior and posterior faces and that the teeth are high crowned and apparently rootless.

UPPER DEFINITION: The deciduous upper fourth premolar is represented by three specimens, none of which is complete. UO25186 is the most nearly complete but is well worn. Also present are fragments consisting of the anterior portion of the tooth. On the more complete specimen only the parafossette remains of the original suite of fossettes. The parastyle and mesostyle are well developed. The tooth is triangular in occlusal outline.

The upper fourth premolar is represented by a single adult specimen, UO25190. No fossettes remain on the occlusal surface at the stage of wear represented. The tooth is high crowned. The parastyle and mesostyle are well developed but have enamel failure on their extreme labial edges. Enamel failure, consisting of a narrow band of exposed dentine, occurs on the posterior face of the tooth. It is one half the width of the flattened portion of the posterior face. Another very narrow strip of enamel failure extends down the lingual side of the tooth immediately opposite the parastyle. The tooth column is broken but that portion which is present indicates a high crowned tooth probably evergrowing. The anterior portion of this tooth differs in occlusal outline from *Liodontia furlongi.* In *Tardontia* sp. the anterior border of the tooth, in occlusal view, is a continuation of the anterior border of the parastyle. In *Liodontia* there is a definite base to the anterior face of the parastyle. The labial edge of the tooth extends antero-lingually to its most anterior point at approximately a 45° angle with the antero-posterior axis of the occlusal surface of the tooth. The comparable face in *Tardontia* sp. is at a greater angle to the anterio-posterior axis-approximately 60°. From the most anterior point the occlusal outline of the tooth of *Liodontia furlongi* continues in a gradual curve postero-lingually to the broadest point on the tooth, about half the length of the tooth. In *Tardontia* sp. the border is concave in its anterior portion. The broadest point of the tooth is very near the posterior border.

The upper first or second molars are represented by only a single nearly complete specimen UO27536. As in *Liodontia* the anterior face of the upper first and second molars is much narrower than the posterior face. In both *Tardontia* sp. and *Liodontia furlongi* there are broad strips of exposed dentine on the anterior and posterior faces. The lingual border of the upper molar in *Liodontia* is symmetrically crescentic whereas in *Tardontia* sp. the border is curved but asymmetric. The labial border of the tooth is more nearly symmetrical in *Tardontia* sp. than in *Liodontia furlongi.* Both *species* have high crowned ever-growing teeth, well shown in the upper molars.

DISCUSSION: The species of *Tardontia* from the Barlett Mt. Fauna differs from the *Aplodontia* in the lack of well developed mesostylids on the lower premolar and molars. The Bartlett Mt. species has high crowned and ever-growing teeth while *Pseudalodon* has rooted teeth. The new species may represent a new genus but in keeping with the example of *Liodontia* in which the Barstovian *L. alexanderae* has closed pulp cavities and the Hemphillian *L. furlongi* has ever-growing teeth it does not seem advisable to erect a new genus until at least associated dental elements in a mandible are available.

SUBORDER SCIUROMORPHA

FAMILY SCIURIDAE

SPERMOPHILUS JUNTURENSIS (Shotwell & Russell 1963)

Citellus junturensis Shotwell & Russell 1963
Ammospermophilus ?sp. Black 1963

The priority of *Spermophilus* over *Citellus* has apparently been established by Hall and Kelson (1959) and is followed here. Black (1963) assigned the lower jaws available at the time of his work to *Ammospermophilus* ?sp. It is my feeling that many of the characteristics of *Ammospermophilus* seen in this material are simply "primitive" and might be expected in a small early spermophile. The lack of longitudinal grooves on the incisors, although present in contemporary sciurids in the Black Butte Fauna, the broad base of the infraorbital foramen and the relatively complete trigonid basins of the lower molars all argue for assignment to *Spermophilus.*

SPERMOPHILUS sp. A

A medium sized ground squirrel, comparable to the living golden mantle ground squirrel and the Hemphillian *S. gidleyi* and *S. argonautus* in size, is present in the Little Valley fauna (UOLoc 2516). The lower dentition is well represented but only three upper molars are available.

LOWER DENTITION: A fragmental mandible with all the molars present but well worn provides the only directly associated dental elements. However, one sub-sample included the lower cheek teeth from both left and right lower jaws. These teeth were apparently all from the same individual judging by the degree of wear and the character of the mandible fragments also present in the sample.

The two lower fourth premolars are either unerupted or possibly deciduous. They have no roots and consist primarily of the enamel caps. The parametaconid and protoconid are in contact and about equal in size. The hypoconid is expanded and much larger than the other cusps. The talonid basin is inflated and accounts for the nearly semicircular occlusal outline of the tooth. The ectolophid is medial to the labial margin of the tooth and rather straight. Mesoconid and mesostylid are absent. The entoconid is small but not entirely obscured by the posterolophid which terminates at that point.

The first molar is slightly smaller than the second and about as long as it is broad. The second molar is much broader than long. The protolophid is complete on both first and second molars and forms a slight protuberance at its contact with the protoconid, however, no external groove is present at that point. The metalophid is very short and poorly developed. A very small, almost indistinguishable, mesostylid is present on the second molars. The entoconid is not distinct. The posterolophid terminates at that point after gently curving from the hypoconid. The ectolophid is slightly curved and contains no mesoconid.

The third molars differs very little from the other molars. It is larger with length and breadth of the tooth nearly equal.

Lower incisors assigned to this species have finely crenulated enamel.

UPPER DENTITION: The upper first or second molar has a well developed anterior cingulum which joins the protocone abruptly. The parastyle is not distinct. The protoloph is complete and connects high on the protocone. The metaloph does not connect to the protocone. A distinct metaconule is not present. The posterior cingulum is strongly developed and connects high on the protocone. There is a small mesostyle present. The upper third molar also has a well developed anterior cingulum. No metaloph is present. The protoloph is complete and lacks a protoconule. The posterior cingulum is somewhat inflated but leaves a distinct groove at its junction with the protocone. The enamle of the upper incisors assigned to this species is finely crenulated.

Although this species is similar in size and in other general characteristics to *S. gidleyi* and *S. argonautus* it differs from both of these poorly known forms in its open trigonid basins in the lower molars. It, however, is assigned to *Otospermophilus.*

SPERMOPHILUS sp. B

A very small spermophile is also present in the Little Valley fauna (UOLoc 2516). It is represented by isolated teeth, a mandible fragment without teeth and a maxilla fragment containing the second and third molars.

LOWER DENTITION: No lower fourth premolar is present in the collection. The lower first or second molar is represented by a single abraded specimen (UO26259). On it the protoloph is complete. The metalophid is short and directed into the talonid basin. The ectolophid is strongly curved. There is no indication of a mesoconid or mesostylid. The entoconid is not distinct, its position is emphasized by the termination of the posterolophid at that point. The tooth is wider than long. The third lower molar is represented by several specimens. It is similar to the first or second molar but proportionately longer.

UPPER DENTITION: The upper fourth premolar exhibits an anterior cingulum nearly the full width of the tooth but expressed as a narrow shelf low on the anterior face of the tooth. A small parastyle is present and is reflected in a slight expansion of the anterior cingulum at that point. The protoloph is straight and connects high on the protocone. There is no protoconule. The metaloph is short and does not connect with the protocone until very late wear. A metaconule is present but not enlarged. The posterior cingulum is well developed and joins


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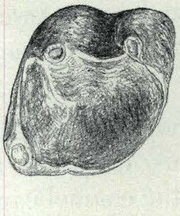
B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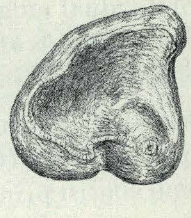
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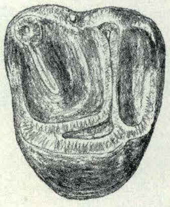
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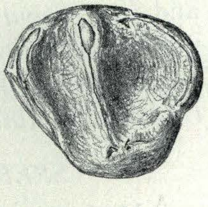
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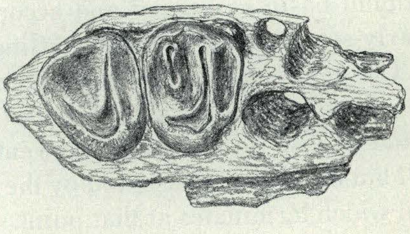
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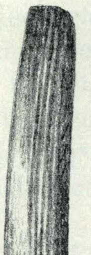
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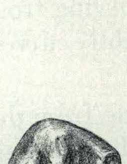
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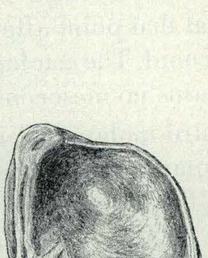

P

the protocone at a point high on it and resulting in a U with the protoloph. The paracone and metacone are closely spaced. No metastyle is present.

The upper first and second molars differ somewhat from the fourth premolar. The anterior cingulum is stronger and joins the protocone abruptly. There is an anterior valley. The connection of the posterior cingulum is more angular. All but one of the upper first and second molars possess a very small mesostyle. The upper third molar has no metaloph. The posterior portion of the tooth is not expanded and is triangular in occlusal outline.

DISCUSSION: This tiny squirrel is similar but smaller than *Spermophilus junturensis* from the Black Butte Fauna. It is in the size range of smaller living species of *Ammospermophilus*. The upper fourth premolar differ from living *Ammospermophilus* in the reduction of the anterior cingulum and parastyle. The protolophid on the lower molars is more complete than in *Ammospermophilus*. The mandible fragment consists of the posterior portion of the mandible beginning at about the position of the fourth premolar. It is shallower than *Spermophilus junturensis* and approaches living species in this characteristic.

Figure 12 **AF** *Spermophilus* sp. A Little Valley UOloc 2516, **A** UO27015 P_4 occlusal view, **B** UO27015 M_1 occlusal view, **C** UO27015 M_2 occlusal view, **D** UO27015 M_3 occlusal view, **E** UO26256 $M^{1 \text{ or } 2}$ occlusal view, **F** UO 27016 M^3 occlusal view, all x 10, **G-J** *Spermophilus* sp. B Little Valley UOloc 2516, **G** UO26248 $M^{2\text{-}3}$ occlusal view, **H** UO26246 M_3 occlusal view, **I** UO26247 M_3 occlusal view, **J** UO27624 P^4 occlusal view, all x 10, **K-L** *Spermophilus* cf. *wilsoni* Juniper Creek Canyon UOloc 2469, **K** UO-21715 $M^{1 \text{ or } 2}$ occlusal view x 5, **L** UO-21725 $M^{1 \text{ or } 2}$ occlusal view x 5, **M-P** *Eutamias* sp. Black Butte UOloc 2500, **M** UO27621 lower incisor anterior view x 7.5, **N** UO27620 upper incisor anterior view x 7.5, **O** UO 24888 P^4 occlusal view x 15, **P** UO24572 $M_{1 \text{ or } 2}$ occlusal view x 15.

SPERMOPHILUS sp. B

A small spermophilid with relatively low crowned teeth is present in the Bartlett Mountain Fauna. The lower dentition is poorly represented but a number of isolated upper cheek teeth give information concerning this species.

All of the lower molars in the collection are fragmental. One specimen reveals a complete protolophid and an apparent lack of a metalophid. A much reduced mesostylid is present. No entoconid is apparent. The posterolophid is smooth and rounded in occlusal outline, terminating at the mesostylid.

The upper fourth premolar exhibits a strong cuspate parastyle which is lower than the other labial cusps. The anterior cingulum is short. The protoloph is straight and connects high on the large protocone. No protoconule is present. The metaloph connects very low on the protocone. It terminates in a poorly developed metaconule. The posterior cingulum is strong and connects high and smoothly on the protocone. A small mesostyle, close to the metacone, is present.

The anterior cingulum of the first or second upper molar is prominent and joins the protocone low and with an abrupt change of direction. The parastyle is smaller than the other labial cusps. Other features are similar to those of the fourth premolar, however, no mesostyle is present. The anterior portion of the third upper molar is similar to that of the other molars. There is no metaloph present. The cingulum has a small fold in its posterior labial extension from the protocone. The posterior portion of the tooth is only slightly expanded.

This squirrel is about the same size or possibly slightly larger than *S. junturensis*. The available material shows a more poorly developed anterior cingulum and larger parastyle on the upper fourth premolar than is present on *S. junturensis*. The similarities in size and character of the teeth, along with their geographic proximity, suggests that these species are probably closely related.

SPERMOPHILUS cf. *WILSONI*

Three upper molars from Juniper Creek Canyon (UOLoc 2469) have well developed parastyles on each specimen. The protoloph is complete while the metaloph connects very low and weakly to the protocone. A metaconule is present as is also a mesostyle. The teeth have the general characteristics of *Otospermophilus* and are similar to the specimen from the Juntura Formation previously described. (Shotwell 1963) They are probably of the same species as the form in the Bartlett Mountain Fauna, however, that sample includes lower teeth and only a fragmental upper molar so that direct comparisons are not possible. An edentulous mandible (UO19203) and an upper incisor (UO19199) from Juniper Creek Canyon locality 2451 probably represents this species.

SPERMOPHILUS cf. *WILSONI*

Several teeth in the Bartlett Mountain sample from locality 2517 represent a large spermophile. An abraded lower fourth premolar has a small protoconid and parametaconid, closely appressed and connected by the metalophid. The talonid is broad, bounded by a posterolophid which does not contact the parametaconid. The ectolophid is high. A damaged lower first molar is complete enough to reveal an enclosed trigonid basin and an occlusal outline which is nearly square. A fragmental upper molar has a complete protoloph with no protoconule, a poorly developed metaconule and metalophid which connects very low on the protocone.

The available material has affinities with *Spermophilus wilsoni* and is provisionally referred to that species to reflect these affinities.

EUTAMIAS sp.

The Clarendonian Black Butte sample (UOLoc 2500) includes a small sciurid with longitudinally grooved incisors. It is represented by a number of isolated teeth.

LOWER DENTITION: The lower incisor is groved. Five longitudinal grooves are prominent near the lateral edge of the enamel of the incisor. Near the tip a number of lesser faint grooves appear medial to the others. The remainder of the enamel lateral and medial to the prominent grooves is slightly crenulated. The lower incisor of *Eutamias* sp. is much more delicate than that of *S. junturensis* present in the same sample.

Two teeth and one fragmental tooth in the sample represent either lower first or second molars. They have incomplete metalophids. The protolophid bypasses the protoconid and is connected only in later wear. A mesoconid is present on the ectolophid. There is no mesostylid present. The occlusal outline is more quadrant shaped than quadrate. Molars are wider than long.

The lower third molar has a strong mesoconid. No metalophid is evident but may be lost due to wear. The protolophid bypasses the protoconid as in the other lower molars but is connected in late wear leaving a groove between the protoconid and labial extension of the protolophid. The talonid basin is broad posteriorly. The third molar is only slightly longer than wide. The character of the entoconid cannot be determined on any of the specimen due to wear.

UPPER DENTITION: The upper incisors display prominent longitudinal grooves near the lateral border of the tooth. Four grooves are present. The enamel medial and lateral to the grooves is slightly crenulated. The upper fourth premolar is smaller than the other cheek teeth. The parastyle is much lower than the paracone and small. The anterior cingulum is abbreviated. The protoloph is straight and directed slightly anteriorly. There is no protoconule. The protoloph is lowest at its mid point. The metaloph is directed anteriorly and connects to the protocone. There is no apparent metaconule. The paracone is larger than the metacone. There is no mesostyle. The posterior cingulum is well developed and includes the hypocone.

The upper first or second molar is similar to the premolar in most characteristics. How-

TABLE 6

MEASUREMENTS OF THE DENTITION OF SCIURIDS

Species	Locality	Tooth	Cat. No.	AP	Tr
Spermophilus sp. A					
	2516	P_4	UO26250	1.67	1.40
	2516	P_4	UO27015	1.56	1.42
	2516	M_1	UO27015	1.88	1.97
	2516	M_2	UO27015	2.02	2.25
	2516	M_3	UO27015	2.36	2.42
	2516	$M^{1\text{ or }2}$	UO26256	2.04	2.38
	2516	$M^{1\text{ or }2}$	UO26241	1.91	2.27
	2516	M^3	UO27016	2.30	2.20
Spermophilus sp. B					
	2516	$M^{1\text{ or }2}$	UO26259	1.22	1.36
	2516	M_3	UO26247	1.44	1.41
	2516	P^4	UO26254	1.01	1.33
	2516	$M^{1\text{ or }2}$	UO27258	1.29	1.53
	2516	M^2	UO26248	1.22	1.59
	2516	M^3	UO26248	1.23	1.39
	2517	P^4	UO24440	1.38	1.67
	2517	$M^{1\text{ or }2}$	UO25224	1.70	2.10
	2517	$M^{1\text{ or }2}$	UO24946	1.74a	2.14
	2517	M^3	UO24441	1.79	1.79
	2517	M^3	UO28033	1.85	1.82
Spermophilus cf. *wilsoni*					
	2469	$M^{1\text{ or }2}$	UO21715	2.10	2.72
	2469	$M^{1\text{ or }2}$	UO21718	1.97	2.66
	2469	$M^{1\text{ or }2}$	UO21725	1.99	2.48
	2517	P_4	UO25216	2.66	1.85
	2517	M_1	UO24984	2.42	2.61
Eutamias sp. A					
	2500	I_1	UO27621	1.79	0.85
	2500	$M_{1\text{ or }2}$	UO24572	1.42	1.55
	2500	$M_{1\text{ or }2}$	UO24573	1.17	1.31
	2500	M_3	UO25296	1.64	1.52
	2500	I^1	UO28034	1.92	0.88
	2500	I^1	UO27620	1.91	0.99
	2500	P^4	UO24888	1.04	1.33
	2500	$M^{1\text{ or }2}$	UO24575	1.19	1.34
	2500	M^3	UO24574	1.55	1.64
Eutamias sp. B					
	2517	$M^{1\text{ or }2}$	UO27019	1.18	1.10
	2517	M_3	UO24944	1.54	1.42
	2517	M_3	UO27021	1.56	1.42
	2517	I^1	UO27022	1.55	0.79
	2517	I^1	UO27023	1.50	0.82
	2517	I^1	UO27017	1.48	0.95
	2517	P^4	UO25218	0.92	1.18
	2517	$M^{1\text{ or }2}$	UO27018	1.11	1.40
	2517	$M^{1\text{ or }2}$	UO27020	1.07	1.40
	2517	$M^{1\text{ or }2}$	UO24442	1.00	1.37
	2517	M^3	UO24439	1.38a	1.40

ever, the parastyle is not so prominent and the anterior cingulum extends nearly the full width of the tooth.

The third upper molar has a strong anterior cingulum which connects high on the protocone. The protoloph is complete. There is no protoconule, metaloph or mesostyle. The posterior cingulum forms a notch at its connection with the protocone. The posterior basin is not inflated and the floor is relatively smooth.

DISCUSSION: The small size of this sciurid, the appearance of longitudinal groves on the incisor, the incomplete metalophid and protolophid, and the occurrence of mesoconids all indicate affinities to *Eutamias, Tamias* or *Ammospermophilus.*

In recent review of the North American Tertiary sciuridae, Black (1963) assigns all of the chipmunks previously referred to *Eutamias* to *Tamias* and recognizes no Tertiary occurrences of *Eutamias.* This is an arbitrary arrangement used by him because of the fragmental nature of the available material which does not allow assignment to either genus by any more direct means or warrant erection of a new genus. Black, however, does recognize both genera as distinct. Previously Ellerman (1940) and Bryant (1945) rejected *Eutamias* as a distinct genus and included the subgenus *Neotamias* under *Tamias* rather than *Eutamias* which accounts for the combination *Tamias (Neotamias) ateles* used by Bryant (1945) and James (1963). Presumably the injection of *Neotamias* in the combination serves to indicate the occurrence is in North America rather than Asia and that the form is small. *Eutamias* occurs in both areas, the subgenus *Eutamias* is Asiatic and *Neotamias* is North American. However, is seems somewhat superfluous to recognize a subgenus of a genus which presumably could not be determined. White (1953) working with living chipmunks recognized ten characters by which he could consistently separate *Eutamias* and *Tamias* and concluded that two distinct genera existed and that the subgenera of *Eutamis* (proposed by Howell 1929) are valid. Hall and Kelson (1959) followed this arrangement.

Recognizing the basis for arbitrary assignment of Tertiary specimens, at least incomplete ones, to one or the other of the two genera, I object to the choice made by Black on primarily a geographic basis. None of the fossil occurrences reviewed by Black occur within the present range of *Tamias* but all of them, with the exception of the Florida specimens, occur within the limits of the present distribution of *Eutamias. Eutamias* occurs today in both North America and Asia and presumably both subgenera are derived from a common ancestral stock of the Teritary. To assign the material to *Tamias* infers generic differences between these forms of two continents when in fact such differences probably did not exist in the Tertiary and do not today. I feel then that the known material is more appropriately referred to *Eutamias* with the understanding that any assignment at this time is arbitrary but on geographic grounds. The use of *Eutamias* causes the least amount of possible misunderstanding in faunal comparisons.

Black apparently considers *Tamias* and *Eutamias* to be more closely related than did White. He proposed a new tribe of sciurids, the Tamiini to include these two genera. White assigned Tamias to the tribe marmotini but tentatively assigned *Eutamias* to the callosciurini, suggesting a convergence of characters accounting for their similarities rather than a divergence of closely related forms, as inferred by Blacks arrangement. The paleontological evidence does not indicate which is the more likely arrangement.

Longitudinally grooved incisors are not recognized in any of the Teritary sciurids previously assigned to *Eutamias, Tamias* or *Ammospermophilus* although this is a common characteristic of living representatives of these genera. The new material differs in this way from all of the described late Tertiary forms assigned to these genera.

The lower dentition of the Black Butte species differs from that of specimens referred to *Eutamias ateles* in the presence of a mesoconid, reduced ectoconid area, presence of a groove between the protolophid and protoconid and grooves on the incisors. The upper dentition of the Black Butte species differs from *E. ateles* in the lack of a mesostyle, stronger connection of the metaloph with a poorly developed metaconule and constriction of the protoloph at the protocone.

Specimens from the Wounded Knee Fauna (Black 1963) have, in the lower molars a mesostylid, distinct entoconid and apparently a complete protolophid, none of which occur in the Black Butte species. The upper molars differ in that they have a mesostyle. The anterior valley of the third upper molar is very narrow.

The Thomas Farm species (Black 1963) lacks a mesoconid in lower molars which are more square than are those of the Black Butte species. A completely enclosed trigonid basin occurs in the lower molars which is not seen in the species described here.

The incisors of modern species of *Tamias, Eutamias* and *Ammospermophilus* are rounded transversely, primarily laterally, whereas those of the Black Butte species round transversely both laterally and medially. The longitudinal grooves of this Clarendonian species are grouped in an area lateral to the center of the enamel but at its most anterior point. Those of living species are distributed more broadly over the enamel face. The lower molars of *Eutamias, Tamias* and *Ammospermophilus* are more quadrate than those of the Black Butte form but otherwise are quite similar. The relative size of the upper fourth premolar to the other molars is more like that of *Eutamias* and *Tamias* rather than much smaller than the molars as in *Ammospermophilus.* The greatly reduced anterior cingulum of the fourth premolar is suggestive of *Eutamias* rather than *Tamias* or *Ammospermophilus* in which this area tends to be broad with a prominent parastyle. The very little expanded posterior basin of the upper third molar is more like that of *Eutamias* than *Tamias* or *Ammospermophilus.* I am therefore assigning this material of *Eutamias* rather tentatively since the existing differences in the incisors and the composite nature of the dentitions both suggest that with more complete material a new genus might be demanded.

EUTAMIAS sp.

The Hemphillian Bartlett Mountain Fauna includes a species of *Eutamias* present in the sample from UOLoc 2517.

LOWER DENTITION: No lower incisors are present in the sample. One complete first or second lower molar is present plus another broken specimen. Two additional damaged molars are present. The complete molar is only slightly worn and nearly square. The protolophid bypasses the protoconid leaving a deep groove from the trigonid basin. The metalophid ends short of the parametaconid but is directed towards it. A partially developed trigonid basin is thus present. The ectolophid is situated well in from the lingual border of the tooth. It is crescentic and has a prominent mesoconid near the mid-point. The posterolophid is noticeably lower beyond the entoconid and connects low on the parametaconid. A very small mesostyle is present. All three major cusps are about the same size. The broken specimen is similar to the one described but is not as square in occlusal outline.

Two lower third molars are present. They differ only in that onehas a serate posterolophid while the other is smooth. The protoloph bypasses the protoconid leaving a deep notch between. The metalophid is very short and narrow. A strong mesoconid is present on the ectolophid. No mesostylid or entoconid can be definitely recognized. The hypoconid is much larger than the other cusps of the tooth. The talonid basin is narrow, not inflated, in fact it is no wider than the hypoconid at its posterior border. The posterolophid is nearly straight. The occlusal outline is thus nearly a right triangle. The floor of the talonid basin is rugose.

UPPER DENTITION: Four strong longitudinal grooves are present on the upper incisor. They are situated near the lateral border of the tooth. The enamel lateral and medial to the grooves is crenulated.

The upper fourth premolar has little or no anterior cingulum. The parastyle is very small and placed low on the side of the paracone. The protocone is situated obliquely so that the protoloph is much shorter than the metaloph. The metaloph which curves anteriorly may include a poorly developed metaconule. Both protoloph and mealoph are complete. The posterior cingulum is strong and nearly as high as the metaloph. A very small mesostyle is present.

The first or second upper molar is larger than the fourth premolar but is similar in characteristics. It, however, has a well developed anterior cingulum. The parastyle, although worn, apparently was a prominent cusp. A strong hypocone and the complete anterior cingulum give a quadrate occlusal outline to the tooth.

Two specimens of upper third molars are available. One is damaged and the other is heavily worn. The damaged specimen is missing the protocone. No metaloph is evident. The anterior cingulum is strong. The posterior cingulum leaves the protocone more labially than posteriorly resulting in a small basin as in the Black Butte species. It cannot be determined if a groove was present at the point of juncture of the posterior cingulum and the protocone.

DISCUSSION: The Bartlett Mountain *Eutamias* is close to that from Black Butte. The comments regarding other Tertiary small sciurids can be applied to the Bartlett Mountain species as well as the Black Butte species. Other than the fact that the Bartlett Mountain *Eutamias* may be somewhat smaller than that from Black Butte and the lower molars are possibly more compressed antero-posteriorly these two forms represent closely related species. The nature of the materials does not allow a more positive statement.

SUBORDER CASTORIMORPHA

FAMILY CASTORIDE

The castoroid beavers, *Eucastor, Hystricops, Dipoides,* and *Procastoroides,* occur in the Pliocene of the Northern Great Basin. Castorid beavers are first recognized in the Hemphillian (Rome fauna). In some samples beavers are abundant and often one of the largest mammals present. A partial associated skeleton of *Procastoroides* from the Castle Butte sample of the Grand View Fauna provides excellent material for comparisons and assignments of the skeletal elements of other beavers. Description and comparisons of the skeletal elements follows the section on occurrences and taxonomic assignments.

SUBFAMILY CASTOROIDINAE

EUCASTOR MALHEURENSIS
Shotwell & Russell 1963

This beaver is well represented in the sample from UOLoc 2500 of the Clarendonian Black Butte fauna. All parts of the skeleton are represented. The dental elements present suggest that there is considerable variation in the persistence of striae and striids.

DIPOIDES VALLICULA n.sp.

TYPE: UO26695, left mandible with P_4-M_3.

HYPODYM: Palate with complete cheek-tooth dentition UO26698; DP_4, UO26891; P_4, UO-26699-UO26703; Lower molars, UO 26704-UO26717; DP^4, UO26718-UO26720; P^4, UO-26721-UO26722, Upper molars, UO26723-UO26730.

TYPE LOCALITY: UOLoc 2516 Little Valley.

AGE: Hemphillian.

DIAGNOSIS: Small species similar in size to *D. wilsoni* Hibbard. Parastriid of lower premolar usually present. Paraflexus and hypoflexus of upper premolar abut leaving small enamel isthmus connecting the anterior loph of the tooth or are confluent isolating the anterior loph. Flexi and flexiids of upper and lower molars transverse and broad at their termination. Molars have S pattern in adult teeth. Premolars apparently rarely have S pattern.

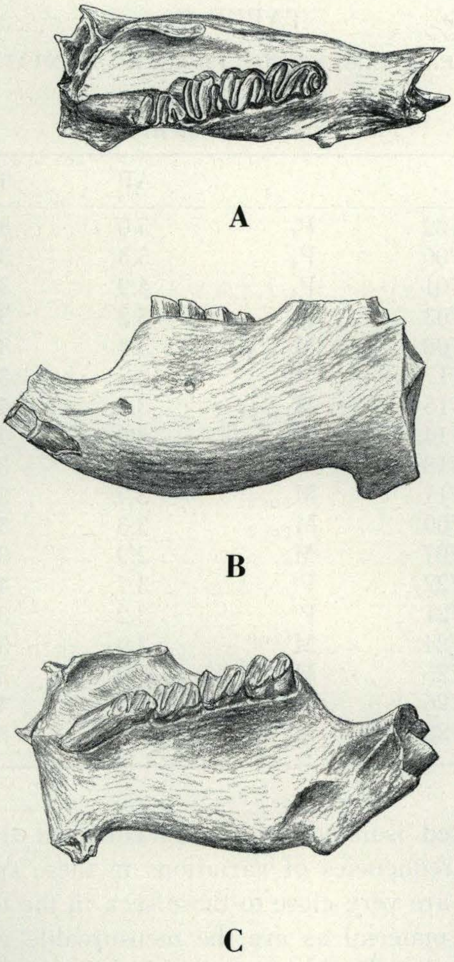


Figure 13. *Dipoides vallicula* n. sp. Little Valley UOloc 2516, **A** UO26695 Type lower left jaw P_4-M_3 dorsal view, **B** lateral view, **C** medial view, **D** UO26698 palate P^4-M^3 each side ventral view, all x 1.5.

DESCRIPTION: The lower deciduous premolar has two poorly developed roots. The hypostriid and mesostriid extend to the base of the enamel. The parastriid is very short and appears only in early wear. The metastriid is only a notch in the unworn tooth. There is an anterior extension of the enamel from the metastylid which partially closes off the mesoflexid. The permanent lower fourth premolar is an evergrowing tooth. The parastriid is present on the full length of the tooth column on three of five specimens. On one of the remaining teeth the parastriid is absent while on the other it is represented by a fossettid. The terminations of the flexids are broad.

The lower first and second molars have the S pattern in adults. A short parastriid is present on little worn teeth along with a metastriid which is little more than a notch. The hypoflexid, is nearly transverse and abuts the enamel of the lingual side of the tooth. The mesoflexid is more oblique and terminates short of the lingual side of the tooth. The flexids are broad at their termination. In very early wear the paraflexid and metaflexid borders are complicated. The lower third molar differs from the other lower molars in its shorter crown height and angle of emergence from the mandible.

The upper deciduous fourth premolar is three rooted. A single broad and long lingual root is present plus two small round labial roots. All the available specimens are relatively well worn so that all exhibit closed para and metastria. A small parafossette and several small lakes in the position of the metafossette represent these structures. The positioning of the several lakes referred to the metafossette suggest that the mesoflexus may have extended posteriorly into the position of the metaflexus in earlier wear. The permanent upper fourth premolar is represented by two isolated teeth and two in a palate. In the isolated teeth the paraflexus and hypoflexus abut leaving a small isthmus of enamel connecting the anterior loph of the tooth to the remainder. In the teeth of the palate the paraflexus and hypoflexus are conjoined isolating the anterior loph of the tooth. The paracone of one of these teeth is an isolated enamel tube the full length of the tooth. The metastria is very short on the upper fourth premolars and is present only in juvenile specimens. The flexi are directed transversely. The termination of the mesoflexus is broad and extends nearly to the opposite side of the tooth.

The upper first and second molars of adults exhibit the S pattern. In early wear parastria and metastria are present and persist for a short time as fossettes but are not reflected in the adult tooth. The parastria is much longer than the metastria. The mesoflexus curves posteriorly in early wear but is nearly transverse in adults and has a broad termination. The mesoflexus tends to be pendulous in occlusal outline. The upper third molar also has an S pattern in adult specimens. The tooth column is more curved antero-posteriorly and less curved transversely as is the case in all beavers with high crowned teeth. The mesoflexus recurves into the metaflexus position which is also common in the upper third molars of beavers.

COMPARISONS: *D. vallicula* is close to *D. wilsoni* in size and in the transverse orientation of the flexi. However in, *D. vallicula* the flexi and flexid terminations are not expanded or flattened. The parastriid of the lower fourth premolar is much more persistent in *D. vallicula*. Material from Oregon previously referred to *D. wilsoni* (see Shotwell 1955) probably should be referred to *D. vallicula*.

TABLE 7

MEASUREMENTS OF ISOLATED DENTAL ELEMENTS OF *Dipoides vallicula*

		AP	Tr
UO26702	P_4	5.0	3.3
UO26700	P_4	5.3	3.7
UO26701	P_4	4.9	3.8
UO26703	P_4	5.2	3.3
UO26708	$M_{1 \text{ or } 2}$	3.4	3.7
UO26717	$M_{1 \text{ or } 2}$	3.5	3.2
UO26715	$M_{1 \text{ or } 2}$	3.5	4.0
UO26714	$M_{1 \text{ or } 2}$	3.9	4.2
UO26713	$M_{1 \text{ or } 2}$	3.4	3.7
UO26711	$M_{1 \text{ or } 2}$	3.7	3.8
UO26709	$M_{1 \text{ or } 2}$	3.3	3.8
UO26707	M_3	2.9	3.2
UO26722	P^4	3.7	4.5
UO26721	P^4	3.2	3.7
UO26724	$M^{1 \text{ or } 2}$	2.9	3.4
UO26725	$M^{1 \text{ or } 2}$	3.0	3.5
UO26726	$M^{1 \text{ or } 2}$	3.3	4.2
UO26728	$M^{1 \text{ or } 2}$	3.2	3.1

DIPOIDES STIRTONI Wilson

Dipoides stirtoni occurs at two localities in Juniper Creek Canyon, UOLoc 2451, and UOLoc 2469. It is also present at UOLoc 2381 near Little Valley and at UOLoc 2342 near Harper. A number of occurrences of *D. stirtoni* have been previously reported from the Juntura Basin (Shotwell 1963). It was originally described from localities near Rome, Oregon (Wilson 1934) and its variations discussed by Shotwell (1955). This species is well represented at UOLoc 2451 in Juniper Creek Canyon. Several mandibles with teeth and several hundred isolated teeth were collected there. The frequencies of variations in these specimens are very close to those seen in the topotypic material as are the mensureable characteristics. The close geographic proximity of these occurrences to the type locality along with the similiarity of size and frequency of occurrence of tooth characteristics leaves no doubt as to the assignment to *D. stirtoni*.

? *DIPOIDES* sp.

Two tooth fragments in the sample from UOLoc 2517, Bartlett Mountain Fauna, indicate the presence of a beaver similar to *Dipoides*. The fragmentary nature of the material does not allow a more accurate determination. *Hystricops browni* is known from this fauna (Shotwell 1963) and the type specimen was collected a few feet from the site of the sample. However, it has not been recognized in the sample. The low crowned character of its dentition makes it clear that the fragments discussed above do not represent *Hystricops browni*.

PROCASTOROIDES IDAHOENSIS n.sp.

TYPE: UO16267, left lower jaw, lacking portion of ramus and M3.

TYPE LOCALITY: Jackass Butte locality of the Grand View Fauna Idaho. UOLoc 2404.

HYPODYM: Right upper incisor UO 16268, right upper incisor UO16269, fragmental lower left incisor UO16270, lower left fourth premolar UO16323, cuboid UO11835, right humerus UO16350, pelvis fragment UO16293, Jackass Butte UOLoc 2404.

REFERRED MATERIAL: Parts of two skeletons including, nearly complete fore and hind feet, limb bones and teeth, UO27541 Castle Butte sample, Grand View Fauna UOLoc 2393; femur fragment UO20399, humerus fragment UO20404, metacarpal UO20405, astragalus UO20400, P_4 UO20402, $M_{1 \text{ or } 2}$ UO20401, Shoofly Creek, Idaho UOLoc 2474.

DIAGNOSIS: A large beaver in the size range of *Procastoroides sweeti*, upper and lower incisors with numerous longitudinal grooves. Cheek tooth pattern and known skeletal elements similar to *P. sweeti* where comparable material exists.

LOWER DENTITION: One well worn left DP4 is available. It has two roots. It displays a very short parastriid and an opposing short striid on the labial side which probably was continuous with the parastriid in earlier wear. This additional striid is so short in the specimen available that it is very nearly represented only by a fossettid. This additional striid will be referred to here as the antero-labial striid and the resulting fossettid and antero-labial fossettid. There also are present full length meta and hypostriids. A rather curious feature of this specimen is the incomplete character of the enamel. At the stage of wear exhibited, only the antero-labial fossettid, the metastriid and hypostriid are bordered by enamel. The remainder of the tooth apparently has no enamel bordering it. The connection of the parastriid with the anterio-labial striid would isolate the first anterior loph. This apparently was the condition earlier in wear.

Two left lower fourth premolars are available from the type locality at Jackass Butte and a right one from Castle Butte. Para, meta and hypostriids are complete on all these specimens. The lophids are generally straight. The first anterior lophid is ovoid to round, the second anterior lophid is inflated lingually and the median lophid is "bent" anteriorly at the labial side narrowing the mesoflexid abruptly. The flexids abut and are flat at their terminations.

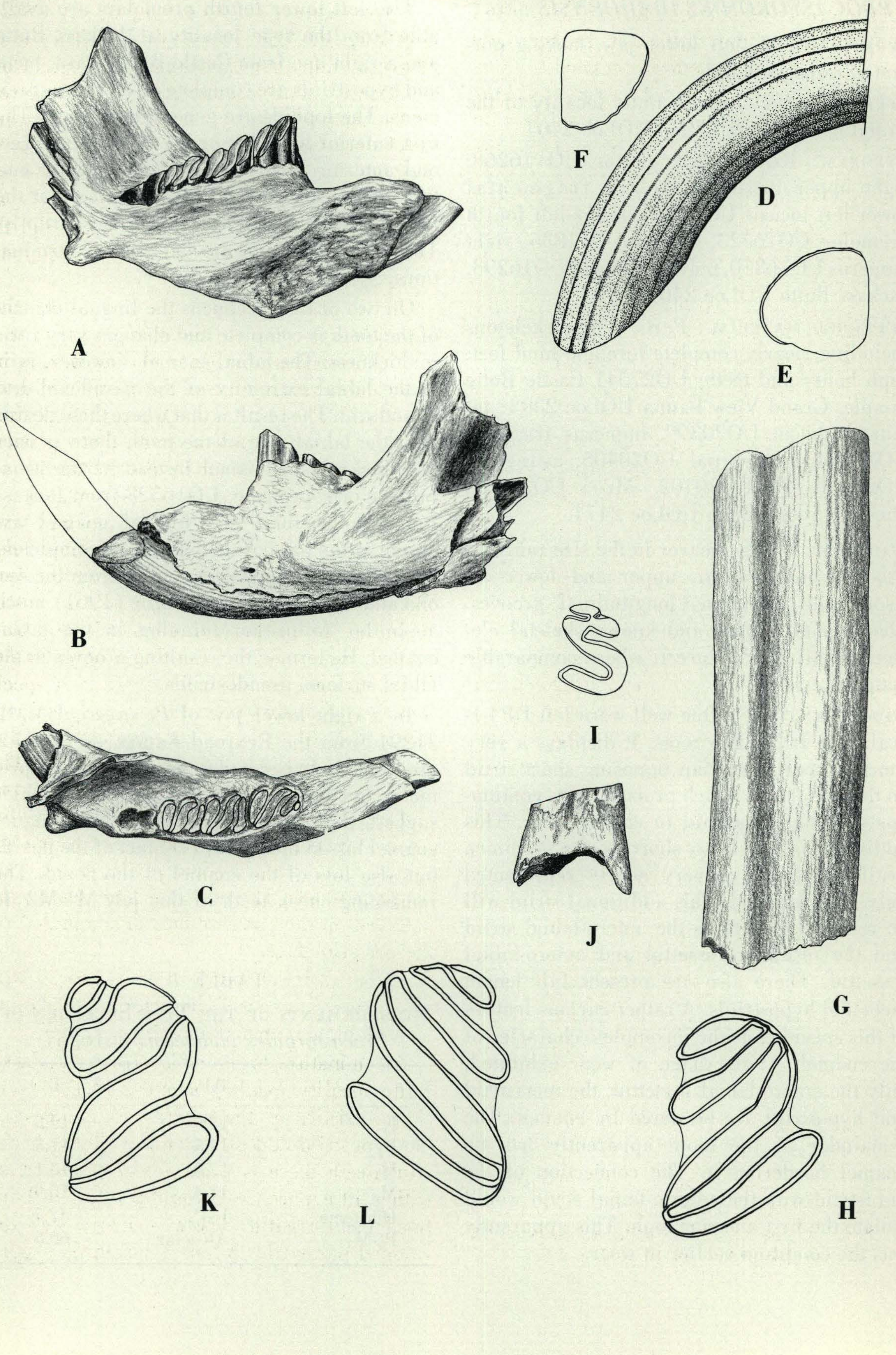
On two of the specimens the lingual enamel of the tooth is complete and changes very little in thickness. The labial enamel, however, fails at the labial extremity of the paraflexid and mesoflexid. The result is that where these flexids abut the labial side of the tooth there is only one thickness of enamel instead of the usual two. On one specimen, UO16323 from Jackass Butte, both labial and lingual enamel are absent at the base of the paraflexid completely isolating the first anterior lophid from the second anterior lophid. Woodburne (1961) noted a similar failure or thinning in the labial enamel. He termed the resulting grooves in the labial surface, pseudostriids.

In a right lower jaw of *P. sweeti*, UMMP 31294 from the Rexroad Fauna, the lophids are completely isolated in the lower fourth premolar but the resulting shape of the lophids suggests that this is a result of not only lingual enamel loss at the point of contact of the flexids but also loss of the enamel of the flexid. The remaining cheek teeth of this jaw M1-M3 do

TABLE 8

MEASUREMENTS OF THE TYPE SPECIMEN OF *Procastoroides idahoensis* UO16267

	AP	T
I_1	14.9	14.8
P_4	17.5	11.3
M_1	12.0	13.1
M_2	11.4	10.9
Diastema	I_1-P_4	42.7
P_4-M_3	Alveolar	60.5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not show this complete isolation of lophs except in the posterior loph of the M3. In them there is only failure of the exterior enamel.

In the fourth premolar of the type specimen of *P. idahoensis* the lophids are completely isolated from each other. There is no indication that they were at any time connected by enamel. The enamel bands are apparently complete around each lophid. This is also the case in the first molar of the same specimen. In the second molar the anterior and median lophids are isolated, however, the flexid enamel connects the median and posterior lophids. Microscopic examination of the enamel at the lingual and labial ends of the lophids, in the fourth premolar, reveals a line in the enamel at this point and a change in the character of the enamel. This suggests a fusion of the flexure enamel and the exterior enamel to form the apparent enamel tube of the lophid. Re-examination of the jaw of *P. sweeti* previously referred to also indicates an apparent fusion of the two enamels in fact there is a very thin band of dentine between the two edges. An upper premolar of *Castoroides*, UMMP 29029, displays this enamel failure and fusion relationships identically with these just described in *P. sweeti* and *P. idahoensis*. The differences between these two genera as regards isolation of tooth lophs is in the frequency of failure and fusion or contact of flexure and exterior enamel rather than any basic structural differences.

Figure 14. *Procastoroides idahoensis* n. sp. **A** UO-16267 Type left lower jaw I, P_4-M_2 Jackass Butte UOloc 2404 medial view x 0.5, **B** lateral view x 0.5, **C** dorsal view x 0.5, **D** UO16269 upper incisor Jackass Butte UOloc 2404 lateral view x 1.0, **E** cross-section x 1.0, **F** cross-section lower incisor x 1.0, **G** UO20392 P_4 Castle Butte UOloc 2393 lateral view x 2, **H** occlusal view x 2.5, **I** UO20394 DP_4 Castle Butte UOloc 2393 occlusal view x 2.5, **J** medial view x 2.5, **K** *Procastoroides sweeti* UMMP 21294 P_4 occlusal view x 2.5, **L** *Procastoroides idahoensis* UO16323 P_4 Jackass Butte UOloc 2404 occlusal view x 2.5.

Some teeth of *Dipoides smithi* (UO2832, UO4095, UO2821, UO10382, UO2821) display very thin exterior enamel at the point of contact with a flexid or actual enamel failure. In the teeth of other species of *Dipoides* in which the enamel of the flexure apparently does not abut the exterior enamel no thinning or failure is present. In some species of *Dipoides* the anterior loph of the upper fourth premolar is commonly isolated from the other lophs of the tooth.

The appearance of an opposing flexid, the antero-labial flexid, in the milk premolar and the occurrence of similar opposing flexids in some upper third molars of *Dipoides* (see Shotwell 1955, p. 131), the mediflexus, which isolates the posterior loph indicates that isolation of lophs may also occur by the confluence of flexids from opposite sides of the tooth.

The lower first and second molars have lophids with similar characteristics of enamel failure as described for the fourth premolar. In two lower left first molars from the Castle Butte locality the anterior enamel is very thin at the abutment of the meso and hypoflexids. There is apparent enamel failure in a specimen from Shoofly Creek. In the type specimen the lophids are isolated. The anterior lophid is narrower than the remainder of the tooth. The anterior border of the loph is slightly curved and the posterior border is parallel except for a concavity near the mid line. The median loph is diagonal with a distinct posterior bend on the lingual side. The posterior loph tends to be flattened on the anterior face and rounded on the posterior face.

The third lower molar is similar to the first and second in general characteristics. The anterior loph is bulbous lingually.

An immature lower molar from the Castle Butte locality exhibits some of the prewear characteristics of the molars. In addition to the hypostriid and mesostriid exhibited in the adult teeth there is a short metastriid which with a little more wear would result in a short-lived metafossettid. There is also a well developed parastriid, 3 mm. long, in this specimen. The paraflexid opens into a series of small flexures at its termination one of which opens to the anterior face of the tooth. At this stage of wear the hypostylid and paraconid are isolated from the remainder of the occlusal pattern. The occlusal pattern of this immature specimen is not unlike molars of *Dipoides* at the same stage of wear.

UPPER DENTITION: A well worn deciduous upper fourth premolar is available in the collection from Castle Butte. It is nearly surrounded by enamel in contrast to the lower deciduous premolar. In addition to the meso and hypostria there is a metafossette indicating the probable presence of a metastria in earlier wear. The tooth is rooted with one large and two small roots. The only other upper cheek tooth available is a third molar from the Castle Butte locality. It is from a young individual. The enamel is entire. In addition to the hypo and mesostria there is a full length metastria.

INCISORS: The incisors are the most unique characteristic of this species. Both upper and lower incisors have numerous longitudinal grooves which give a corrugated effect to the surface. In the upper incisors the enamel face is curved and covers all but the most ventral and the median sides of the tooth. The corrugations are more closely spaced on the lateral side of the tooth and are absent from about one centimeter of the medial edge. This relatively smooth area is interrupted by a single shallow but narrow groove about 1 mm. from the medial edge. Superimposed on these corrugations are numerous very fine longitudinal striations which give the entire surface of the tooth a roughness. Two upper right incisors UO16268 and UO16269, from the type locality display a curious notch in the wear face of the tooth. See Fig. 14. In the lower incisor corrugations cover the entire surface of the tooth enamel. The fine longitudinal striations seen in the upper incisors are not so numerous and do not roughen the enamel surface. There are at least ten major longitudinal grooves in the lower incisor of the type specimen and nine or ten in the upper incisor.

MANDIBLE: As pointed out by Hibbard (1941, p. 279) the incisor passes under the M_3 in *Procastoroides*. This is also the case in *Monosaulax*, *Eucastor*, *Dipoides*, and *Castoroides*. In *Castor* the incisor does not cross the cheek tooth row but is lingual to the tooth row crossing labially to the masseteric crest posterior to the tooth row. In the castoroid beavers noted *(Monosaulax, Eucastor, Dipoides, Procastoroides and Castoroides)* the incisor extends much further laterally than in *Castor* resulting in the greatly enlarged masseteric crest typical of these beavers.

The angle of the jaw is inflected in both *Castor* and the castoroid beavers. The inflection forms a narrow gently antero-posterior curved flat shelf in *Castor* which lies in a plane titled at an angle of about 25° to the long axis of the jaw. In the castoroid beavers this shelf is much wider and proportionately shorter and very nearly parallel to the long axis of the jaw. In the type specimen of *P. idahoensis* this shelf is incomplete but the supporting anterior lingual protuberance from the jaw just below and posterior to the base of M3 indicates that this shelf was well developed in this species. The jaw of *P. idahoensis* appears to be more massive than that of *P. sweeti*.

DISCUSSION: Barbour and Shultz (1937) assigned the genus *Procastoroides* to large castoroid beavers which occur in the Broadwater Fauna of Nebraska. Hibbard (1938) proposed the genus *Eocastoroides* for large beavers in the Rexroad Fauna of Kansas but later (Hibbard 1941) considered these beavers to be "generically the same" as those from the Broadwater but of a different species. Woodburne (1961) considered the Rexroad species (*lanei*) and the Broadwater species (*sweeti*) to be synonomous. The present situation in the literature indicates one recognized species, *Procastoroides sweeti*. The new species differs from *P. sweeti* primarily in the numerous longitudinal grooves, on the incisors much like those in *Castoroides*. Occasional single longitudinal inflections do occur in *P. sweeti* (Woodburne 1961). These do not compare in character with the grooves of the new species.

Barbour and Schultz (1937) characterized (*Procastoroides*) as "approaching *Castoroides*," and having cheek teeth as in *Castoroides*. Hibbard (1941, p. 281) pointed out that there was a difference in enamel configuration between these beavers and stated that, "in the lower teeth of *Castoroides* the enamel inflections are not present and there is a layer of enamel completely or nearly completely surrounding dentine, then a layer of cement. The striae on the labial and lingual sides of the teeth are confluent in *Castoroides*. This condition also exists in the upper teeth of *Castoroides* distinguishing them from *Procastoroides*." The new material described here indicates that both these conditions exist in *Procastoroides*, that is, in some specimens the teeth are made up of a series of enamel tubes as in *Castoroides*, whereas, in others the lophs are not completely isolated but are connected by enamel. This problem is dealt with in detail above. It is sufficient to point out here that the differences are those of stage of evolution rather than fundamental structural differences.

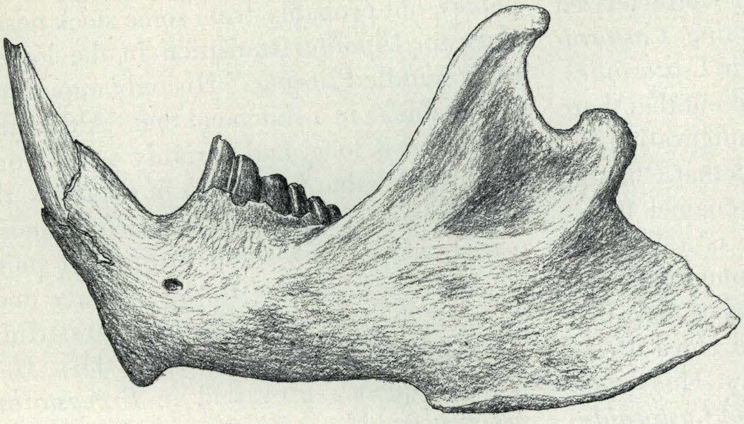
Woodburne (1961, p. 84) states that "*Procastoroides* probably developed independently the tendency toward the complete separation of lophs by tracts of cement." (in the cheek teeth) He apparently does not consider *Procastoroides* as ancestoral to *Castoroides* because of the lack of an observed trend toward crenulation of the incisor enamel. The new species described here has the crenulated enamel (numerous longitudinal grooves) and displays both conditions of tooth lop isolation referred to. Examination of a number of specimens of incisors of *Dipoides smithi* reveals that occasionally *Dipoides* has very subtly crenulated enamel which is only visible when oriented properly so that they can be seen with reflected light. Considering the new evidence provided by the material from the Grand View faunas there seems to be little doubt that the new species is closely related to the subsequent *Castoroides*.

Woodburne (1961, p. 84) does "not believe that *Procastoroides* arose directly from *Dipoides*, but probably from some stock near the *Eucastor-Dipoides* transition in the lower or early middle Pliocene." His only apparent basis for this is in a statement that "Although the parastriid is long, and variably occurs for the complete height of the tooth in *Dipoides*, there is no species of that genus in which a persistent parastriid is a consistent feature." I pointed out that in *Dipoides stirtoni* in only one of thirty-three premolars was the parastriid incomplete (Shotwell 1955, Table 1B). If this same frequency prevailed in *Procastoroides sweeti* it would not be surprising, considering the amount of material known, to not have seen an incomplete parastriid on a premolar. However, even if Woodburne's statement were acceptable I cannot see how it would deny the origin of *Procastoroides* in *Dipoides*. As I showed in the earlier paper referred to (Shotwell, 1955) the differences between some of the better known species of *Dipoides* is actually more of the nature of differences of frequency of the occurrence of characters rather than the presence or absence of characters considered to be useful in the recognition of species of beavers. All of the known characteristics of *Procastoroides* can be seen either as well developed features of *Dipoides* or as incipient in *Dipoides*. The only exceptions to this may possibly be in some proportions of limb elements and in the character of the milk premolars and even here these are only qualifying characteristics. *Procastoroides* appears as a greatly enlarged *Dipoides* in a progression of size increase in castoroid beavers. Other lines of

TABLE 9

MEASUREMENTS OF ISOLATED DENTAL ELEMENTS OF *Procastoroides idahoensis*

Specimen	Tooth	Locality	AP	Tr
UO16323	P_4	2404	15.1	10.8
UO20392	P_4	2393	14.6	11.7
UO20388	$M^{1 \text{ or } 2}$	2393	9.0	10.0
UO20386	$M^{1 \text{ or } 2}$	2393	8.7	11.7
UO20385	M^3	2393	8.7	8.2
UO16268	I^1	2404	17.8	18.0
UO16269	I^1	2404	17.5	18.8



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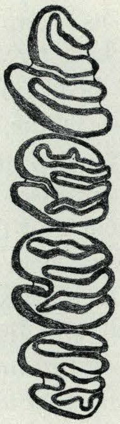

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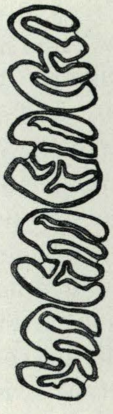

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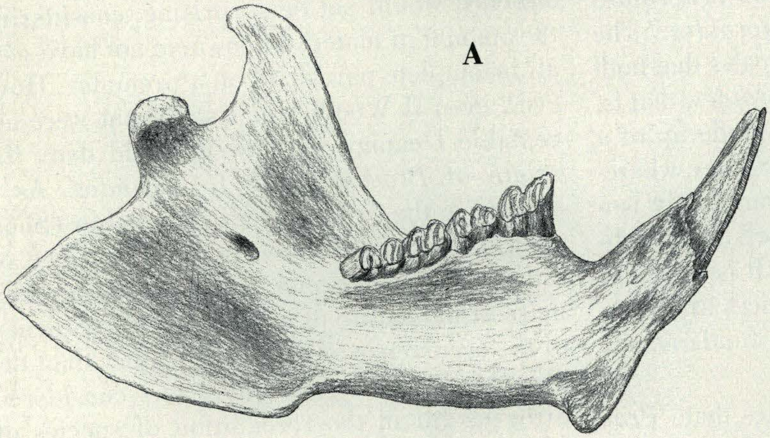

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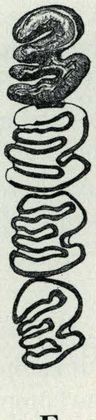

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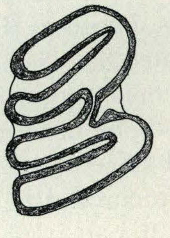

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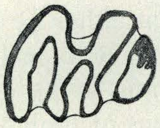

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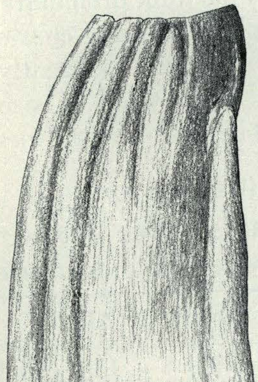

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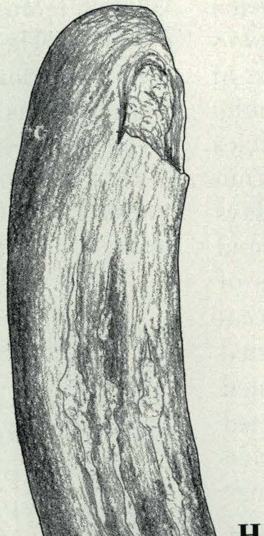

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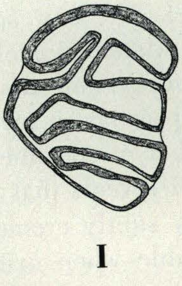

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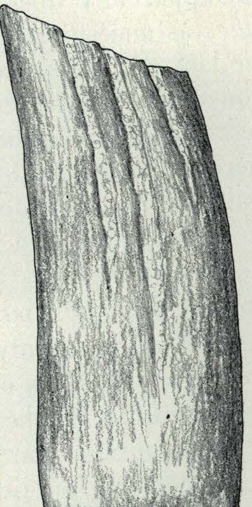

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castoroid beavers are known in the Pliocene (viz. *Hystricops*) but they show no relationships to *Procastoroides*. The known beaver material indicates that the line *Dipoides-Procastoroides-Castoroides* is the most probable sequence.

SUBFAMILY CASTORINAE

CASTOR ACCESSOR Hay 1927

Hay (1927) assigned the name *Castor accessor* to a single lower fourth premolar collected in the "Idaho Formation" near Froman Ferry. Beavers of the genus *Castor* from Hagerman have been tentatively assigned to this species (Gazin, 1936). The type specimen is a tooth of a young individual and displays an occlusal pattern common in both fossil and living beavers of the genus *Castor*. Since the type is from a young individual, it is not possible to determine the relative length of striids to those of other beavers. The specimens representing *Castor* from the Grand View Fauna cannot be directly assigned to *C. accessor* by their identity with the type material nor can they be excluded from the species by any differences. Variations in the pattern of beaver teeth often does not allow assignment of single specimens to species and conversely single tooth types of species disallow assignment of material to the species for which they are the name bearer. The beaver from the vicinity of Froman Ferry probably is of approximately the same age as those from Grand View and less than 50 airline miles away geographically. The probability is that the Grand View *Castor* represents the species from Froman Ferry even though the specimens do not allow morphological determination of identity. The alternate procedure is to assign a new name to the Grand View fauna *Castor*. This would likely do violence to the actual biological relationships and eventually be confusing. I thus consider the new material as representing *Castor accessor* Hay and use it as a supplimentary type in order that this beaver may be characterized. Future work may prove this to be unsound.

Figure 15. *Castor accessor* Jackass Butte UOloc 2404, **A** UO16338 lower left jaw lateral view x 0.75, **B** medial view x 0.75, **C** P_4-M_3 occlusal view x 1.5, **D** UO16336 P_4-M_3 occlusal view x 1.5, **E** UO16337 P_4-M_3 occlusal view x 1.5, **F** UO17436 P_4 Jackass Butte UOloc 2400 occlusal view x 5, **G** lateral view x 2.5, **H** UO-16328 P^4 Jackass Butte UOloc 2404 lateral view x 2.5, **I** occlusal view x 2.5, **J** UOloc 16331 P_4 occlusal view x 2.5, **K** lateral view x 2.5.

DIAGNOSIS: Large beaver, approximately 10% larger than the living *Castor canadensis* but similar in gross characters of dentition and skeleton. In the lower fourth premolar the hypostriid and mesostriid are directly opposite. Stria and striids of cheek teeth longer than in *C. californicus* and shorter than in *C. canadensis*. Occlusal pattern of lower P4 variable in occurrence of isolated lophs and development of fossettes to about the same degree as *C. canadensis*. Hypostria and hypostriid to base of teeth.

PLESIOTYPE: Complete left lower jaw, UO16-338 from Jackass Butte UOLoc 2404, of the Grand View fauna.

REFERRED MATERIAL: Other specimens from UOLoc 2404 which exhibit variations and characteristics of other elements of the skeleton of *C. accessor* include; left lower jaw UO 16336, right lower jaw UO16337, isolated teeth of upper and lower dentition, humerus UO16294 and tibia UO11826. Specimens from Jackass Butte locality 2400 and Wild Horse Butte locality 2396 also represent this species.

DESCRIPTION OF MATERIAL: In the plesiotype, UO16338, the mandible is 117 mm long from the tip of the incisor to the posterior edge of the condyle. The incisor is 9.1 mm wide and 9.9 mm deep perpendicular to the enamel face. The fourth lower premolar is 10.7 mm anterior posteriorly and 8.2 mm transversely. The hypoflexid and mesoflexid do not isolate the anterior half of the tooth from the posterior. This variant is aparently rather common in *C. vidali* (Crusafont 1948). It does not appear in any of the other material from the Grand View Fauna. However, the little worn teeth may typically have this separation judging from unworn and little worn material available.

In the first lower molar the paraflexid bends abruptly anteriorly near its termination and has an invagination into the first anterior loph in the anterior border. The mesoflexid curves slightly approaching a chevron directed posteriorly. The hypoflexid is transverse at its inception but turns posteriorly near its termination abuting the anterior side of the metaflexid. The metaflexid is directed slightly posteriorly at its inception, straightens out mid-way, then turns abruptly posteriorly at its contact with the hypoflexid. In the second lower molar the pattern is essentially the same as in the first but lacks the invagination from the paraflexid into the first anterior loph. This invagination is probably a character of the teeth of young adults and thus transitory. In the third lower molar there is an invagination of the enamel of the metaflexid border into the posterior loph of the tooth.

In lower jaw UO16336 the occlusal pattern of the lower fourth premolar is quite different than in UO16338 described above. Here the hypoflexid and mesoflexid abut. The base of the metaflexid is visable suggesting that this jaw is from an older individual. Other notable characteristics of the cheek teeth include T shaped terminations of the metaflexid in the first and second molars and the complicated shape of the hypoflexid on these teeth. Isolated teeth of the lower jaw indicate that the para and mesostriids are generally about the same length, often with the parastriid slightly shorter and the metastriid much shorter than the others. The hypostriid extends to the base of the tooth.

The lower fourth premolar pattern varies greatly in fact each of the specimens exhibit a different pattern. They all represent somewhat different individual ages and thus may only indicate wear differences since all these variation can be seen in little worn teeth. For instance the lower fourth premolar of UO16-336 represents the middle adult pattern—that of UO16338 has a pattern often seen in young individuals. The isolation of the first anterior loph and or a portion of the second anterior loph occurs in young individuals. All the common variations can thus be seen as various stages of wear of a single hypothetical tooth. In some instances these characteristics persist longer than in others. This variation of fourth premolar pattern is also typical of *Castor canadensis*.

TABLE 10

Measurements of the Dentition of *Castor accessor* uoloc 2404

	UO16336	UO16337	UO16338
I_1AP	8.3		9.9
I_1Tr	8.5	6.8	9.1
P_4AP	8.3		10.7
P_4Tr	7.5		8.2
M_1AP	7.7	7.0	7.8
M_1Tr	8.4	7.3	8.7
M_2AP	7.5	6.0	7.9
M_2Tr	7.8	6.7	7.9
M_3AP	7.5	6.7	7.6
M_3Tr	6.8	5.6	6.8
P_4-M_3	34.3	30.2	36.4

TABLE 11

Measurements of Isolated Dental Elements of *Castor accessor*

Specimen	Tooth	Locality	AP	Tr
UO16277	I_1	2404	9.5	8.2
UO16331	P_4	2404	9.5	7.1
UO17436	P_4	2400	11.0	8.2
UO17436	M_1	2400	7.7	8.4
UO16341	I^1	2404	9.3	8.4
UO16276	I^1	2404	8.1	7.7
UO16328	P^4	2404	8.5	9.2
UO16332	M^1	2400	5.7	7.1
UO16330	M^1	2404	6.6	7.3
UO17420	M^1	2402	6.7	6.7
UO16329	M^2	2404	6.9	7.8
UO17466	M^2	2444	8.3	9.9
UO16346	M^3	2404	7.2	6.9

A humerus and a distal fragment of a tibia are identical to *C. canadensis* in characters but significantly larger.

COMPARISONS:The striae and striids of *C. californicus* Kellogg are apparently somewhat shorter than in *C. accessor*. The two beavers are, however, about the same size. They are both larger than *C. canadensis*. A number of isolated teeth from Hagerman appear to represent the same species of *Castor* as those from Grand View. The known more complete material was not available, to me for study.

TABLE 12

COMPARATIVE MEASUREMENTS APPENDICULAR SKELETAL ELEMENTS OF *Procastoroides idahoensis* AND *Castor canadensis*

Measurement	*Procastoroides idahoensis*	*Castor canadensis*
Femur—		
Total length	76.7	81.0
Breadth	19.7	23.3
Thickness AP	15.0	10.7
Tibia—		
Total length	178.0	121.0
Hind foot—		
length Mt I	22.8	16.4
length Mt II	58.5	41.6
length Mt III	79.4	49.2
length Mt IV	88.5	59.3
length Mt V	61.4	40.0
Total length (Calcaneum-claw)	255	180
Humerus—		
Total length	101.5	80
Radius—		
Total length	134	94
Ulna—		
Total length	179	120
Forefoot—		
length Mc I	9.8	7.2
length Mc II	25.5	16.4
length Mc III	31.4	23.0
length Mc IV	24.7	20.5
length Mc V	20.0	13.6
Total length (Scapholunar-claw)	90	75

The Skeleton of Castoridae

A large portion of an associated skeleton of *Procastoroides idahoensis* allows the assignment of the skeletal elements of a number of late Tertiary beavers which occur in the Northern Great Basin. Emphasis is placed on the appendicular skeleton and contrasts are made between the castoroidinae and *Castor*.

HUMERUS: The proximal end of the humerus of the castoroid beavers is similar to that of *Castor*. However, in the castoroid beavers the lesser tuberoisity is seperated from the head by a sulcus. In *Castor* the lesser tuberosity molds into the head. Both *Castor* and the castoroid beavers have strongly developed deltoid tuberosities. A teres tuberosity is also present on the shaft of the humerus of both and forms a keel-like ridge extending to the lesser tuberosity. The lateral condyloid crest is highly expanded in *Castor* and the castoroid beavers. The medial epicondyle is much broader in the castoroid beavers. The humerus of *Procastoroides idahoensis* is much broader in proportion to its length than in *Dipoides* or *Castor*. The humerus of the castoridae is quite similar to that of *Aplodontia* and *Ondatra*. In *Aplodontia* the deltoid tuberosity is well developed but not recurved as in the castoridae. There is also present an entepicondylar foramen not present in the castoridae. The humerus of *Ondatra* is most like *Castor* in that the medial epicondyle is not as broad as in the castoroid beavers, while in *Aplodontia* it is broad.

RADIUS: The radius of castoroid beavers is close in most characteristics to that of *Castor*. Minor difference occur in the facets of the distal articular surface, however, these vary within the castoroid beavers. The cross-sectional outline of the distal end of the radius in both castoroid beavers and *Castor* is essentially an equilateral triangle. In this they roughly resemble *Ondatra* but differ considerably from *Aplodontia* which has a more flattened cross-sectional outline.

ULNA: The olecranon and semi-lunar notch of the ulna in the castoroid beavers compares closely with that of *Castor*.

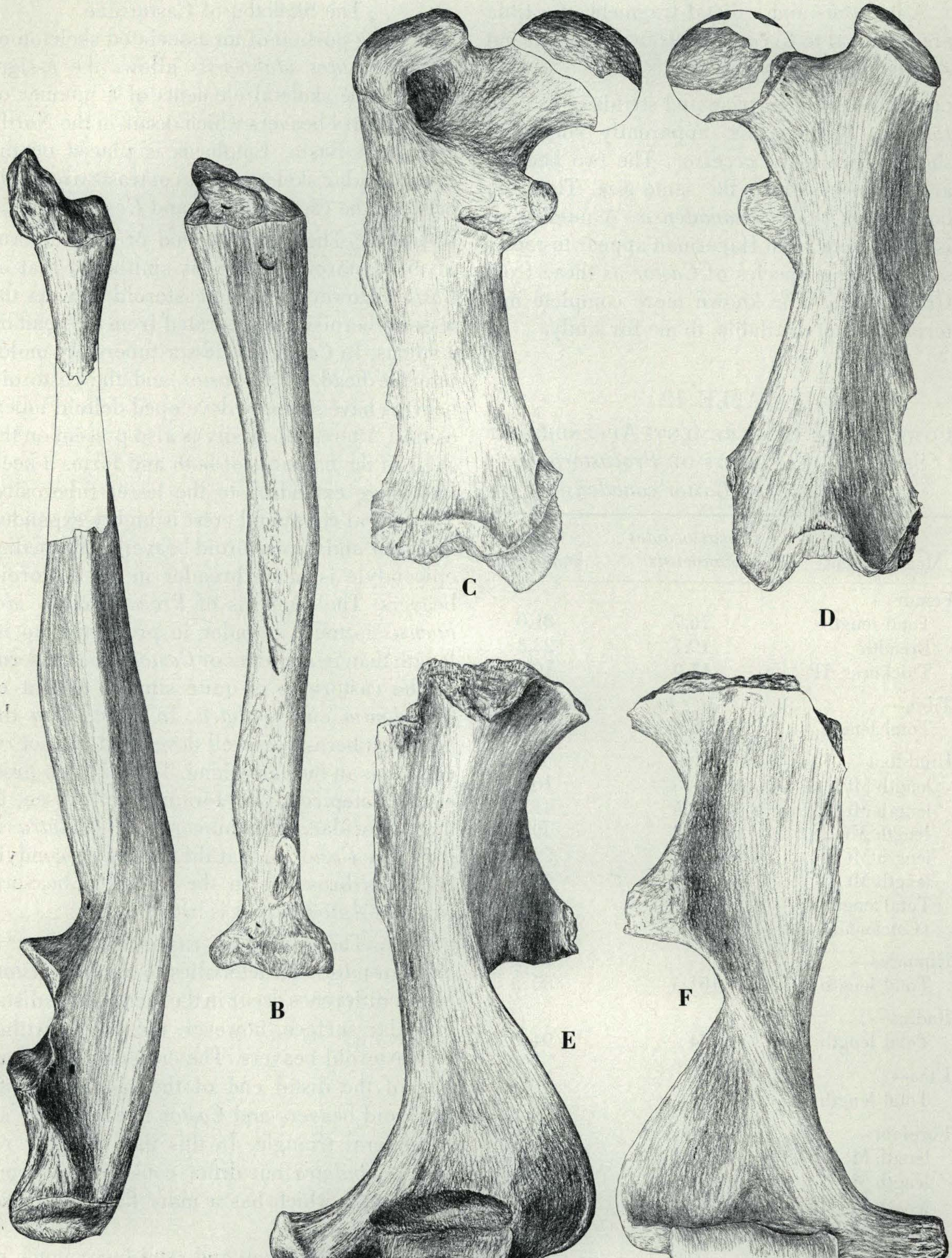


Figure 16. *Procastoroides idahoensis* n. sp. Castle Butte UOloc 2393, **A** UO27541 ulna lateral view, **B** UO27541 radius medial view, **C** UO27541 femur anterior view, **D** posterior view, **E** UO27541 humerus posterior view, **F** anterior view, all x 1.

There is a strong crest beginning at the medial side of the point of attachment of the biceps and brachialis muscles and running distally well down the shaft. This is a smooth crest without rugosities. In *Castor* this crest is represented only by a sharpness in the cross-sectional shape of the shaft.

The styloid process is complex in the castoroid beavers whereas in *Castor* it is a simple bulbous process with a base tapering to the large shaft. The process itself is well sculptured with a sharp lateral ridge and is well separated from the rest of the distal articular surface of the ulna by a deep notch.

PISIFORM: The gross shape of the pisiform of the castoroid beavers is very much like that of *Castor*. The articular surface, however, is simpler than in *Castor* in that it is concave laterally and convex antero-posteriorly. In *Castor* the antero-posterior curvature is primarily convex but is recurved at the anterior edge forming a small shallow basin. It articulates with the ulna and cuneiform.

CUNEIFORM: The most obvious difference between the cuneiform of the castoroid beavers and that of *Castor* is in the character of the facet to receive the styloid process of the ulna. In *Castor* this is a deep slightly ovate depression. Whereas in *Procastoroides* and its late Tertiary ancestors the facet is shallow and ovate. The head-like articulation with the scapholunar is relatively much larger with a proximal projection in the castoroid beavers. This to some extent gives a different overall shape of the cuneiform in this portion of the bone. They otherwise are similar. The cuneiform articulates with the unciform, pisiform and scapholunar.

SCAPHOLUNAR: The distal surface of the scapholunar of the castoroid beavers is similar to that of *Castor*, however, the facet for the trapezium extends much further ventrally. The medial-ventral process which carries the facet for the trapezium when viewed from the medial side is elongate and pointed ventrally in *Procastoroides* and its predecessors, whereas in *Castor* it is nearly square. On this process are two facets for the falciform in *Castor*. In the castoroid beavers a smooth area in the center of the medial face of the process may represent a falciform facet. No falciform, however, is present in the fossil material of any known castoroid beaver. The proximal surface is more rounded than in *Castor* and suggests along with the shallow styloid facet of the cuneiform that the castoroid beavers had somewhat more flexibility in this joint than does *Castor*. The scapholunar articulates with the radius, cuneiform, unciform, magnum (only very slightly), centrale and trapezium.

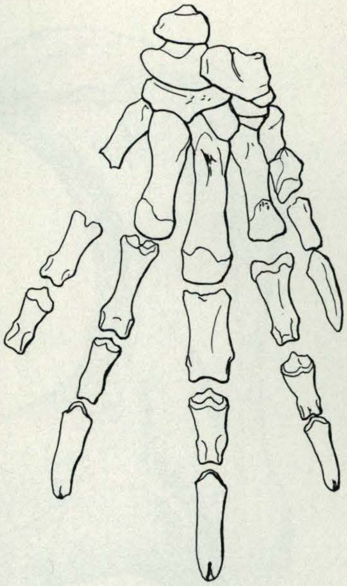
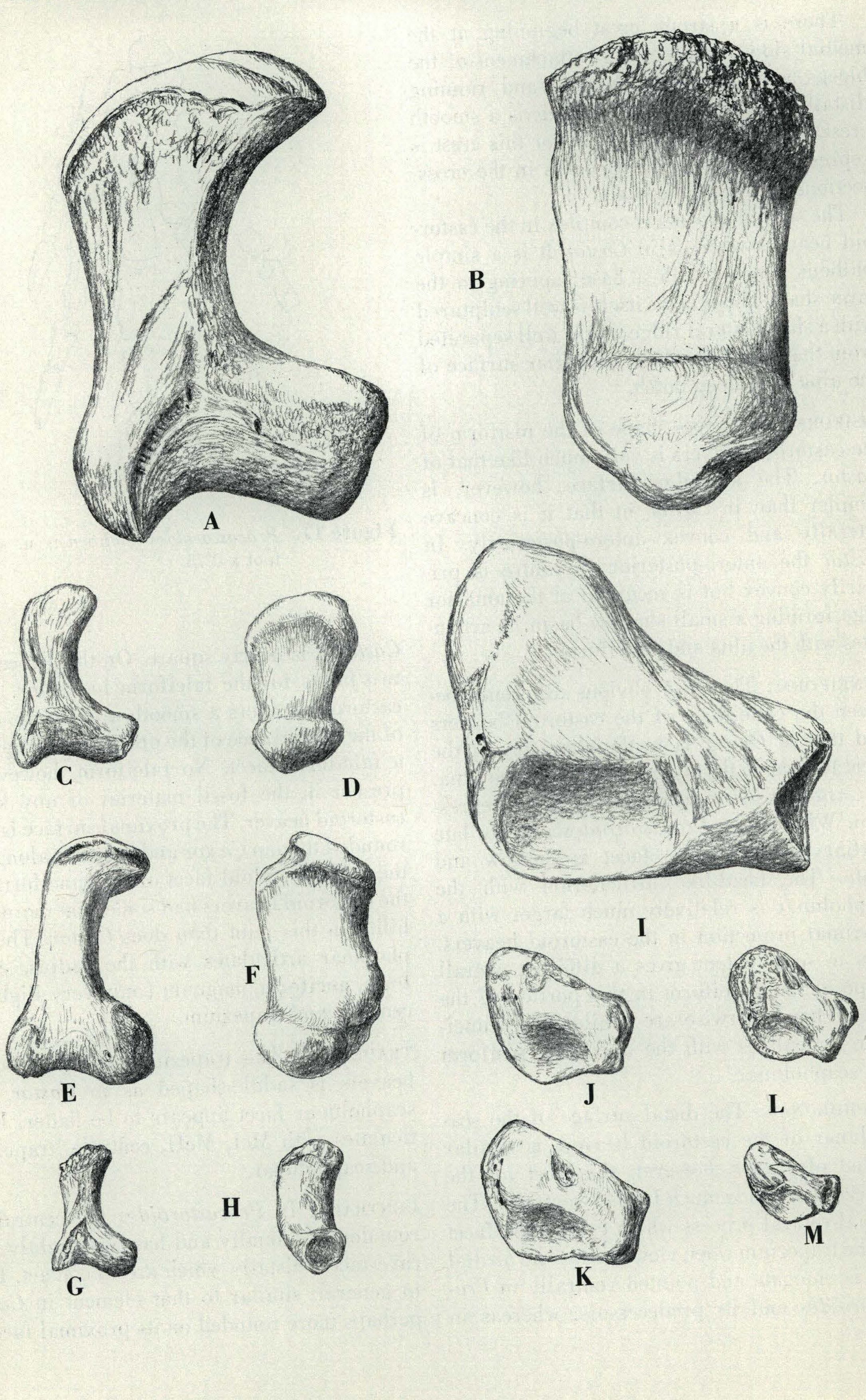


Figure 17. *Procastoroides idahoensis* n. sp. fore foot x 0.75.

TRAPEZIUM: The trapezium of the castoroid beavers is saddle-shaped as in *Castor*. The scapholunar facet appears to be flatter. It articulates with McI, McII, centrale, trapezoid, and scapholunar.

CENTRALE: In *Procastoroides* the centrale is rounded proximally and has two slightly concave facets distally which are in contact. It is, in general, similar to that element in *Castor* perhaps more rounded on its proximal face. It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articulates with trapezium, scapholunar, magnum and trapezoid.

MAGNUM: In *Procastoroides* the magnum is trapezoid in shape, very similar to that bone in *Castor*. The facet for McII is basined whereas in *Castor* it is nearly flat. It articulates with the McII, trapezoid, centrale, scapholunar (slightly), unciform, and McIII.

UNCIFORM: The facets for McIII and the magnum join at an obtuse angle in *Procastoroides* whereas in *Castor* they form a more nearly continuous surface. Otherwise this element is similar to that in *Castor*. It articulates with the magnum, scapholunar, cuneiform, McV, IV and III.

METACARPALS: Those of *Procastoroides* tend to have narrower proximal articular surfaces, for their size, than in *Castor*. They otherwise are similar. In the McV of *Castor* the articulation with McIV and the unciform is much broader and rounder than in *Procastoroides*.

PHLANGESS The phalanges of *Procastoroides* are similar allowing for the difference in size to those of *Castor*. The third phlanges of digit II, III and IV are much flatter, dorso-ventrally, than in *Castor*, indicating a very flat claw. The third phlanx of digit I is more like *Castor*. The third phalanx of digit V is not present in the material.

PELVIS: A fragment of a pelvis of *Procastoroides idahoensis* is present in the Castle Butte material. More complete material is known from Jackass Butte and is the basis of the description here. The available material consists of a partial right pelvis with the extremities of the illium, pubic and ishium missing. The only significant difference between the pelvis of *Castor* and *Procastoroides* is in size. The pelvis of *Procastoroides* is more massive. A similar fragment of *P. sweeti* from the Rexroad fauna (UMMP 42592) is close to the one from Jackass Butte. The acetabulum of the Rexroad specimen appears to be deeper but this undoubtedly reflects differences in the individual ages of the specimens.

Figure 18. Pisiform **A** *Procastoroides idahoensis* posterior view, **B** medial view, **C** *Dipoides vallicula* posterior view, **D** medial view, **E** *Dipoides smithi* posterior view, **F** medial view, **G** *Monosaulax progressus* posterior view, **H** medial view, **I-M** Cuneiform, **I** *Procastoroides idahoensis* distal view, **J** *Dipoides vallicula* distal view, **K** *Dipoides stirtoni* distal view, **L** *Eucastor malheurensis* distal view, **M** *Monosaulax progressus* distal view all x 5.

FEMUR: One femur, of *Procastoroides idahoensis*, lacking the proximal articulation, is present in the Castle Butte (UOLoc 2393) material, two other less complete specimens are also included. A fragmental femur is present in the Shoofly Creek material.

The most striking feature of the femur of *P. idahoensis* is its shortness. The specimens available are little longer than those of a large *Castor*. They differ, however, from *Castor* in a number of significant features. In *Procastoroides*, as also is the case in *Dipoides* and *Castoroides*, the shaft is proportionately much thicker than in *Castor*. There is some flattening, to be sure, but not comparable to that of *Castor* where the shaft is more than twice as wide as it is thick. The third trochanter is present in *Procastoroides* and as in *Dipoides* and *Castoroides*, it is nearly opposite, the second trochanter. In *Castor* the third trochanter is well down the shaft, in comparison. In *Procastoroides*, as in *Dipoides* and *Castoroides* the third trochanter is large and blade-like rather than the nature of a tubercle as in *Castor*.

Although the femur of *Procastoroides* is about the same length as that of *Castor* it is much more massive and the head is much larger. In *Procastoroides* and *Dipoides* the neck is shorter and directed more at right angles to the axis of the shaft than in *Castor*. The first trochanter in *Procastoroides* is similar to *Castor* but much larger. Highly aquatic mammals such as seals and sea lions typically have a very short femur. This characteristic in *Procastoroides* may indicate that *Procastoroides* is more aquatic in its habits than *Castor* or the earlier castoroid beavers.

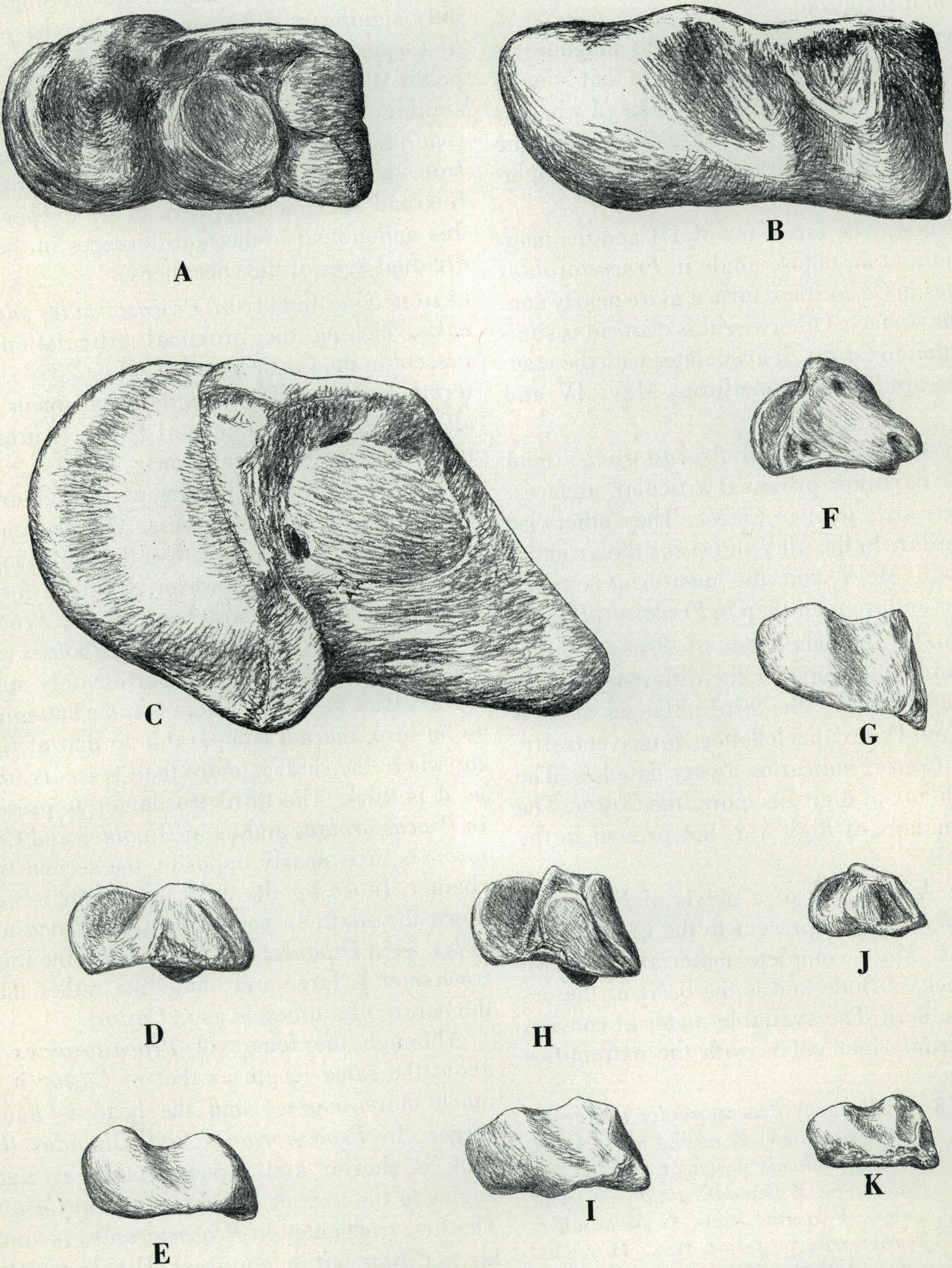


Figure 19. Scapholunar, **A** *Castor canadensis* medial view, **B** dorsal view, **C** *Procastoroides idahoensis* medial view, **D** *Dipoides smithi* medial view, **E** dorsal view, **F** *Dipoides vallicula* medial view, **G** dorsal view, **H** *Eucastor malheurensis* medial view, **I** dorsal view, **J** *Monosaulax progressus* medial view, **K** dorsal view, all x 5.

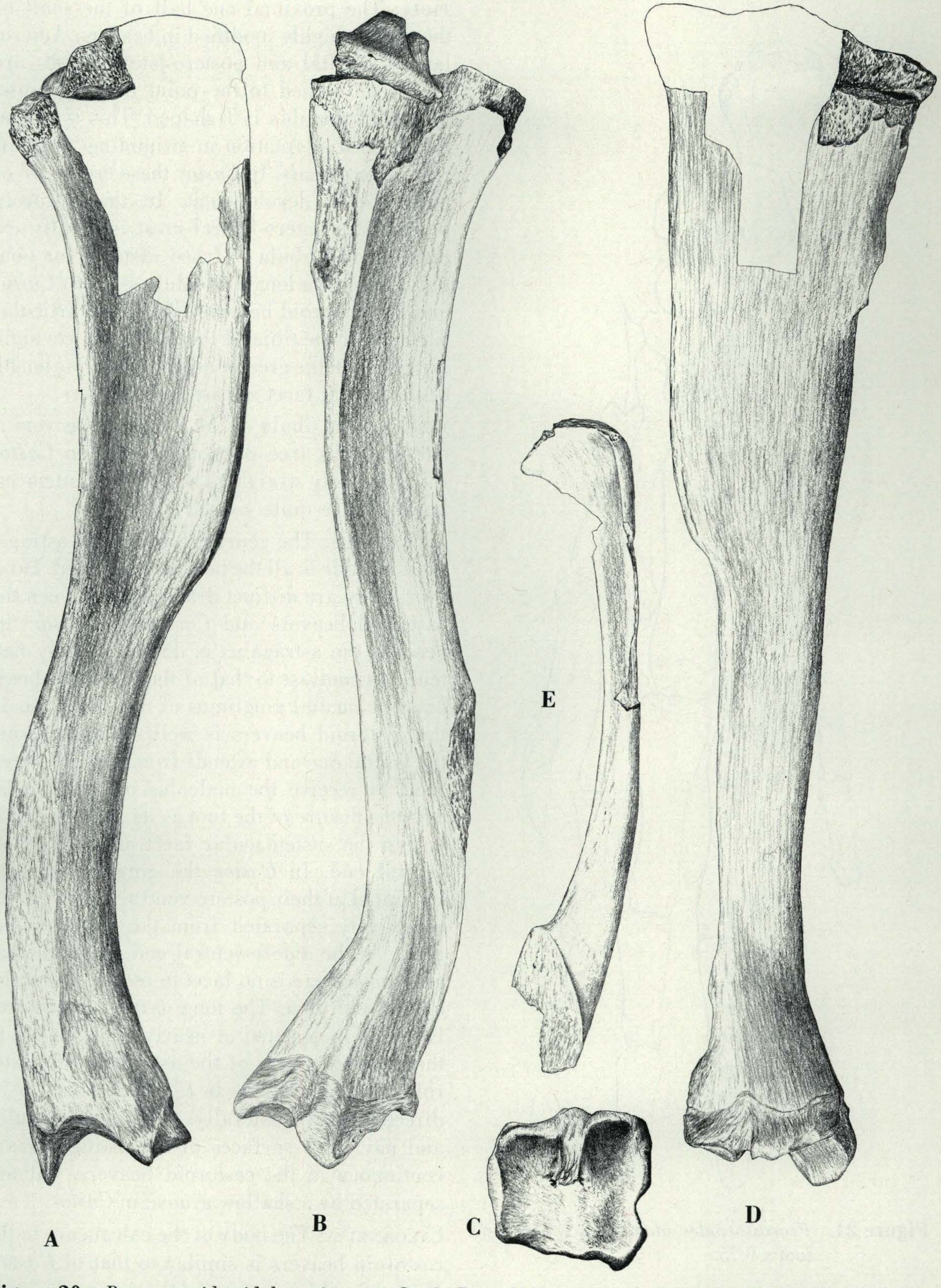


Figure 20. *Procastoroides idahoensis* n. sp. Castle Butte UOloc 2393, **A** UO27541 Tibia lateral view, **B** medial view, **C** ventral view, **D** anterior view, **E** UO27541 Fibula, all x 1.0.

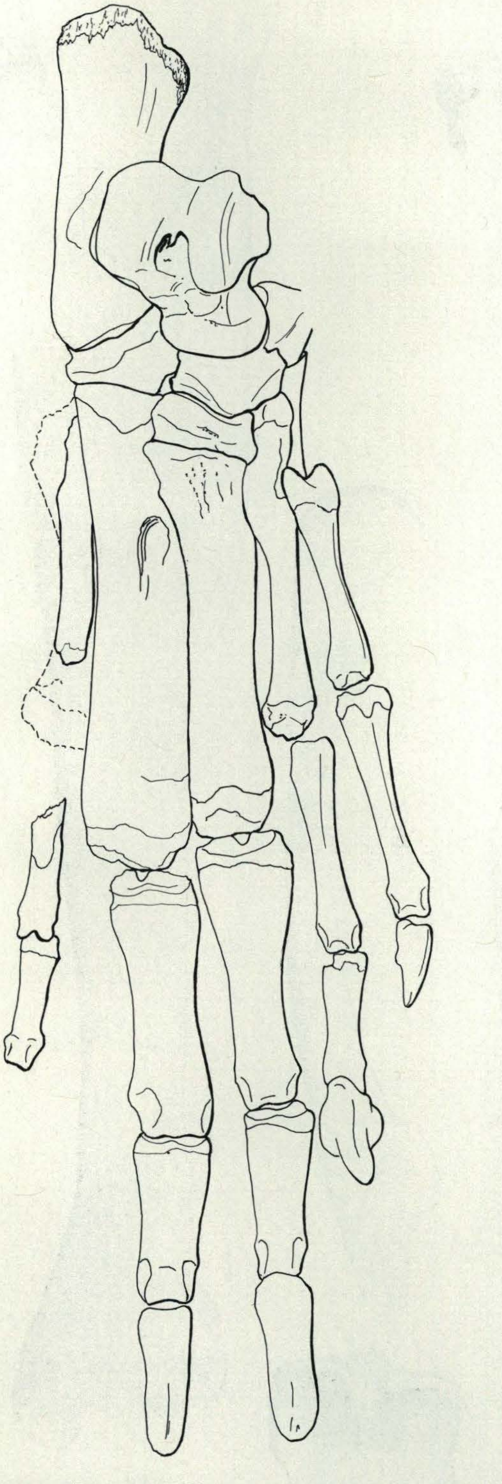


Figure 21. *Procastoroides idahoensis* n. sp. hind foot x 0.75.

TIBIA: The proximal one half of the shaft of the tibia is highly modified in beavers. Antero-lateral, medial and postero-lateral crests are highly developed to the point that the cross-section of the tibia is T shaped. This is a commonly seen adaptation in swimming and burrowing mammals. In *Castor* these crests are of about equal development. In the castoroid beavers the antero-lateral crest is greatly expanded. The fibula is fused distally for bout one third of its length in adults of both *Castor* and the castoroid beavers. The distal articular surfaces of the tibia of these beavers are similar expect in the greater antero-posterior length of the lateral facet in castoroid beavers.

FIBULA: The fibula of the castoroid beavers is curved in its free portion whereas in *Castor* it is relatively straight. The articular surfaces, however, are quite similar.

ASTRAGALUS: The general form of the astragalus is similar in all the beavers examined. However, there are distinct differences between the castoroid beavers and *Castor*. In *Castor* the head of the astragalus is dorso-ventrally flattened in contrast to that of the castoroid beavers. The medial ginglimus of the astragalus in the castoroid beavers is well separated from the lateral one and extends from a well defined facet to receive the maleolus of the tibia at extreme flexure of the foot as its antero-ventral end to the sustentacular facet at the postero-ventral end. In *Castor* the ginglimi are not separated at their postero-ventral ends and are completely separated from the sustentacular facet. At the antero-ventral end of the medial ginglimus there is no facet to receive the maleolus of the tibia. The long narrow sustentacular facet is oriented at nearly right angles to the transverse axis of the astragalus in castoroid beavers whereas in *Castor* it tends to be directed ventro-laterally. The sustentacular and navicular surfaces of the astragalus are continuous in the castoroid beavers, but are separated by a shallow groove in *Castor*.

CALCANEUM: The body of the calcaneum in the castoroid beavers is similar to that of *Castor*. However, the sustentaculum is much more prominent and extends further medially than in *Castor*. The medial articular surface on the sustentaculum is parallel to the long axis of the calcaneum in the castoroid beavers whereas in *Castor* the medial articular surface is oriented at an angle of about 25° from the long axis of the bone. This reflects the situation seen in the complimentary facet of the astragalus.

NAVICULAR: The body of the navicular of the castoroid beavers is transversely broad whereas in *Castor* it is narrower. This is reflected in the nearly round facet which receives the head of the astragalus. In *Castor* this facet is ovoid, the shorter diameter is oriented transversely. The other articular facets of the navicular are more nearly alike in the beavers examined.

CUBOID: The cuboid of the castoroid beavers is also much broader, proportionately, than in *Castor*. The articulation for the MtV occupies most of the ventral surface of the bone and is broad in the castoroid beavers, narrower in *Castor*. The dorsal articular surface for the calcanium forms an irregular shaped plane situated at an angle to the plane of the ventral articular surface. In *Procastoroides* the planes of the two articular surfaces are nearly parallel but the medial articular face of this surface is raised considerably above the main articulation and canted at about a thirty degree angle. *Monosaulax*, *Eucastor* and *Dipoides* are more like *Castor* in this characteristic.

ECTOCUNEIFORM: The arrangement of the articular facets of the ectocuneiform in *Castor* is similar to that in the castoroid beavers, however, some differences are recognized. The articular facet for the third metatarsal is concave in *Castor* and convex in the castoroid beavers. The dorso-ventral thickness of the ectocuneiform is much less, proportionately in *Procastoroides* than in *Castor*. *Monosaulax* and *Eucastor* are intermediate between the two in this characteristic.

NAVICULAR SESAMOID: The major articular surface of the navicular sesamoid is broad in *Procastoroides* and *Monosaulax* and narrow in *Castor* and *Eucastor*. The other articular facets are more similar.

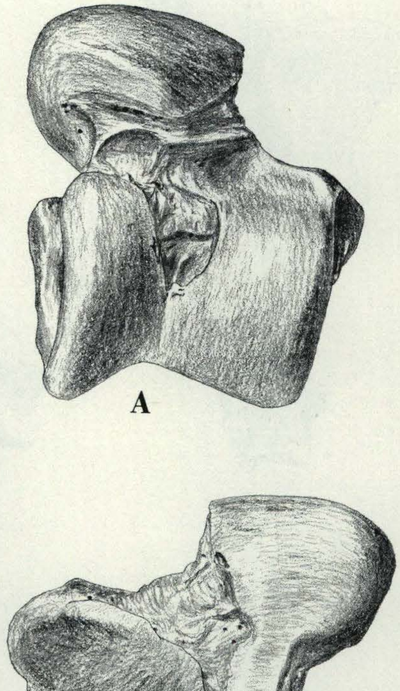
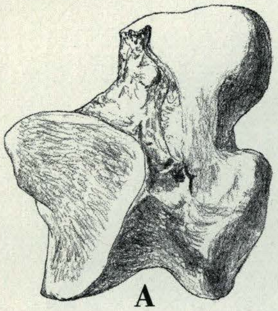


Figure 22. *Procastoroides idahoensis* n. sp. Castle Butte UOloc 2393 Astragalus UO27541, **A** dorsal view, **B** ventral view, **C** distal view, all x 1.5.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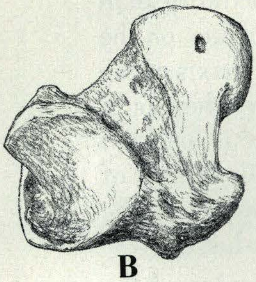
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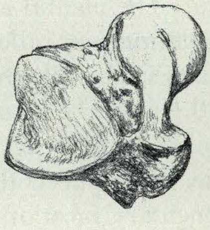
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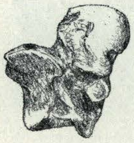
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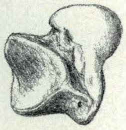
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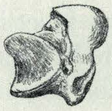
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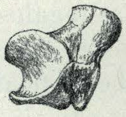
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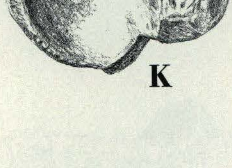
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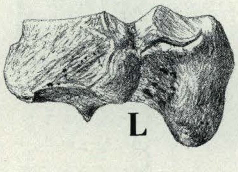
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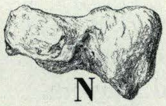
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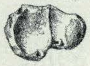
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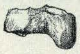
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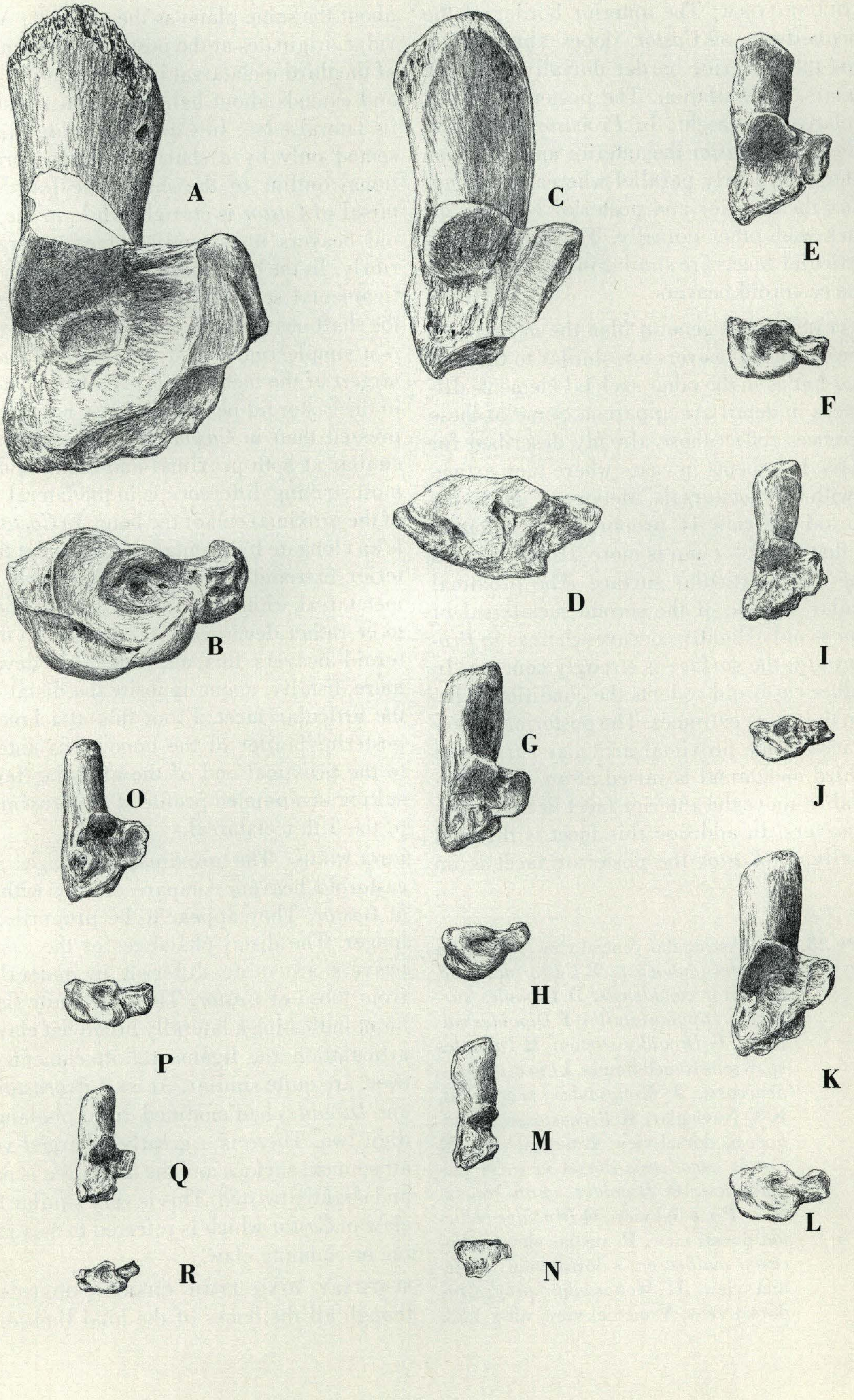
ENTOCUNEIFORM: The anterior border of the entocuneiform of *Castor* slopes abruptly towards the posterior border dorsally from the metatarsal articulation. The posterior border is relatively straight. In *Procastoroides, Dipoides* and *Eucastor* the anterior and posterior borders are nearly parallel whereas in *Monosaulax* the anterior and posterior borders approach each other dorsally. The arrangement of articular facets are similar in *Castor* to those of the castoroid beavers.

METATARSALS: In general plan the metatarsals of the castoroid beavers are similar to those of *Castor* but as in the other skeletal elements differences in detail are apparent. Some of these differences reflect those already described for the tarsal elements in cases where they articulate with the metatarsals. Metatarsal one in the castoroid beavers is proportionately longer than that of *Castor* and is more strongly keeled at the distal articular surface. The proximal articular surface of the second metatarsal of *Castor* is only slightly concave whereas in *Procastoroides* the surface is strongly concave. In the other castoroid rodents the condition is between these two extremes. The posterior articular facet of the proximal articular surface of the third metatarsal is raised at an angle considerably above the anterior facet in the castoroid beavers. In addition this facet is directed medially. In *Castor* the posterior facet is on about the same plane as the anterior. A strong ridge originates at the posterior proximal edge of the third metatarsal in the castoroid beavers and extends about halfway down the shaft on its lateral edge. In *Castor* this ridge is represented only by a sharpness in the cross-sectional outline of the shaft. The fourth metatarsal of *Castor* is straight while in the castoroid beavers it is gently curved antero-posteriorly. In the castoroid beavers there is a deep ligamental scar on the antero-medial side of the shaft near its proximal end. In *Castor* there is a simple rugosity at this point. This is the largest of the metatarsals. The fifth metatarsal in the castoroid beavers is more laterally compressed than in *Castor*. The articulations are similar at both proximal and distal ends. The most striking difference is in the lateral profile of the proximal end of the bone. In *Castor* there is an elongate ligamental attachment at the posterior extremity of the proximal end of the metatarsal which causes this end of the bone to be rather deep in lateral profile. In the castoroid beavers this attachment is developed more distally, about opposite the distal end of the articular facet. From this attachment the posterior border of the bone turns anteriorly to the proximal end of the articular facet resulting in a pointed profile at the proximal end of the fifth metatarsal.

Figure 23. **A-J** Astragalus ventral view, **A** *Procastoroides idahoensis,* **B** *Castor accessor,* **C** *Castor canadensis,* **D** *Dipoides stirtoni,* **E** *Dipoides smithi,* **F** *Dipoides vallicula,* **G** *Dipoides stirtoni,* **H** *Dipoides* sp. Krebs Ranch Fauna, **I** *Eucastor malheurensis,* **J** *Monosaulax progressus,* **K-V** Navicular, **K** *Procastoroides idahoensis* dorsal view, **L** medial view, **M** *Castor canadensis* dorsal view, **N** medial view, **O** *Dipoides smithi* dorsal view, **P** medial view, **Q** *Dipoides vallicula* dorsal view, **R** medial view, **S** *Eucastor malheurensis* dorsal view, **T** medial view, **U** *Monosaulax progressus* dorsal view, **V** medial view, all x 1.25.

PHALANGES: The proximal phalanges of the castoroid beavers compare closely with those of *Castor*. They appear to be proportionately longer. The distal phalanges of the castoroid beavers are quite different in general view from those of *Castor*. They are quite flat and blunt indicating a laterally broad flat claw. The articulation and ligamental attachments, however, are quite similar. At least *Procastoroides* and *Dipoides* had modified distal phalanges on digit two. There is a greatly enlarged ventral attachment surface and the claw area is narrow and slightly twisted. This is very similar to this claw in *Castor* which is referred to as a grooming or combing claw.

SUMMARY HIND LIMB CHARACTERISTICS: Although all the bones of the hind limb of *Pro-*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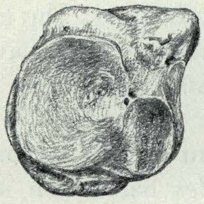
castoroides are superficially similar to those of *Castor*, there are significant differences in their proportions and specific characters. The most obvious proportional differences are in the relative size of the tibia and femur. The femur of *Procastoroides* has a rounder and heavier shaft than does *Castor* and also differs in some minor characteristics. The femur of *Procastoroides* is about the same length as that of a large *Castor* with which is was compared. The tibia of *Procastoroides* is much longer than that of the same large *Castor* specimen. Since in both cases the elements were from single individuals it is clear that the lower leg of *Procastoroides* was proportionately much longer than that of *Castor*. *Procastoroides* is half again larger than *Castor* in all its elements other than the femur. This disparity is not as great in *Dipoides* where the relative length of the femur to the tibia is closer to that of *Castor*.

The hind foot although similar to *Castor* differs in many characteristics which determine its positioning and mobility. The character of the astragalus, calcaneum, distal tibia and tarsal elements indicate that *Castor* can elevate the foot to a sharper angle with the tibia than could *Procastoroides* but can not extend the foot to a position in line with the long axis of the tibia as apparently *Procastoroides* was capable. Lateral movement at the trochlear joint of the foot is limited in both beavers by the well developed trochlear grooves of the tibia and ginglimi of the astragalus. Some lateral movement is afforded by rotation at the astragalus-navicular joint in both beavers. The much rounder astragalus head and proximal navicular articulation in *Procastoroides* along with the more antero-posterior orientation of the facet of the sustentaculum of the calcanium suggest that *Procastoroides* had much more antero-posterior flexibility at this joint than does *Castor*. Comparison of these foot elements of *Monosaulax, Eucastor* and *Dipoides*, which make up the ancestral lines of *Procastoroides* shows that these forms also differ from *Castor* in these same characteristics. These differences in two parallel lines of beavers indicate that the castoroid beavers had hind feet adapted for somewhat different use than that of *Castor*. In the characteristics noted the castoroid beavers show convergence with the muskrat to some degree and may have used their hind feet similarly. Such similarities and differences are, however, difficult to access.

Figure 24. Calcaneum, **A** *Procastoroides idahoensis* anterior view, **B** distal view,**C** *Castor canadensis* anterior view, **D** distal view, **E** *Dipoides stirtoni* UOloc 2469 anterior view, **F** distal view, **G** *Dipoides stirtoni* UOloc 2380 anterior view, **H** distal view, **I** *Dipoides vallicula* anterior view, **J** distal view, **K** *Dipoides smithi* anterior view, **L** distal view, **M** *Eucastor* sp. Unity anterior view, **N** distal view, **O** *Eucastor malheurensis* anterior view, **P** distal view, **Q** *Monosaulax progressus* anterior view, **R** distal view, all x 1.25.

CAUDAL VERTEBRAE: Because of the importance of the fleshy tail in beavers the caudal vertebrae are important in an accessment of their relative morphologies. Caudal vertebrate have been compared from a number of mammals. Modern forms included *Castor*, *Erethizon* and *Ondatra*, all rodents with fleshy tails. They represent a flat-tailed swimming form, a climbing form and a round-tailed swimming form. These were compared with caudal vertebrate of the castoroid beavers *Monosaulax, Eucastor, Dipoides* and *Procastoroides*, which represent an apparent phylogeny in the late Pliocene in the order they appear above.

The most obvious differences and similarities in the tail of these seven genera of living and fossil rodents are in the character of the transverse process. In *Castor* the transverse process is well developed and occurs on all but the terminal vertebrae. The process is thin and projects slightly caudal in the first few vertebrate but is nearly perpendicular to the axial column in the remainder. Beginning with about the tenth caudal vertebrae the distal end of the transverse process is bifurcate. This bifurcation becomes deeper until at about caudal vertebrae fifteen there are essentially two transverse



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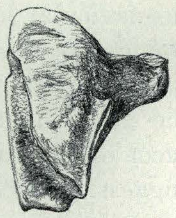

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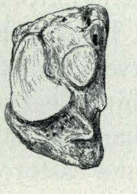

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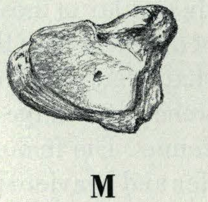

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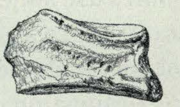

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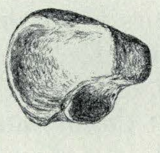

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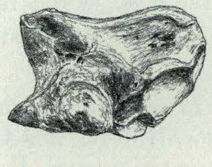

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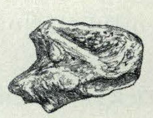

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processes, the anterior one the longer. In *Erethizon* (porcupine) the transverse processes are well developed but rather differently than in *Castor*. The processes are not so long as in *Castor* nor are they bifurcate. They terminate in a broad attachment surface which is apparent even on the most terminal vertebrae. In *Ondatra* (muskrat) the transverse process is reduced to a ridge with distal thickening. This ridge extends the full length of the vertebrae and is reflected in the epiphysis of the vertebrae. In the castoroid beavers *(Monosaulax, Eucastor, Dipoides* and *Procastoroides)* the transverse process is greatly reduced but thickened on the distal ends. The transverse process is relatively larger than in *Ondatra* but most like it of the three forms studied. The development of the transverse process of the fourteenth caudal of *Erethizon* is very much like that of the anterior caudal vertebrate of the castoroid beavers.

The centrum of the caudal vertebrae of *Castor* are nearly round at the epiphysis in the anterior vertebrate. Posteriorly starting with about the tenth vertebrae they become noticeably flattened dorso-ventrally and become progressively more flattened posteriorly in the tail. The centrum of the caudal vertebrae of *Erethizon, Ondatra* and the castoroid beavers show no flattening.

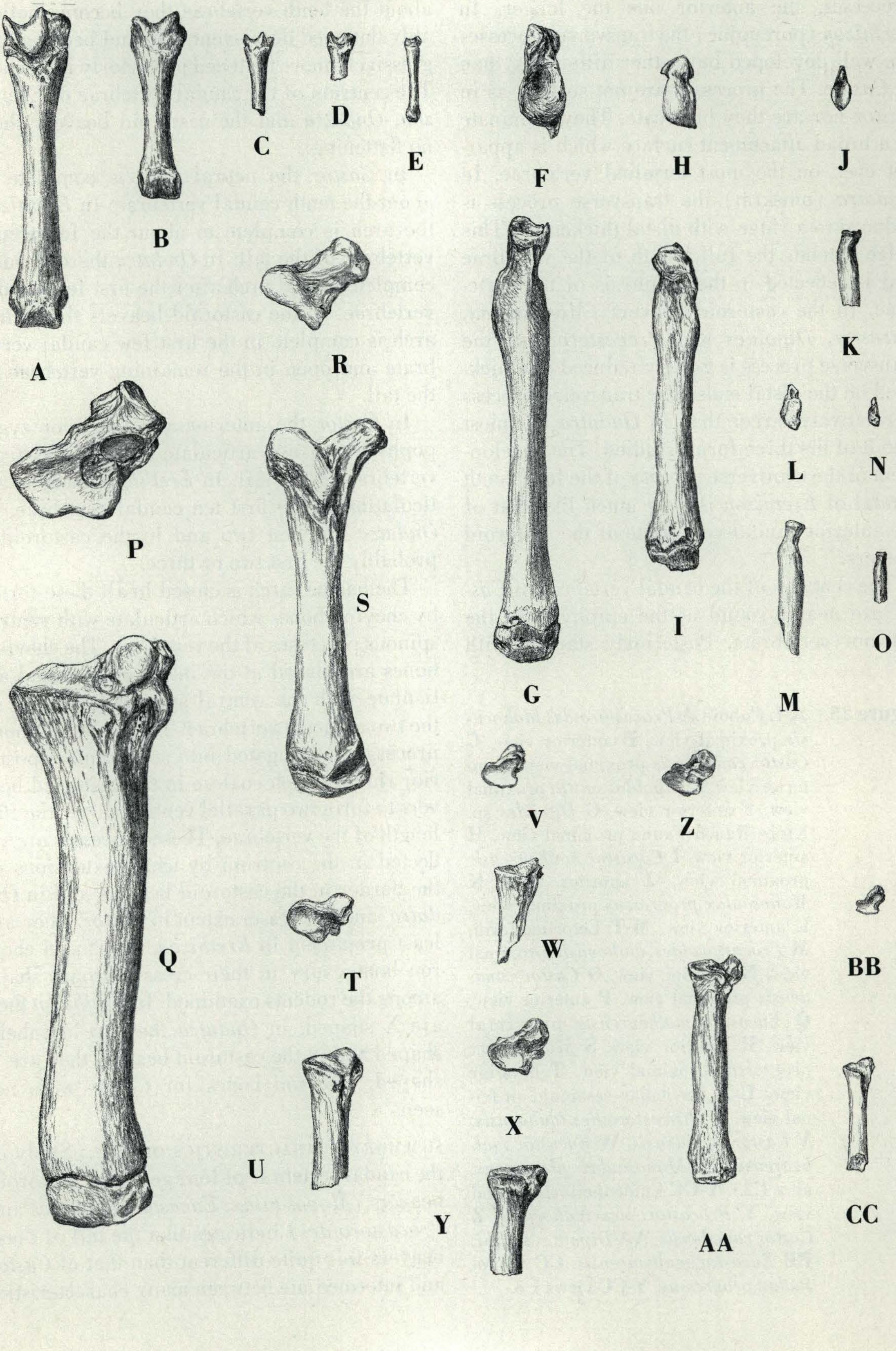
In *Castor* the neural arch is complete to about the tenth caudal vertebrae. In *Erethizon* the arch is complete to about the fourteenth vertebrae of the tail. In *Ondatra* there is not a complete neural arch after the first few caudal vertebrae. In the castoroid beavers the neural arch is complete in the first few caudal vertebrate and open in the remaining vertebrae of the tail.

In *Castor* the anterior and posterior zygopophyses do not articulate beyond the sixth vertebrae of the tail. In *Erethizon* there is articulation in the first ten caudal vertebrae, in *Ondatra* the first two and in the castoroides probably the first two or three.

The haemal arch is closed in all these forms by chevron bones which articulate with ventral spinous processes of the vertebrae. The chevron bones are placed at the inter centrum and articulate with the ventral spinous processes of the two adjacent vertebrae. The ventral spinous process are elongated into small antero-posterior ridges which coalese in the castoroid beavers to form two parallel ventral ridges the full length of the vertebrae. These processes are reflected in the centrum by small extensions of the border in the castoroid beavers and in *Ondatra*, and to a lesser extent in *Castor*. They are least prominent in *Erethizon*. The fused chevron bones vary in their cross-sectional shape among the rodents examined. In *Erethizon* they are X shaped, in *Ondatra* they are dumbell-shaped and in the castoroid beavers they are Y shaped. Chevron bones for *Castor* were not seen.

SUMMARY CHARACTERISTICS OF TAIL: Study of the caudal vertebrae of four genera of castoroid beavers *(Monosaulax, Eucastor, Dipoides* and *Procastoroides)* indicates that the tail of these beavers was quite different than that of *Castor* and intermediate between many characteristics

Figure 25. **A-L** Cuboid,**A** *Procastoroides idahoensis* proximal view, **B** anterior view, **C** *Castor canadensis* proximal view,**D** anterior view, **E** *Dipoides smithi* proximal view, **F** anterior view, **G** *Dipoides* sp. Krebs Ranch Fauna proximal view, **H** anterior view, **I** *Eucastor malheurensis* proximal view, **J** anterior view, **K** *Monosaulax progressus* proximal view, **L** anterior view, **M-T** Ectocuneiform, **M** *Procastoroides idahoensis* proximal view, **N** anterior view, **O** *Castor canadensis* proximal view, **P** anterior view, **Q** *Eucastor malheurensis* proximal view, **R** anterior view, **S** *Monosaulax progressus* proximal view, **T** anterior view, **U-X** Navicular sesamoid proximal view, **U** *Procastoroides idahoensis,* **V** *Castor canadensis,* **W** *Eucastor malheurensis,* **X** *Monosaulax progressus,* all x 1.25, **Y-CC** Entocuneiform medial view, **Y** *Procastoroides idahoensis,* **Z** *Castor canadensis,* **AA** *Dipoides smithi,* **BB** *Eucastor malheurensis,* **CC** *Monosaulax progressus,* **Y-CC** views x 5.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of *Erethizon* and *Ondatra*. The lack of flattening of the centrum, the reduced transverse processes and well developed chevron bones lead to the conclusion that their tail was muscular, round and possibly ventrally keeled. It is for this reason that I have referred to the castoroid beavers as "round-tailed beavers" in contrast to the 'flat-tailed beavers" (*Castor*) (Shotwell 1962).

SUBORDER MYOMORPHA

SUPERFAMILY MUROIDEA

FAMILY CRICETIDAE

SUBFAMILY CRICETINAE

? *ORYZOMYS* sp.

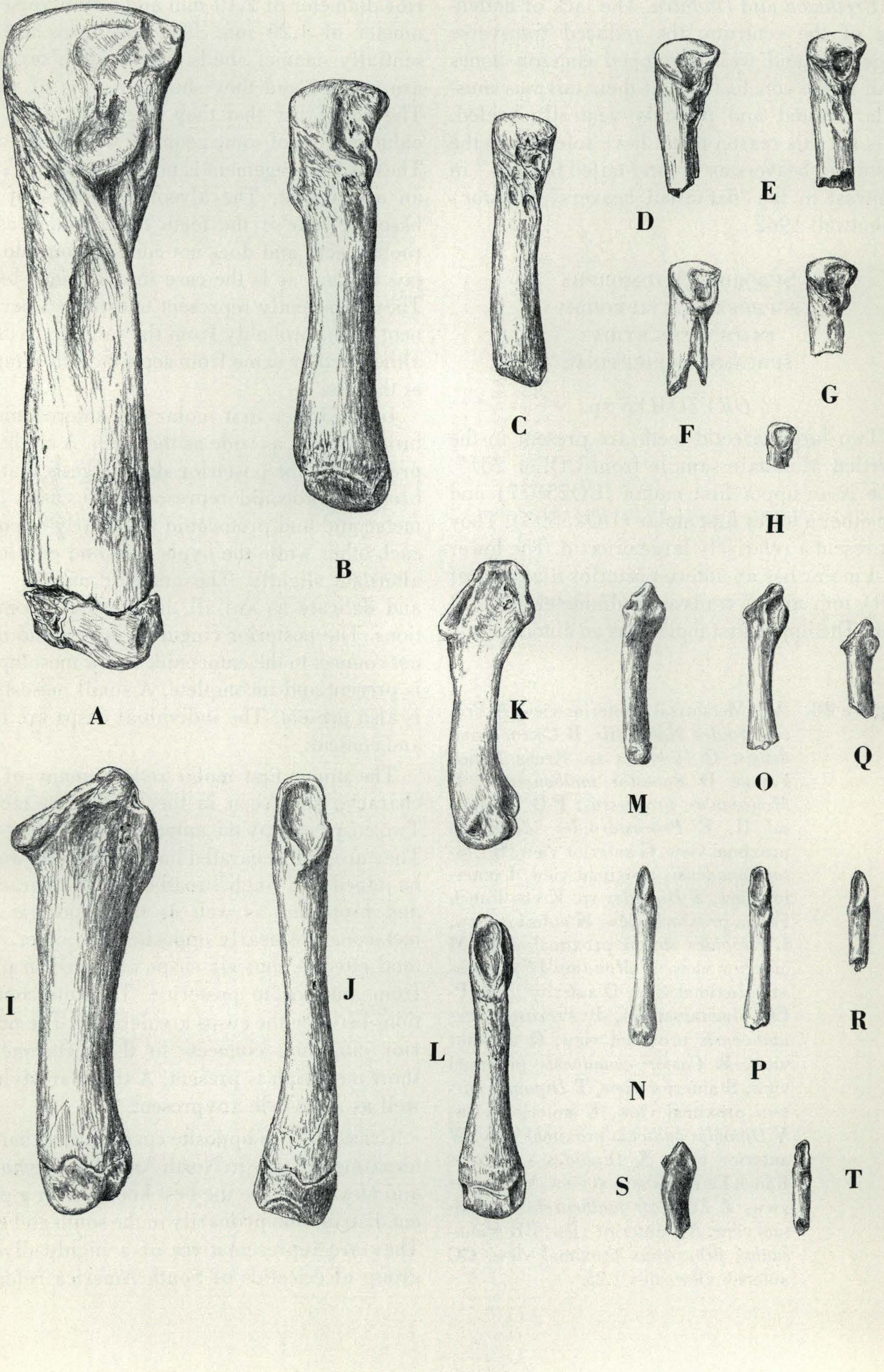
Two large cricetid teeth are present in the Bartlett Mountain sample from UOLoc 2517. One is an upper first molar (UO25077) and the other a lower first molar (UO25593). They represent a relatively large cricetid. The lower first molar has an antero-posterior diameter of 2.01 mm and a transverse diameter of 1.13 mm. The upper first molar has an antero-posterior diameter of 2.19 mm and a transverse diameter of 1.26 mm. The specimens are essentially enamel shells. No dentine or roots are present and they show no signs of wear. The possibility that they might represent deciduous teeth of some geomine was considered. The cusp arrangement is not suggestive of such an assignment. The alveolar borders of the base of each of the teeth tucks under as in rooted teeth and does not continue on into the jaw or flare as is the case in deciduous teeth. They apparently represent unerrupted permanent teeth, probably from the same individual although they came from separate sub samples at the site.

In the lower first molar the anteroconid is broad, nearly as wide as the tooth. A slight depression on the posterior side suggests that the broad anteroconid represents two cusps. The metaconid and protoconid are nearly opposite each other while the hypoconid and entoconid alternate slightly. The anterior mure is low and delicate as are all the intercusp connections. The posterior cingulum is low and does not connect to the entoconid. A low mesolophid is present and incomplete. A small mesostylid is also present. The individual cusps are high and conical.

The upper first molar reflects many of the characteristics seen in the lower first molar. Two cusps occupy the anterior end of the tooth. They are well separated but in late wear would be joined as a single broad cusp. The paracone and protocone as well as the hypocone and metacone are nearly opposite each other. The total effect is thus six cusps arranged in pairs from anterior to posterior. The interconnections between the cusps are delicate. The posterior cingulum connects to the metacone. A short mesoloph is present. A tiny parastyle as well as mesostyle are present.

Cricetids with opposite cusps rather than alternating are rare in North America. *Sigmodon* and *Oryzomys* are the best known with a present distribution primarily in the south and east. They are representatives of a highly diverse group of cricetids of South America referred

Figure 26. **A-E** Metatarsal I anterior view, **A** *Procastoroides idahoensis*, **B** *Castor canadensis*, **C** *Dipoides* sp. Krebs Ranch Fauna, **D** *Eucastor malheurensis*, **E** *Monosaulax progressus*, **F-O** Metatarsal II, **F** *Procastoroides idahoensis* proximal view, **G** anterior view, **H** *Castor canadensis* proximal view, **I** anterior view, **J** *Dipoides* sp. Krebs Ranch Fauna proximal view, **K** anterior view, **L** *Dipoides smithi* proximal view, **M** anterior view, **N** *Monosaulax progressus* proximal view, **O** anterior view, **P-CC** Metatarsal III, **P** *Procastoroides idahoensis* proximal view, **Q** anterior view, **R** *Castor canadensis* proximal view, **S** anterior view, **T** *Dipoides stirtoni* proximal view, **U** anterior view, **V** *Dipoides vallicula* proximal view, **W** anterior view, **X** *Dipoides* sp. Krebs Ranch Fauna proximal view, **Y** anterior view, **Z** *Eucastor malheurensis* proximal view, **AA** anterior view, **BB** *Monosaulax progressus* proximal view, **CC** anterior view, all x 1.25.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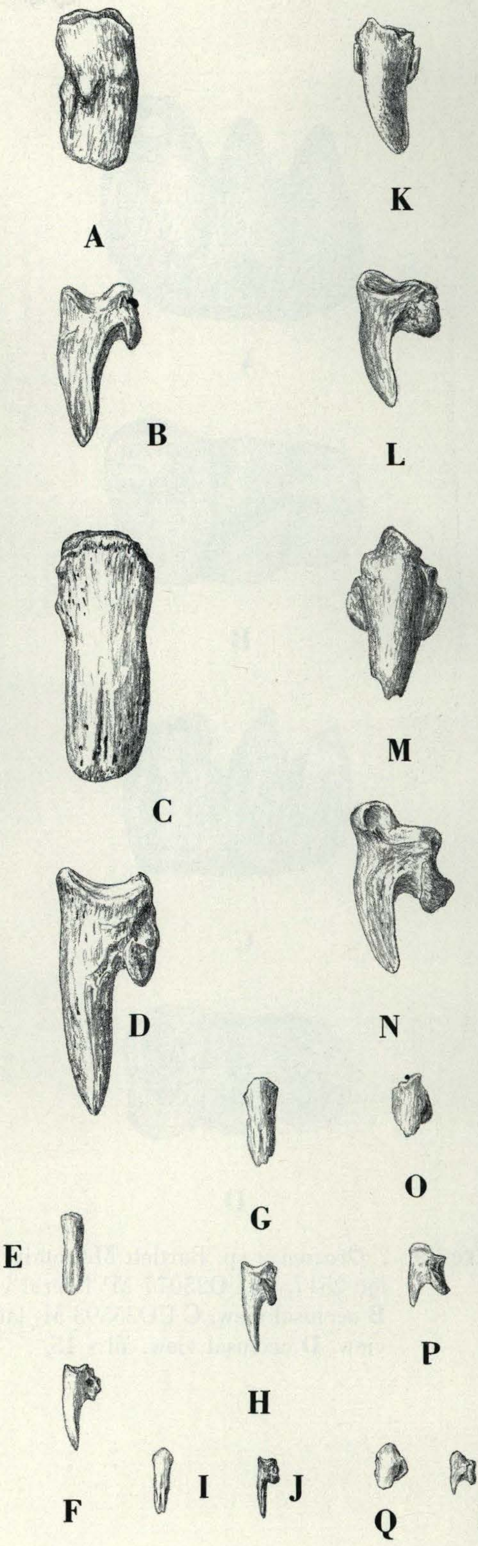


Figure 28. **A-J** Terminal phalanges III or IV, **A** *Castor canadensis* anterior view, **B** lateral view, **C** *Procastoroides idahoensis* anterior view, **D** lateral view, **E** *Eucastor malheurensis* anterior view, **F** lateral view, **G** *Dipoides* sp. Krebs Ranch Fauna anterior view, **H** lateral view, **I** *Monosaulax progressus* anterior view, **J** lateral view, **K-R** Terminal Phalanges II-grooming claw, **K** *Castor canadensis* anterior view, **L** lateral view, **M** *Procastoroides idahoensis* anterior view, **N** lateral view, **O** *Dipoides* sp. Krebs Ranch Fauna anterior view, **P** lateral view, **Q** *Monosaulax progressus* anterior view, **R** lateral view, all x 1.25.

to as the scapteromyines by Hershkovitz (1966 A). Hershkovitz (1966 B) considers *Sigmodon* and *Oryzomys* to be migrants from South America. *Oryzomys* occurs in Pleistocene faunas of the southern and central United States. *Sigmodon* is also, represented in Pleistocene faunas of Kansas and Florida. Opposing cusps are present on the teeth of a number of Eurasian cricetine and murine rodents. The hamsters, for example, are quite similar to the new material.

The individual cusps of Sigmodon are strongly interconnected obliquely resulting in a lophiodont appearance to the dentition. The median cusps of the upper teeth and the lateral cusps of the lower teeth are interconnected in

Figure 27. **A-H** Metatarsal IV anterior view, **A** *Procastoroides idahoensis,* **B** *Castor canadensis,* **C** *Dipoides* sp. Krebs Ranch Fauna, **D** *Dipoides smithi,* **E** *Dipoides stirtoni,* **F** *Dipoides vallicula,* **G** *Eucastor malheurensis,* **H** *Monosaulax progressus,* **I-T** Metatarsal V, **I** *Procastoroides idahoensis* lateral view, **J** anterior view, **K** *Castor canadensis* lateral view, **L** anterior view, **M** *Dipoides vallicula* lateral view, **N** anterior view, **O** *Dipoides* sp. lateral view, **P** anterior view, **Q** *Eucastor malheurensis* lateral view, **R** anterior view, **S** *Monosaulax progressus* lateral view, **T** anterior view, all x 1.25.

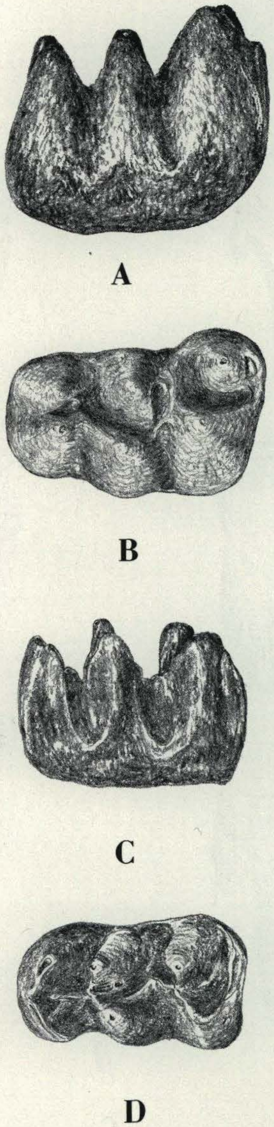


Figure 29 ? *Orozomys* sp. Bartlett Mountain UOloc 2517, **A** UO25077 M^1 lateral view, **B** occlusal view, **C** UO25593 M_1 lateral view, **D** occlusal view, all x 15.

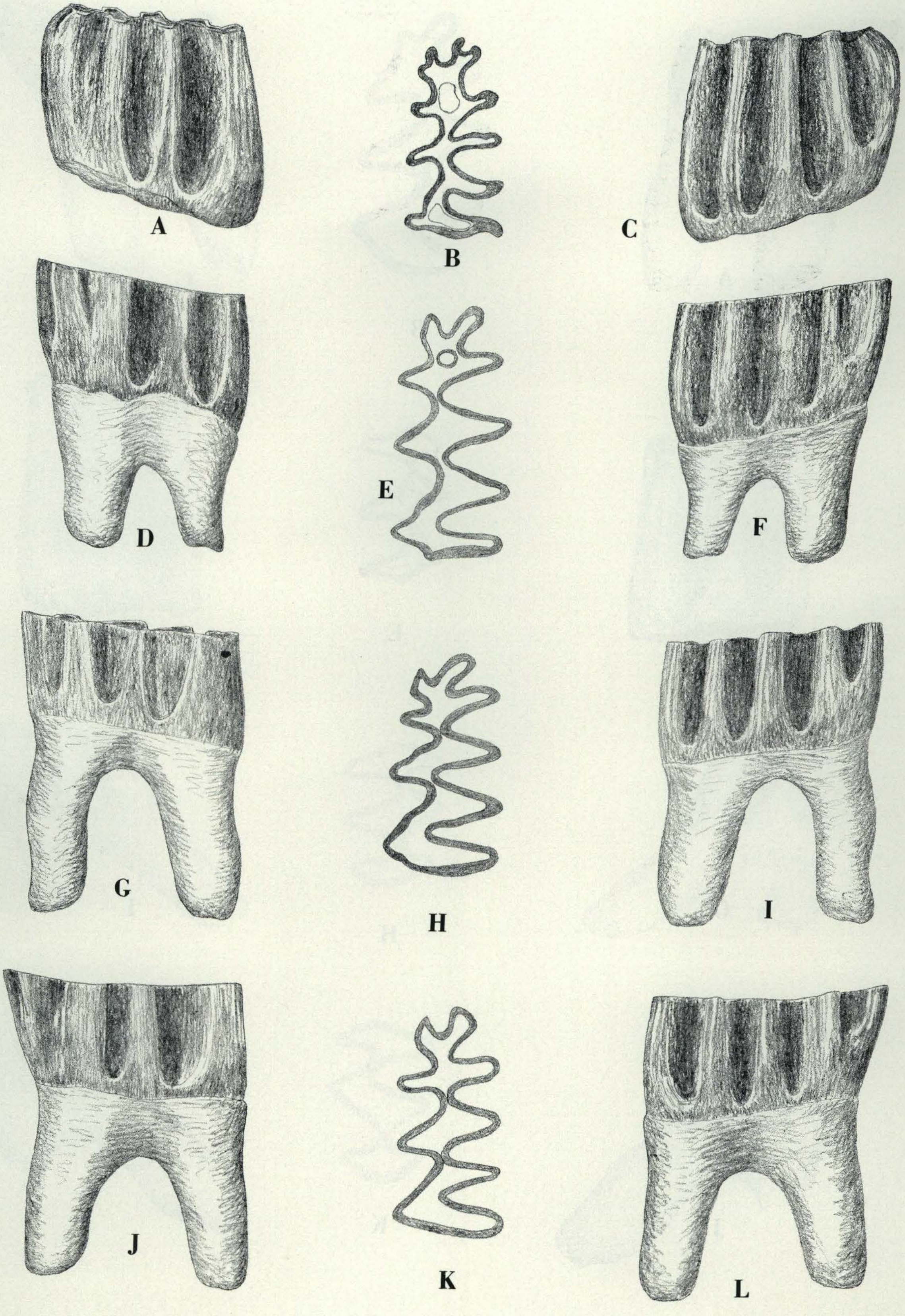
Oryzomys with the opposite cusps relatively isolated. In the upper teeth of *Cricetus*, the cusps are connected transversely at both the anterior and posterior borders usually resulting in a small lake between the connections. In the lower teeth the protoconid and metaconid are closely appressed. The entoconid and hypoconid are connected at their anterior borders. The teeth of these species are all of about the same size as the new material. *Oryzomys* appears to be closest to the new material which is assigned to that genus in the broadest sense in fact it might be more accurate to indicate that an orozomyine is represented. With so little material only a very tenative assignment can be made. It appears, however, that these two specimens represent a cricetid previously unknown in the North American Hemphillian.

SUBFAMILY ARVICOLINAE

MICROTOSCOPTES sp.

An anterior fragment of a M_1 (UO24479) from the Clarendonian Black Butte locality (UOLoc 2500) represents *Microtoscoptes*. The specimen represents a tooth in late wear. Moderately worn lower first molars of microtines frequently fracture just posterior to the anterior root since with progressive wear this region becomes weaker. Comparison with a similarly fractured and worn lower first molar of *Microtoscoptes disjunctus* (UO24595) from the Hemphillian Bartlett Mountain sample (UOLoc 2517) described below is identical in characteristics of the occlusal outline. The Black Butte specimen is slightly larger and appears to have a stouter root. Because of the stage of wear of the tooth it is not possible to determine the original height of crown.

Figure 30 *Microtoscoptes disjunctus* Bartlett Mountain UOloc 2517 variations in the lower molar, **A** UO27025 lateral view, **B** occlusal view, **C** medial view, **D** UO27030 lateral view, **E** occlusal view, **F** medial view, **G** UO27028 lateral view, **H** occlusal view, **I** medial view, **J** UO27027 lateral view, **K** occlusal view, **L** medial view all x 15.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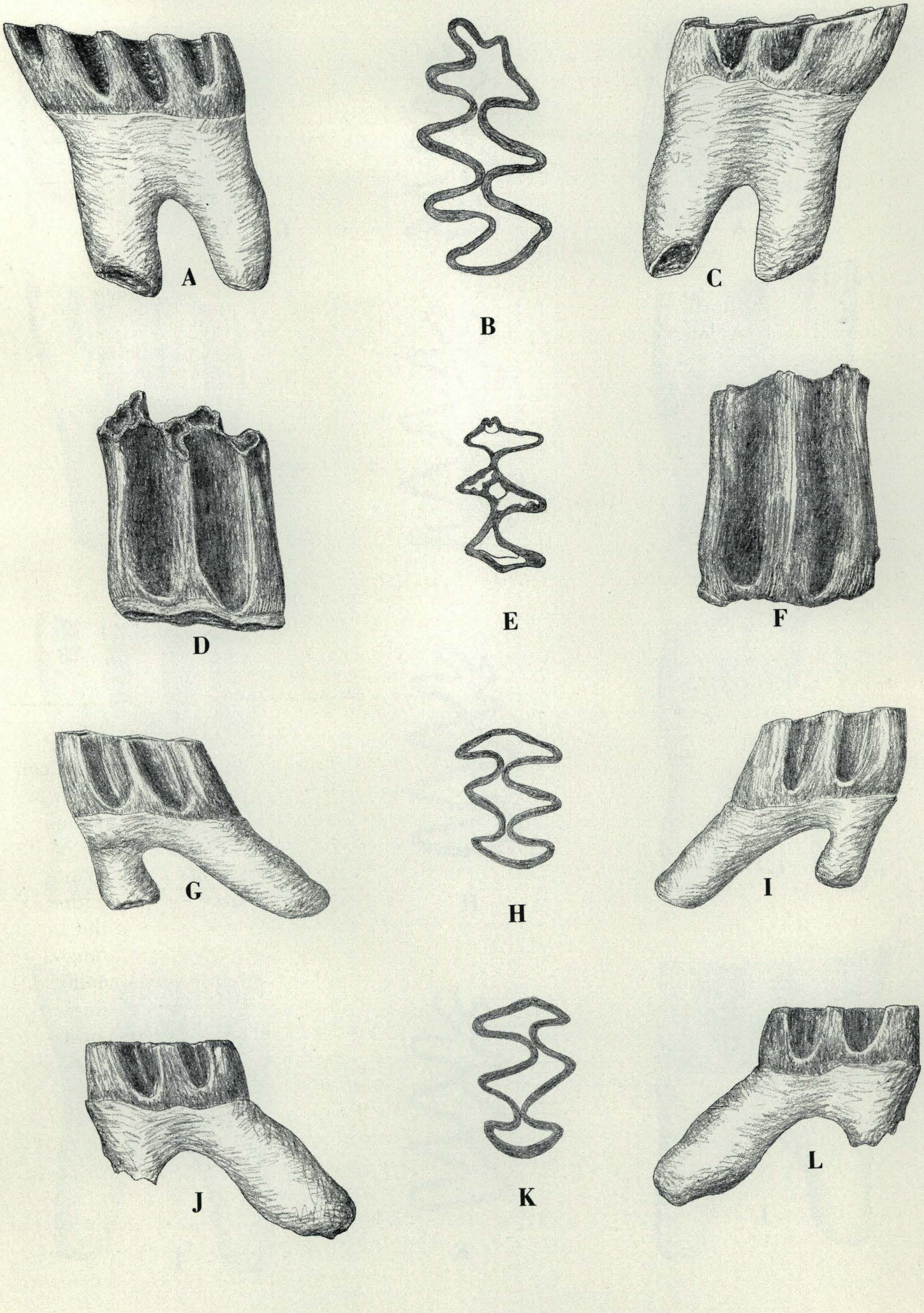
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This specimen represents the oldest known record of a microtine rodent. It is unfortunate that better material is not available to relate it to the known representative of *Microtoscoptes*. There can be little doubt, however, that this is a microtine and similar to *Microtoscoptes* in its characteristics.

MICROTOSCOPTES DISJUNCTUS (Wilson)

This aberrant microtine rodent is well represented in the Bartlett Mountain sample (UOLoc 2517). A lower second molar was previously reported from the same site by Shotwell (1963). The new material includes representatives of all the cheek teeth. A single lower first molar is present in the sample from Juniper Creek Canyon, UOLoc 2451.

LOWER DENTITION: The new material indicates something of the nature of the variations of the anterior loop of the lower first molar. In little worn specimens it is characterized by well developed lingual, labial and antero-medial indentations which have much the character of reentrant angles. These indentations persist into late wear. A small lake occurs in the middle of the anterior loop in some specimens in early wear. Variations consist of a small second labial indentation, a bifurcate antero-medial indentation and a very small indentation between the antero-medial and lingual ones. The lower second molar is a simple tooth consisting of a posterior loop two opposing triangles and an anterior loop. No significant variations are represented in the material from the Bartlett Mountain site. The lower third molar is similar to the second but the posterior loop is quite narrow and the posterior root bends strongly posteriorly.

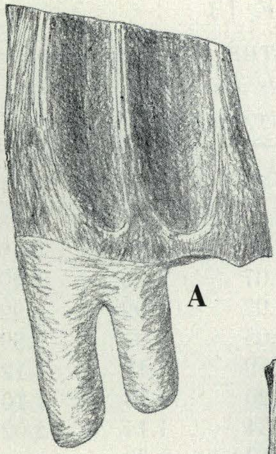
Figure 31. *Microtoscoptes disjunctus* Bartlett Mountain UOloc 2517, **A** UO24988 M_1 medial view, **B** occlusal view, **C** lateral view, **D** UO27041 M_2 medial view, **E** occlusal view, **F** lateral view, **G** UO-27048 M_3 medial view, **H** occlusal view, **I** lateral view, **J** UO27047 M_3 medial view, **K** occlusal view, **L** lateral view, all x 15.

TABLE 13

MEASUREMENTS OF THE DENTITION OF *Microtoscoptes disjunctus* BARTLETT MOUNTAIN LOC 2517

No.	Tooth	AP	Tr	HC
UO27030	M_1	2.11	1.06	1.33
UO24988	M_1	2.25	1.23	0.49
UO27024	M_1	2.07	1.04	1.49
UO27025	M_1	1.97	1.92	0.92
UO27026	M_1	2.05	1.01	1.59
UO27027	M_1	2.19	1.12	1.12
UO27028	M_1	2.20	1.13	1.10
UO27034	M_1	2.34	1.14	2.02
UO27041	M_2	1.59	1.00	
UO27047	M_3	1.55	0.98	
UO27048	M_3	1.50	1.05	
UO27049	M_3	1.61	1.18	
UO24596	M_3	1.37	0.95	
UO27056	M^1	1.91	1.28	
UO27057	M^1	1.78	1.00	
UO27060	M^2	1.52	0.97	
UO24597	M^2	1.47	0.96	
UO24598	M^2	1.53	0.89	
UO27063	M^3	1.33	0.95	
UO27068	M^3	1.75	1.20	
UO27066	M^3	1.59	0.97	
UO27067	M^3	1.48	1.00	

UPPER DENTITION: The upper first molar consists of an anterior loop, two opposing triangles and a posterior loop. A small protuberance is present on the postero-median border of the posterior loop. The reentrant angle enamel of opposite sides is in contact with no dentine exposed in between as is the case in the lower molars. The tooth has three roots arranged as in other cricetids. The upper second molar pattern consists of an anterior loop, a single triangle opposite a broad reentrant and a posterior loop. The posterior loop has an indentation in the postero-median border. There is a large bifurcate anterior root and a smaller posterior one. Repenning (1968) has illustrated upper second molars from Rome, Oregon with an occlusal pattern similar to the lower second molar. The upper third molar is similar to the second in root development and in the general enamel pattern. However, in the third molar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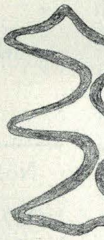
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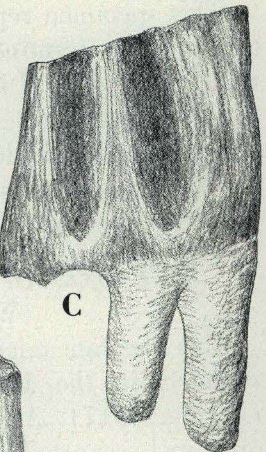
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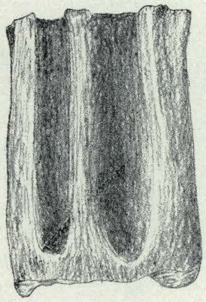
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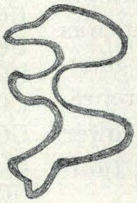
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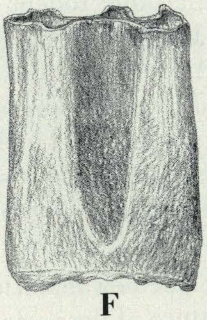
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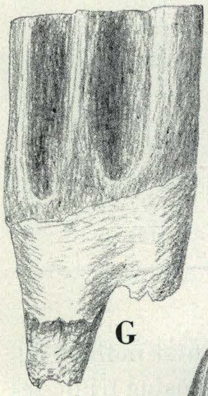
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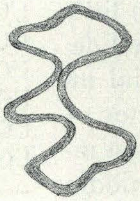
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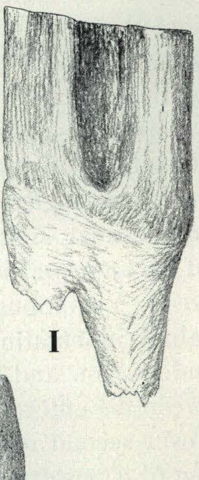
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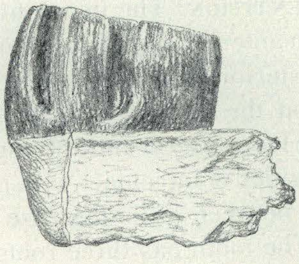
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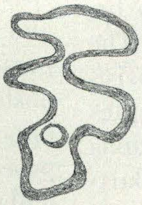
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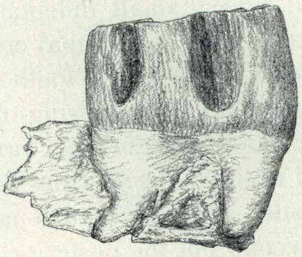
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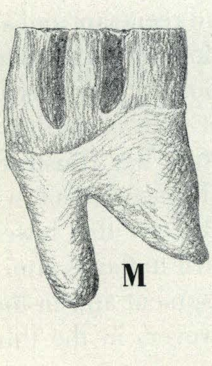
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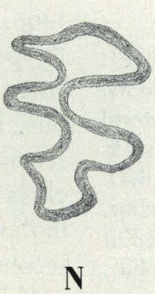
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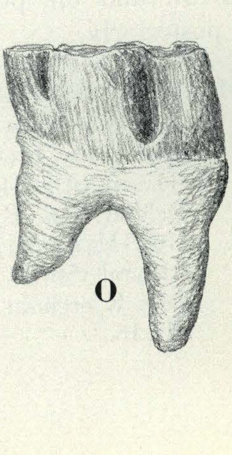
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the anterior and posterior loops are more complicated. The anterior loop is unsymmetrical and has a broad indentation on its smaller side on the anterior face in early wear. The posterior loop is reminiscent of the anterior portion of the anterior loop of the lower first molar and is equally variable. In some specimens a lake is a prominent feature of the loop whereas in others of a similar stage of wear the lake is not present. The posterior loop of the upper third molar is oriented more antero-posteriorly than in the second molar and the posterior indentation is much deeper. An additional indentation is also present and sometimes is well developed.

Measurements of the teeth are included in Table 13. They are greatest occlusal diameters. Height of crown was determined by measurement of the vertical height of the first reentrant angle.

The anterior loop of the lower first molar from Juniper Creek Canyon is more like the original Rome material than are the Bartlett Mountain specimens. Similar differences were noted in an occurrence in Wyoming described by Hibbard (1959). I do not feel these differences indicate that more than one species is represented in the limited known material.

SYNAPTOMYS VETUS Wilson 1933

This lemming was originally described from the Grand View Fauna. It occurs in our samples Jackass Butte (UOLoc 2400, 2404), Wild Horse Butte (UOLoc 2396), and Castle Butte (UOLoc 2393).

OPHIOMYS PARVUS (Wilson 1933)

Wilson (1933) assigned this species with some reservations to *Mimomys*. Hibbard (1950) assigned it to *Pliophenacomys*. Kretzoi (1955) assigned it to *Pliomys* and Hibbard and Zakrzewski (1967) to a new genus, *Ophiomys*. The type material came from a locality on Jackass Butte. Specimens occur in our samples from Jackass Butte (UOLoc 2404), Wild Horse Butte (2396) and Castle Butte (2393). Hibbard and Zakrzewski (1967) considered variations in the dentition of *Ophiomys taylori*, studied from three localities (two at the level of the Hagerman horse quarry and one at Sand Point, Idaho) to show a progressive change in the M_1 indicating a phyletic trend towards *Ophiomys parvus*. The four occurrences were presumed to be from successive stratigraphic horizons. However, as pointed out in the stratigraphic section of this paper the two Hagerman localities are apparently not lower than the San Point in the Glenns Ferry Formation as indicated in their Table 1 and text and there is no geologic evidence published that demands that the Grand View localities are any higher in the Glenns Ferry Formation than the other localities involved. They point out that the two Hagerman localities may be reversed in their time order (because of characteristics of the *Ophiomys taylori* sample not stratigraphic evidence) and that their differences may be an ecologic factor rather than time. Since time differences cannot be demonstrated by independent evidence for any of the four samples all of the differences may be ecologic rather than phyletic. All four samples might conceivably represent the same variable species, a number of subspecies or different genera as indicated by Hibbard (1959). Their inter-relationships taxonomically and temporally are not clear. There is no justification for a conclusion that one sample represents ancestral stock to any of the others at the present time.

PLIOPOTAMYS IDAHOENSIS (Wilson 1933)

Muskrats occur at a number of our localities in Idaho. They occur in three of the major samples described here, Jackass Butte (UO-2404), Castle Butte (UO2393) and Wild

Figure 32. *Microtoscoptes disjunctus* Bartlett Mountain UOloc 2517, **A** UO27057 M^1 medial view, **B** occlusal view, **C** lateral view, **D** UO25497 M^2 medial view, **E** occlusal view, **F** lateral view, **G** UO-27060 M^2 medial view, **H** occlusal view, **I** lateral view, **J** UO27067 M^3 medial view, **K** occlusal view, **L** lateral view, **M** UO27066 M^3 medial view, **N** occlusal view, **O** lateral view, all x 15.

Horse Butte (UO2396). In addition we have collected a sample from Hagerman (UO2347). Muskrats have been previously described from other localities on Jackass Butte, from Sand Point and the Hagerman localities (Wilson 1933, Hibbard 1959). Wilson (1933) assigned specimens from Jackass Butte and Hagerman localities to different subspecies, emphasizing their similarities but also noting the difference in size. Subsequently Hibbard (1959) has assigned these specimens plus additional material to separate genera. The primary character difference between these genera *(Ondatra* and *Pliopatomys)* is in the presence of dentine tracks on the teeth of *Ondatra*, and their absence on those of *Pliopatomys.* These dentine tracts are elongate dorso-ventral areas on the teeth in which enamel is missing. They are most prominent on the lower first molar but not restricted to it. They are continguous with the other un-enameled areas at the base of the teeth. Hibbard considers the absence of these tracts to be a primitive characteristic and thus imparts age differences between those species which have these tracts as opposed to those which do not. Dentine tracts occur in many other families of rodents and at many points in Cenozoic time.

In order to describe the degree of development of dentine tracts a measurement of the extreme height of the dentine track above the base of the adjacent reentrant valley was employed. This measurement is not affected by wear until very late when the dentine tract enters the occlusal surface. Measurements were made of the anterior labial tract of the anterior loop and the labial tract of the posterior loop of the lower first molar. Table 14 indicates the results. The average of the Hagerman specimens (UOLoc 2437) as contrasted to the average of the Jackass Butte specimens (UOLoc 2404) shows the dentine tracts of the antiloop of the Jackass Butte specimens to be three times longer than that of those from Hagerman. The two usable specimens from Castle Butte (UOLoc 2393) have dentine tracts on their lower first molars approximately twice as long as those from Hagerman while the Wild Horse Butte specimens fall within the lower part of the range of Jackass Butte specimens. In the case of the dentine tracts of the posterior loop of the lower first molars the difference between Jackass Butte and Hagerman specimens is extreme. The specimens from Castle Butte and Wild Horse Butte fall about half way in between in their development of dentine tracts on the posterior loop of the lower first molar.

The base of the anterior labial reentrant was used in the measurement of the anterior dentine tract. This, however, is a variable characteristic. The bases of the other three labial reentrants are in line whereas the base of the anterior one is more dorsal. The distance between the ventro-dorsal position of the base of the anterior reentrant to a line determined by the bases of the other labial reentrants varies from sample to sample. This is also true of the lingual side. Measurements of these distances on the specimens appear in Table 14.

The distances present on the labial side of the lower molars from the Hagerman locality are smaller than those from the Jackass Butte locality. The data for specimens from Castle Butte and Wild Horse Butte fall within the range of those from Hagerman. On the lingual side of the same teeth the bases of all four reentrants are in line on many specimens from Hagerman whereas on the westerly localities there is some difference. The greatest is in the Jackass Butte specimens while those from Castle Butte and Wild Horse Butte are intermediate.

The only significance of these minor differences in ventral extension of the reentrant base is in the effect it has on the measurements of dentine tracts. Since the anterior labial dentine tract was measured from the base of the anterior labial reentrant and it has been seen that the ventral position of this reentrant in relation to the others varies, these same variations are in the dentine tract measurements. A better datum would be the line projected by the bases of the three other labial reentrants. The distance between this datum line and the base of

TABLE 14
DENTINE TRACT DEVELOPMENT OF M1 *Pliopatomys*

	Anti-Labial Reentrant		Basal Difference 1st & 2nd rentrants		Posterior Labial reentrant		Adjusted HD		
Locality	Av HD	range	1-2	range	Av HD	range	No. sp.	Av HD	range
Hagerman 2437	0.53	0.38-0.72	0.41	0.30-0.56	0.23	0.10-0.36	7-8	0.90	0.76-1.02
Castle Butte 2393	0.97	0.95-1.05	0.32		0.86		3	1.37	
Wildhorse Butte 2396	1.38	1.30-1.47	0.37		0.99	0.95-1.03	2	1.67	
Jackass Butte 2404	1.51	1.00-1.85	0.72	0.51-0.90	2.15	1.75-2.62	7-12	2.18	1.83-2.51

HD—height of dentine tract above base of adjacent reentrant

TABLE 15
SIZE COMPARISONS OF M1 *Pliopatomys*

	Ant. Post. diameter			Transverse Diameter		
Locality	No. sp.	Av.	Range	No. sp.	Av.	Range
Hagerman 2437	10	4.11	3.89-4.44	10	1.85	1.73-2.02
Castle Butte 2393	2	4.37	4.31-4.43	2	1.89	1.87-1.90
Wildhorse Butte 2396	2	4.56	4.52-4.60	2	2.01	1.92-2.10
Jackass Butte 2404	13	4.49	4.26-4.93	13	1.94	1.80-2.15

the anterior labial reentrant is known for each specimen. The height of the anterior labial dentine tract above the datum line described can be determined by simply adding the two figures. The height of the dentine tract on the posterior loop is not affected since it is essentially a measurement from the datum line. The adjusted figures for the total height of the anterior dentine tract are given in Table 14. The relative adjusted heights of the anterior labial dentine tracts from the various samples now fall into the same pattern as those of the posterior loop. Jackass Butte specimens have the highest, Hagerman the lowest and Castle Butte and Wild Horse Butte intermediate.

A more obvious apparent difference between the Jackass Butte and Hagerman muskrats is size. This can also be described in terms of the lower first molar. Table 15 includes the data on measurements from the four localities referred to previously. Only specimens beyond early wear are included to avoid variations which are due solely to stage of wear. The anterior posterior diameter of the lower first molars from the four localities were compared by use of the "t" test. The Hagerman (UO2437) specimens are significantly (at 1%) smaller than those from Jackass Butte (UO2404), Castle Butte (UO2393) and Wild Horse Butte (UO2396). The Castle Butte specimens are significantly (at 1%) smaller than those from Jackass Butte. Wild Horse Butte and Jackass Butte specimens are not significantly different in size. Three size categories of lower first molars are therefore recognized. The smallest is represented by the Hagerman sample, Castle Butte specimens are next and Wild Horse Butte and Jackass Butte represent the largest.

Another often noted characteristic in microtine dentition is that of root development. In the small Castle Butte sample all the upper teeth have three roots. This is also the case in the small sample from Wild Horse Butte. The upper first and second molars in the Hagerman sample all have three roots. One of the five upper third molars has two while the others have three. At Jackass Butte all of the upper first molars have three roots, five of the six upper second molars have two roots and three of the four upper third molars have two roots. The remaining upper second and third molars have three rots. Stephens (1960) has shown that in *Ondatra zibethicus* the frequency of upper first molars with two roots varies with individual age. In one year old animals eighty five percent had only two rots while in three year old animals only one half that many had two roots. It appears then that the variations in numbers of roots on upper molars from the Idaho samples are probably of little significance taxonomically.

Characteristics of the occlusal pattern of the first lower molar of the Idaho muskrats reflects the nature of the differences and variations present in the entire dentition from sample to sample. The basic pattern of the lower first molar consists of a posterior loop, five alternating triangles and an often complicated anterior loop. In little worn specimens of the Hagerman sample an enamel lake is present extending from the base of the anterior labial reentrant (f) anteriorly into the anterior loop. In some specimens this lake is confluent with the anterior labial reentrant. A little worn lower first molar in the Jackass Butte sample displays several such lakes or pits. One is confluent with an indentation of the anterior face of the anterior loop, one confluent with an indentation on the labial side of the anterior loop and one is isolated just beyond the base of the anterior labial reentrant. Hibbard (1956, Fig. 5) has illustrated similar variations in *Pliopotamys meadensis* from the Sanders fauna of the Great Plains.

Often four to six shallow grooves extend down the face of the anterior loop from the occlusal surface on the lower first molar of the Idaho muskrats. These are reflected in the occlusal pattern until wear obliterates them. These are designated here using the conventional letter system. One of these grooves occurs just anterior to the anterior lingual reentrant (g) and appears to be an incipient reentrant (i). At Hagerman this groove is small in cross-section and sometimes divided. It extends over half way down the tooth in little worn specimens. At Wild Horse Butte, Castle Butte, and Jackass Butte this groove tends to be broadly open shallow and extends further ventrally than at Hagerman.

The anterior lingual reentrant (g) is deep, straight and directed postero-lingually in specimens from Jackass Butte, Castle Butte and Wild Horse Butte. In specimens from Hagerman this reentrant is directed transversely. At Hagerman the reentrant (e) just posterior to the anterior lingual reentrant extends anteriorly in later wear and sometimes reaching the point between the bases of the anterior labial (f) and anterior lingual (g) reentrants. This development of reentrant e was not seen in specimens from any of the other localities.

A number of other similar character differences might also be descirbed. However, those discussed above adequately reflect the nature of the differences to be seen among the Idaho muskrats reviewed. These are primarily differences of degree or frequency. They are adequate to separate small samples and possibly individuals. However, they all suggest taxonomic differences of the order of species or subspecies. Separation at the generic level does not seem warranted. Hibbard's (1938) primary basis for generic distinction was based on the presence or obsence of dentine tracts, however, it appears that the situation is really one of degree of development of these tracts. These species can all be easily segregated from living *Ondatra* and possibly should all belong to another genus presumably *Pliopotamys.* I prefer to follow Wilson (1933) in estimating the degree of differences between the several samples seen but will suggest that this may best be indicated by calling the Hagerman specimens one species and the other localities another. This may even over emphasize the differences. The total variation of all of these samples is similar to that which we might expect to see in a series of contemporaneous occurrences geographically and or ecologically separated.

SUPERFAMILY DIPODOIDEA
FAMILY ZAPODIDAE
SUBFAMILY SICISTINAE

MACROGNATHOMYS cf. *NANUS* Hall

A well worn lower first molar (UO24895) is present in the Black Butte fauna (UOLoc 2500) indicating the presence of a sicistine rodent. The characteristics of the specimen which can be recognized indicate that it is very much like the Quartz Basin species including the accessory lophids. It is slightly larger than the Quartz Basin form but not significantly judging from size variations in more complete samples.

A moderately worn lower second molar is also present (UO24443). It exhibits a centrally connected anteroconid, accessory lophids in the lingual valleys, mesostylid and mesolophid and is thus similar to one of the varients which will be described later in a Bartlett Mountain species.

A third lower molar (UO25291) is similar to that seen in the Bartlett Mountain species described below but includes accessory lophids in each of the major lingual valleys. The single well worn specimen available does not indicate any other notable differences.

Assignments of this species to *Macrognathomys nanus* is based partly on the evidence provided by the Bartlett Mountain species. It should be pointed out that the type of *M. nanus* is from a fauna of very nearly the same age as the Black Butte Fauna. Measurement are included in Table 16.

MACROGNATHOMYS cf. *NANUS*

The Bartlett Mountain Fauna (UOLoc 2517) contains some forty specimens representing a small sicistine rodent.

LOWER DENTITION: The lower first molar indicates that this species is highly variable. The anteroconid is connected in four specimens and isolated in seven others. It is a prominent cusp in all specimens. A mesostylid is present on all specimens and connected to the rest of the tooth pattern by a mesolophid except in one specimen in which no mesolophid is present. Half of the specimens have ectostylids and the ectolophid is highly variable from poorly developed or virtually absent to a prominent low ridge connecting the ectostylid to the central mure. On five specimens there is an accessory loph in the post entoconid valley and on one specimen it connects to the posterior cingulum resulting in a small lake. Several specimens are damaged in this region so that the frequency of occurrence of the accessory lophid in this sample cannot be determined. Undamaged specimens exhibit a prominent hypoconulid. The entoconid and hypoconid are strongly connected and in early wear form a single transverse lophid isolated from the remainder of the cusps and lophids. UO24445, is very much like the M_1 in the type specimen of *Macrognathomy nanus*.

The lower second molar varies in much the same way as does the first. The anteroconid is strong, in some specimens it is isolated, in others it is connected centrally to the anterior mure or by the anterior cingulum. In the available specimens the anteroconid is isolated in two, is connected centrally in three and connected by the anterior cingulum in three. The protoconid and metaconid are strongly joined transversely as are the entoconid and hypoconid. These tend to be two transverse isolated lophids in early wear. A mesolophid is present on all but one of the specimens. Accessory lophids are present in the post entoconid valley in five specimens and represented by expansions in the enamel in two others.

The lower third molar is represented by a single specimen. It is in an early stage of wear and all its characteristics are clearly shown. The anteroconid is greatly reduced if present. The anterior border of the tooth consists of a narrow high cingulum connected lingually to the metaconid, centrally and extending to the labial border of the tooth apparently terminating in a small stylar cusp. The protoconid and metaconid are strongly connected transversely. At the early stage of wear exhibited in the specimen the mesolophid connects to a mure but is not in turn connected to the anterior moiety of

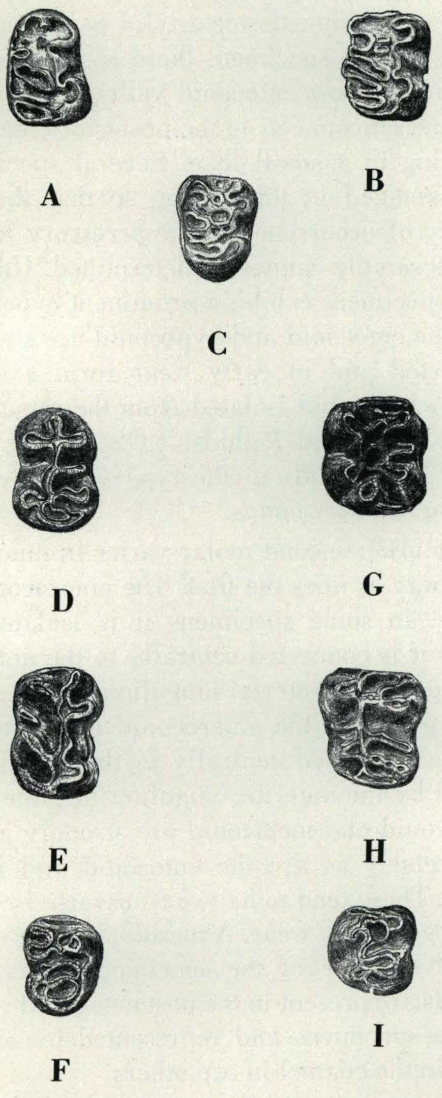


Figure 33 *Macrognathomys* cf. *nanus*, **A-C** Black Butte UOloc 2500, **A** UO24895 M$_1$ occlusal view, **B** UO24443 M$_2$ occlusal view, **C** UO25291 M$_3$ occlusal view, **D-I** Bartlett Mountain UOloc 2517, **D** UO-27543 M$_1$ occlusal view, **E** UO25207 M$_2$ occlusal view, **F** UO25208 M$_3$ occlusal view, **G** UO25213 M^1 occlusal view, **H** UO25210 M^2 occlusal view, **I** UO27622 M^3 occlusal view, all x 15.

the tooth. The entoconid is much reduced comparable to the mesolophid-mesostylid in development. The posterior cingulum joins high on the entoconid and is extended as a lingual cingulum anteriorly to the metaconid thus cutting off the post metaconid, post mesolophid and post entoconid valleys. No accessory lophids are present in the post entoconid valley.

UPPER DENTITION: No upper fourth premolars are present in the collection representing the upper dentition. Segregation of the first and second molars is difficult since all but one specimen of seventeen are abraded, it is in place in a maxillary fragment indicating that it is a first upper molar. This has primarily been the basis of assignment of the available specimens.

In the first upper molar the anterocone varies from a small cusp, well connected to the anterior cingulum which extends both lingually and labially, to a large cusp nearly isolated from the other cusps. The paracone and metacone each have two lophs connecting to the opposing cusps. A mesoloph is present terminating in a mesostyle on the border of the tooth. A spur-like ectoloph is opposite the mesoloph. The posterior cingulum connects to the hypocone and extends around the posterior border of the tooth not connecting to the metacone leaving an open post metaconal valley. There apparently is no hypoconule.

The second upper molar has a much reduced antercone serving as a mure. From it the anterior cingulum is strongly developed labially terminating at the border of the tooth, but not connecting to the paracone. There is a small loph connecting across the preparaconal valley isolating a portion of the valley in a small lake. The lingual extension of the anterior cingulum is poorly developed. The paracone and metacone join the protocone and hypocone by means of a single loph. The mesoloph frequently has an anterior branch extending towards the paracone. The posterior cingulum is similar to the anterior cingulum in mode of attachment, that is it does not atach to either of the adjacent major cusps (hypocone and metacone) but forms a T with the central loph

TABLE 16

MEASUREMENTS OF THE DENTITION OF *Macrognathomys*

Locality No.	Specimen No.	Tooth	AP	Tr
2500	24895	M_1	1.00	0.67
2500	24443	M_2	0.91	0.70
2517	25201	M_1	1.04	0.70
2517	24445	M_1	0.99	0.71
2517	25204	M_1	1.03	0.73
2517	25196	M_1	0.90	0.66
2517	25743	M_1	1.02	0.72
2517	25211	M_2	1.02	0.74
2517	24981	M_2	0.94	0.70
2517	25206	M_2	1.01	0.76
2517	25207	M_2	1.11	0.80
2517	25197	M_2	0.94	0.70
2517	25198	M_2	0.98	
2517	25208	M_2	1.00	0.74
2517	24968	M^1	0.89	0.75
2517	25213	M^1	0.99	0.88
2517	25212	M^2	0.99	0.85
2517	25194	M^2	0.92	0.86
2517	24975	M^2	0.97	0.83
2517	25210	M^2	1.01	0.89
2517	25195	M^2	0.97	0.88
2517	25200	M^2	0.97	0.89

of the tooth possibly at the hypoconule. The anterior and posterior borders of the tooth thus are quite similar.

A single specimen which I take to be a upper third molar is present in the Bartlett Mountain material. The anterior cingulum is reduced. The anterocone connects both to the paracone and protocone. These two cusps are also connected posteriorly isolating a lake between them. The hypocone is somewhat reduced but still distinctive. A strong mesoloph and mesostyle are present. The posterior cingulum is simple connecting to the hypocone and extending to the base of the metacone. There are no accessory lophs in the post metaconal valley.

DISCUSSION: Comparing the Bartlett Mountain sicistine with *Pleisiosminthus clivosus*, the lower first molar of the Bartlett Mountain species has a much larger anteroconid which is often much more strongly connected to the rest of the tooth. *P. clivosus* apparently does not have the accessory lophids which appear in the Bartlett Mountain species. The lower second molar of *P. clivosus* does not have an obvious anteroconid and lacks the accessory lophids in the post entoconal valley. The third lower molar has a double connection between the small anteroconid and protoconid and metaconid whereas a single connection is present in the Bartlett Mountain species. In the upper first molar the anteroconid is more strongly developed in the Bartlett Mountain species, the connections between protocone-paracone and hypocone-metacone are double lophs whereas they are single in *P. clivosus* and the posterior cingulum is more prominent in the Bartlett Mountain species. Thus the Bartlett Mountain species appears to differ from *P. clivosus* in much the same way as does the Quartz Basin species. All three species are essentially the same size. Measurements of the dentition are included in Table 16.

The lower first molars of the Quartz Basin and Bartlett Mountain species are quite similar if comparisons are made between variants in the Bartlett Mountain sample which have connected anteroconids. The upper first molars differ in the arrangement of accessory lophs associated with the metacone and the development of the anterocone. However, the differences present between the Bartlett Mountain and Quartz Basin species are those that might be expected in a single lineage in the time involved. The presence also of intermediate occurrences in time of species also similar suggest strongly that there was a single line of sicistines present in the Northern Great Basin from at least the Barstovian into the Hemphillian which show some minor morphologic changes but no significant change in size.

SUBORDER CAVIOMORPHA

SUPERFAMILY ERETHIZONTOIDEA

FAMILY ERETHIZONTIDAE

ERETHIZON BATHYGNATHUM

Wilson 1935

Several fine specimens of *E. bathygnathum* occur in the sample from Jackass Butte

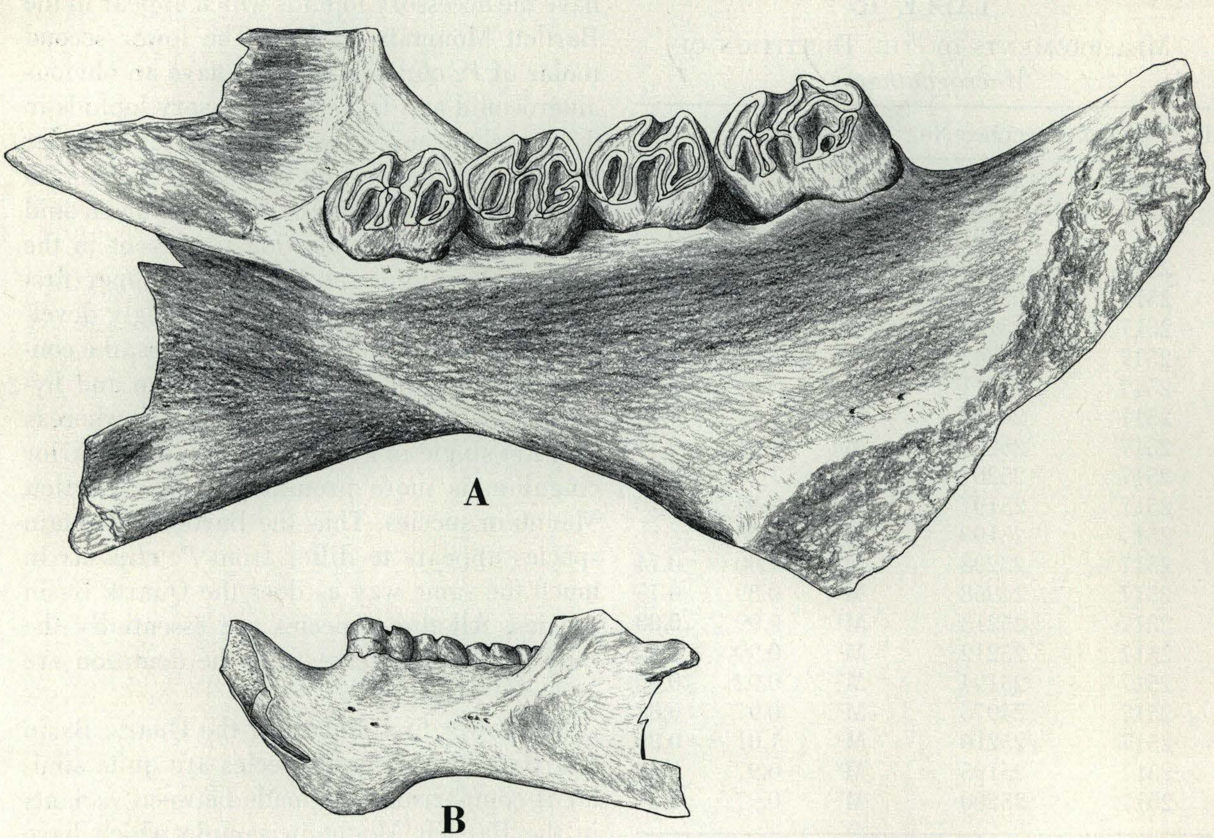


Figure 34 *Erethizon bathygnathum* Jackass Butte UOloc 2404 UO16271 left lower jaw P_4-M_3, **A** medial view x 2.5, **B** lateral view x 1.

(UOLoc 2404). One lower left mandible (UO-16271) is nearly complete and provides some additional information on this species. Wilson (1935) in his description of the type specimen, which came from Castle Butte, pointed out the more massive character of the lower jaw as compared with modern porcupines. The new material from Jackass Butte indicates that *E. bathygnathum* has a significantly shorter diastma between the incisor and fourth premolar. This adds to the robust appearance of the jaw. In the more complete material it is apparent that *E. bathygnathum* had a well developed attachment shelf for the masseter muscle as in the living species. The dentition of UO16271 is less worn than in the type specimen and also includes the third molar, not present in the type. Even in the less worn dentition it appears that there is a strong tendency for the anterior and posterior lakes to be formed in early wear, much earlier than in living porcupines.

ORDER CARNIVORA
SUBORDER FISSIPEDA
SUPERFAMILY CANOIDEA
FAMILY CANIDAE
SUBFAMILY CANINAE

CANIS DAVISI Merriam 1911

Fragmental material representing dogs approximately the size of coyotes and smaller frequently occur in Pliocene Northern Great Basin faunas. Most of this material has been too poorly represented to give a clear picture of the character of these dogs. Merriam (1911) described the species *Canis davisi* from the Hemphillian Rattlesnake fauna of the John Day Basin. The type material consists of a maxillary fragment including the first and second molars. No other material was associated with the specimen and some doubt existed as to whether it was derived from the Mascall or Rattlesnake Formations in that the specimen was float on the Mascall but immediately below the Rattlesnake which locally overlies it. Subsequently a number of equally fragmentary specimens have been provisionally assigned to this species.

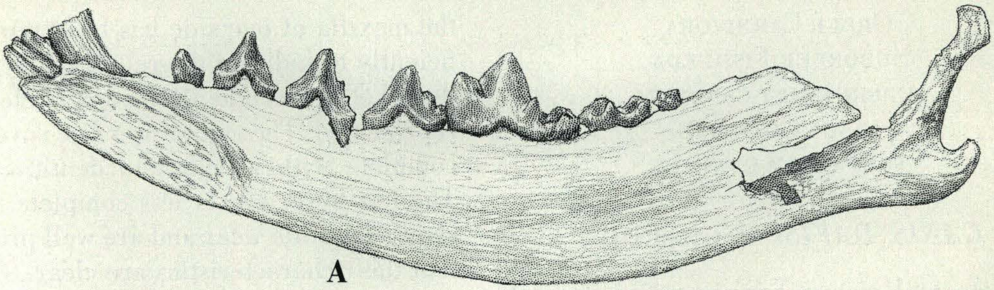
Shotwell (1956) described the species *C. condoni* from the Hemphillian McKay Reservoir Fauna just south of the Columbia River in Oregon. A complete mandible with only a second molar present is the type specimen. In the same collection a number of isolated teeth and several edentulous mandible fragments provide additional information about the characteristics of this small dog.

Locality UOLoc 2381 east of the major Little Valley fauna localities has provided a considerable portion of the anterior skeleton of a dog. This specimen, UO26742, consists of a much fragmented skull with dentition, both lower jaws and their dentition, much of the atlas and axis vertebrae, scapula, humerus fragment, distal ends of the ulna and radius, scapholunar, magnum, all four metacarpals, and several phalanges. Although the skull is too badly broken to reveal many of its features the maxilla of one side has been repaired sufficiently to indicate the relative spacing of the dental elements and all the dental elements are represented. The right lower jaw is very nearly complete with a complete dentition present. The left lower jaw is less complete. The teeth show very little wear and are well preserved so that their characteristics are clear. This specimen is particularly useful in that it provides an association of upper and lower dental elements, previously not available, and the proportions of the lower jaw are revealed.

The mandible is long and proportioned as in *Canis latrans lestes*, the coyote of the Northern Great Basin today. The mandible suggests a dog of very nearly the same size as *Canis latrans*. The angular process is hook shaped but with no lateral or medial expansion as seen in *Tomarctus*. The right lower jaw has a single large mental foramen located below the first premolar while the left jaw has two mental foramina, one below the first premolar and one below the third. The anterior one is much larger. In addition there appears a small foramen below the diastema of the left lower jaw and more ventral than the mental foramina.

LOWER DENTITION: The incisors are progressively larger from the first to the third. The first is only slightly bifurcate, the second more so and the third has a strong asymmetrical bifurcation. The medial side of the canine is somewhat flattened forming a locally sharp posterior border. There is a shallow groove near the medial anterior edge of the tooth.

The first lower premolar is apparently single rooted and transversely compressed. There is a single large cusp. In the second premolar two roots are present. There is only a slight irregularity on the posterior edge of the tooth but no apparent accessory cusps. However, on the third lower premolar two small accessory cusps are present on the posterior edge. One is situated very low on the tooth with its base on the small heel. The fourth premolar is similar to the third but the dorsal accessory cusp is much larger. The second accessory cusp is also conjoined with the posterior cingulum and gives



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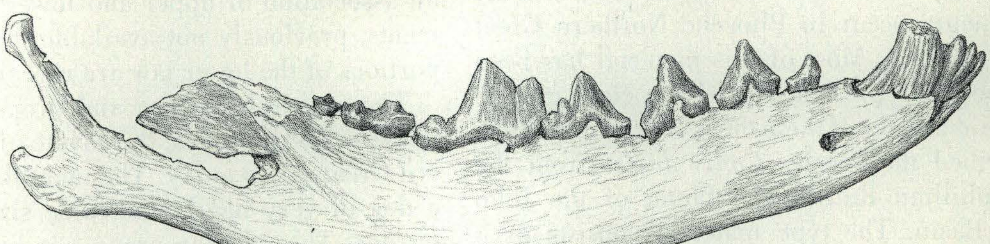

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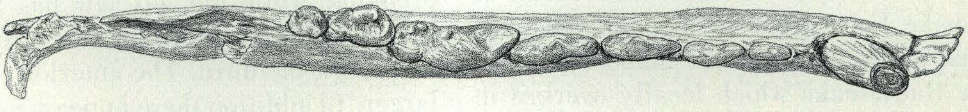

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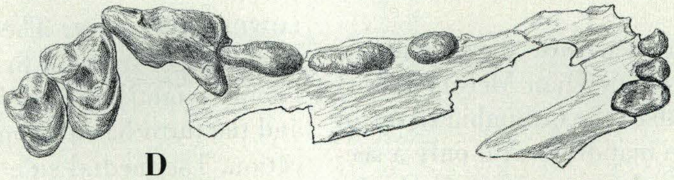

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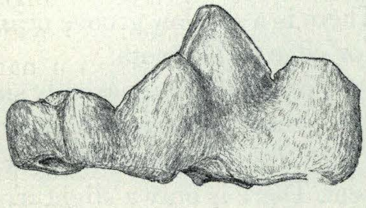

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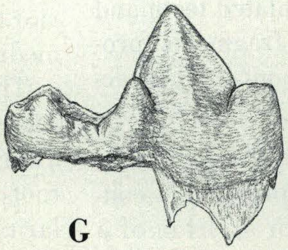

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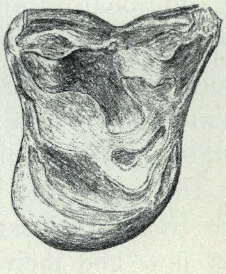

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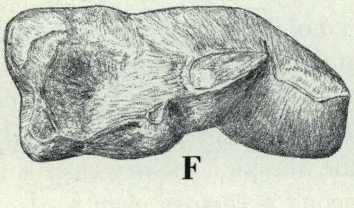

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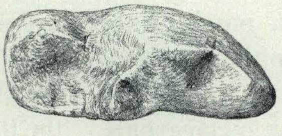


H

the appearance of a much reduced trenchant heel.

The metaconid of the first lower molar is well developed but not proportionately larger than in *Canis latrans*. The heel of this tooth consists of a well isolated hypoconid with a very small accessory cusp just anterior to it and a smaller entoconid also with an accessory cusp anterior to it but larger than the one associated with the hypoconid. The entoconid and hypoconid are well separated and are located at the edge of the tooth on their respective sides of the heel. The protoconid of the lower second molar is large and separated from the labial edge of the tooth by a cingulum. There is a small loph extending antero-lingually from the protoconid to the anterior border of the tooth. The paraconid is only slightly smaller than the protoconid and situated on the lingual edge of the tooth a little posterior to the protoconid. The paraconid and protoconid are joined very low in the center of the tooth. The hypoconid is smaller than the trigonid cusps. It is well separated from the other cusps. A very small entoconid forms a slight irregularity in the lingual surface of the heel.

The small third lower molar is dominated by a coalescing of the protoconid and paraconid. There is a very slight heel.

UPPER DENTITION: The upper third incisor is much larger than the first and second and is caniniform in character. Accessory cusps are not highly developed on the first and second incisors. The upper first premolar is a simple, single rooted tooth. Accessory cusps are not present on the upper second or third premolars. The protocone of the upper fourth premolar is apparently small but is damaged on the available material. It is well separated lingually from the major part of the tooth. No evidence of a parastyle is present. There is a narrow ridge on the center of the anterior face of the paracone. The notch between the paracone and metacone is open. A cingulum extends posteriorly from the protocone along the entire lingual side of the tooth.

TABLE 17

MEASUREMENTS OF THE DENTITION OF *Canis davisi*

LITTLE VALLEY LOCALITY 2381

	AP	Tr
UO26742R lower canine	8.2	6.4
P_1	4.6	2.6
P_2	8.5	3.5
P_3	10.0	3.7
P_4	11.0	4.3
M_1	17.3	6.7
	heel	5.7
M_2	8.0	5.8
M_3	4.5	4.0
P_1-M_3	67.4	
UO26742L lower canine	8.6	5.7
P_1	4.8	2.8
P_2	8.4	3.3
P_3	10.0	3.6
P_4	11.4	4.4
M_1	17.6	6.7
	heel	6.3
U026742R upper canine	10.0	5.0
P^1	5.6	3.0
P^2	9.1	3.0
P^3	10.3	3.8
P^4	18.3	8.8
M^1	10.6	13.3
M^2	6.9	9.4
UO26742R upper canine	9.1	5.0
P^1	5.1	3.1

The paracone of the first upper molar is a large conical cusp, considerably larger and higher than the metacone. A cingulum extends posteriorly along the labial edge of the paracone from the parastyle. Another cingulum occupies a similar position relative to the metacone. The conical shape of the paracone and metacone is interrupted by an antero-posteri-

Figure 35. **A-D** *Canis davisi* Little Valley UOloc 2381 UO26742, **A** right lower jaw medial view, **B** lateral view, **C** Dorsal view, **D** ventral view partial palate, all x 1, **E-I** *Canis* cf. *davisi* Juniper Creek Canyon UOloc 2451, **E** UO19030 M_1 medial view, **F** occlusal view, **G** UO19028 M_1 medial view, **H** occlusal view, **I** UO19027 M^1 occlusal view, all x 2.5.

orly directed loph which extends through the highest points of these cusps and serves to give them a sharp edge. The labial anterior and posterior cingula all terminate at the point of intersection of this sharp edge with the anterior and posterior borders of the tooth. The protocone is small but distinct. It is connected by a continuous loph running from the anterior edge of the parastyle, through the protocone and back to the posterior edge of the metacone. The resultant V shaped loph has the character of a cingulum, labially, and of a protoloph and metaloph as it extends lingually to the protocone. The metaconule is situated on the metaloph portion of this loph but is very small and appears as a swelling in the loph. The hypocone forms a broad heel. A cingulum extends labially from the hypocone along the anterior side of the tooth. The hypocone is displaced slightly posteriorly resulting in some curvature of the occlusal outline of the anterior border of the tooth. The second upper molar is smaller than the first. It is very similar to the first molar in its major features. However, the paracone and metacone are of more nearly equal size. The labial cingulum is complete and more strongly developed than on the first molar.

The scapholunar and magnum compare closely with those of *C. latrans* except in their somewhat smaller size. The metacarpals are proportionately shorter than those of *C. latrans*.

DISCUSSION: The specimen described here is so similar in many respects to *Canis latrans* that its assignment to the genus *Canis* seems unavoidable. The limited material previously available representing *C. davisi,* primarily the type specimen and some of the Thousand Creek Fauna specimens, cannot be separated from the new specimen. Specimen UO26742 is therefore considered to represent *C. davisi* and to provide a clearer picture of the characteristics of that species. *C. davisi* differs from the contemporaneous *C. condoni* in the following characteristics: The hypoconid and entoconid of the heel of the lower first molar of *C. condoni* are strongly joined forming a broad cusp transversely across the heel of the tooth. In the upper fourth premolar the protocone is not well separated from the remainder of the tooth. There is no ridge on the anterior face of the tooth in *C. condoni* and the internal cingulum is confined to the metacone. The upper first and second molars of *C. condoni* are not known. Although the known *C. condoni* mandibles suggest a smaller species than *C. davisi* some specimen referred below to *C. davisi* are very nearly the same size. When more topotypic material of those two dogs is known they may be shown to be synonomous. Presently available materials indicate significant differences. Measurements are included in Table 17.

CANIS cf. *DAVISI*

Locality UO2469 Juniper Creek Canyon has produced a fragmentary maxilla with first and second molars (UO19950). These teeth compare closely in size and character to the type of *C. davisi.* A fragment of the upper fourth premolar is present and suggests a more closely appressed protocone than in the UO-26742 described above. Measurements are included in Table 18.

CANIS cf. *DAVISI*

At Little Valley locality 2516 a fragmental mandible with P_1-M_2 (UO26743) is present in the collection. A number of isolated upper and lower teeth and mandible fragments are also present. This material represents a slightly smaller individual than UO26742 from locality 2381 to the east. The lower second premolar has a slight heel. A single accessory cusp is present on the lower third premolar and also on the fourth lower premolar. The position of the second accessory cusp low on the heel of UO26742 suggests that it may be lost with wear. The lower molar is similar to that of UO-26742 but smaller. This material is as small as that known for *C. condoni* but has the dental characteristics of *C. davisi.*

CANIS cf. *DAVISI*

A fragment of a M_2 UO24962 from UOLoc 2517, Bartlett Mountain, is assigned here to *C. davisi.*

CANIS cf. *DAVISI*

A number of isolated teeth from UOLoc 2451, Juniper Creek canyon, are by their characteristics assignable to *C. davisi*, however, the range in size is considerable. These include two lower first molars, UO19030 and UO19-028, two lower second molars UO19034 and UO19035, one upper fourth premolar, UO19-029, and one upper first molar UO19027.

CANIS sp.

A fragmentary mandible from Jackass Butte (UOLoc 2403) and three isolated teeth from Jackass Butte (UOLoc 2404) represent a coyote sized dog. The teeth include a lower fourth premolar, a lower first premolar and a lower canine. They cannot be distinguished from *Canis latrans*. The distal end of a humerus of a dog from UOLoc 2404 apparently represents this same species.

SUBFAMILY BOROPHAGINAE

BOROPHAGUS sp.

An upper canine, and upper and lower fourth premolars, representing a large *Borophagus*, are present in the collections from Jackass Butte locality 2404. The lower premolar is unworn whereas the upper teeth are well worn, the upper fourth premolar is damaged.

The available material does not allow specific assignment.

TABLE 18

MEASUREMENTS OF THE DENTITION OF *Canis* cf. *davisi* JUNIPER CREEK CANYON

		AP	Tr
UO19028	M_1	14.1	4.4
UO19029	P^4	11.0	5.2
UO19034	M_2	6.4	3.5
UO19030	M_1	17.6	7.8
UO19027	M^1	11.1	12.0

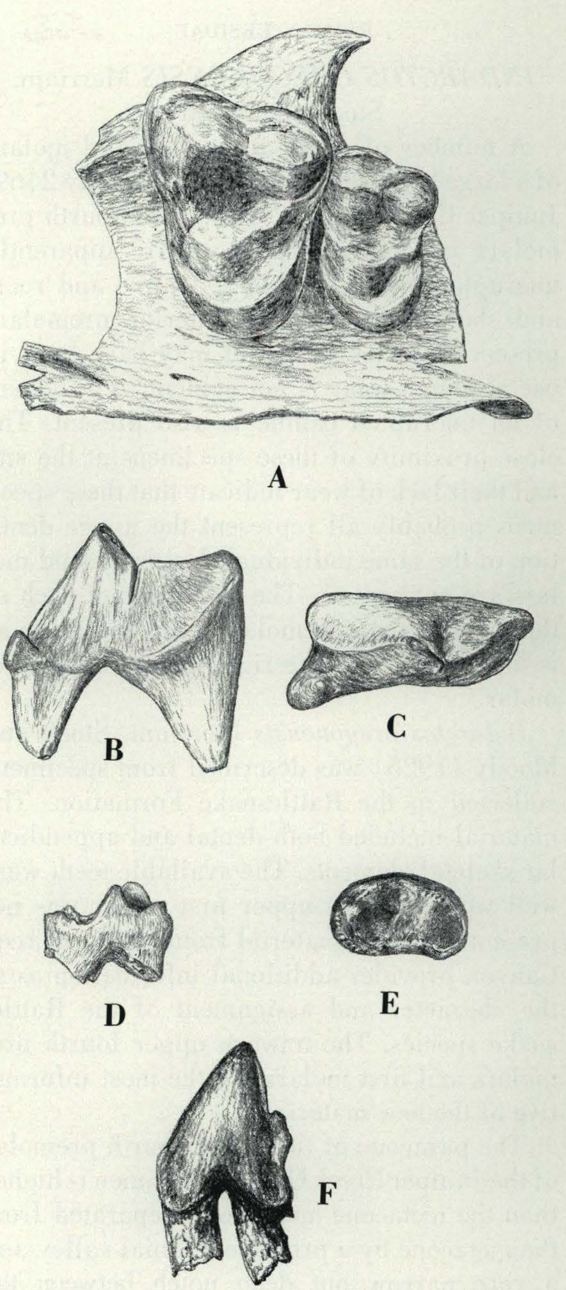


Figure 36 **A-E** *Canis* cf. *davisi*, **A** UO19950 maxilla fragment M^{1-2} Juniper Creek Canyon UOloc 2469 ventral view x 2.5, **B** UO19029 P^4 Juniper Creek Canyon UOloc 2451 medial view x 2.5, **C** occlusal view x 2.5, **D** UO19034 M_2 Juniper Creek Canyon UOloc 2451 medial view x 2.5, **E** occlusal view x 2.5, **F** *Borophagus* sp. Jackass Butte UOloc 2404 UO16343 lateral view x 1.

FAMILY URSIDAE

INDARCTOS OREGONENSIS Merriam, Stock and Moody

A number of upper premolars and molars of a large bear were recovered at locality 2469, Juniper Creek Canyon. The upper fourth premolars and upper first molars are apparently unerupted teeth. They lack dentine and roots and show no wear. The anterior premolars present also lack roots but may have been in use although wear is not evident. A fragment of an unerupted canine is also present. The close proximity of these specimens at the site and their lack of wear indicate that these specimens probably all represent the upper dentition of the same individual. Upper second molars are not present. The protocone of each of the upper fourth premolars is broken away as is the parastyle of the right upper fourth premolar.

Indarctos oregonensis Merriam, Stock and Moody (1925) was described from specimens collected in the Rattlesnake Formation. The material included both dental and appendicular skeletal elements. The available teeth were well worn and the upper first molar was not present. The new material from Juniper Creek Canyon provides additional information as to the character and assignment of the Rattlesnake species. The unworn upper fourth premolars and first molars are the most informative of the new material.

The paracone of the upper fourth premolar of the Juniper Creek Canyon specimen is higher than the metacone and is well separated from the metacone by a prominent labial valley and a very narrow but deep notch between the cusps. The lingual borders of the two cusps are continuous, in occlusal outline, forming a gentle antero-posterior curve. The parastyle consists of a prominent cusp situated on a strong cingulum which projects labially from the parastyle and supports at least several other small cusps coalesced into a low ridge. There is a narrow cingulum along the lingual base of the metacone to the point of breakage, presumably where the protocone was attached.

TABLE 19

MEASUREMENTS OF THE DENTITION OF *Indarctos oregonensis* JUNIPER CREEK CANYON

		AP	Tr
UO19945R	M^1	30.8	26.3
UO20241R	P^3	11.0	6.6
UO19945L	M^1	30.7	26.0
UO19945L	P^3	10.4	7.1
UO19945L	P^2	9.3	6.4
UO19945L	P^4	29.1	

The upper first molars are complete and well preserved. The enamel surface is irregular over most of the tooth as a result of numerous small shallow grooves on the major cusps. The paracone and metacone are of about the same size and well separated from each other. Each has a strong antero-posterior crest running over the highest point of the cusp. A lesser crest extends down the lingual side of each cusp. A low parastyle is present anterior to the paracone and a larger metastyle is present posterior to the metacone. The protocone is a low broad cusp, lengthened antero-posteriorly. The cusp is ridge-like and forms a long lophiodont crest which continues antero-labially as a cingulum to the parastyle. There is a minor interruption in the crest which forms a slight transverse bifurcation. The hypocone is smaller than the protocone but higher. The two cusps are not as well separated as the paracone and metacone. A crest has its origin at the peak of the hypocone and extends posteriorly to a broad posterior cingulum which in turn extends labially to the metastyle. A small narrow cingulum is present on the antero-lingual border of the protocone. A labial cingulum is not present but a cuspule blocks the lower part of the labial valley separating the paracone and metacone.

Measurements of the upper fourth premolar and first molar (Table 19) show the antero-posterior length of the two teeth to be about equal and the first molar to be longer than wide. In *Agriotherium* the upper first molar is slightly wider than long and the upper fourth premolar tends to be longer than the upper first molar, with a strongly developed parastyle. The upper first molar of *Indarctos* is typified by a quadrangular occlusal outline with the lingual and labial halves of the tooth about the same antero-posterior length, whereas in *Agriotherium* the labial half of the tooth is usually longer. The Juniper Creek Canyon specimen is not quite quadrangular due to the extension of the antero-labial border of the tooth as a result of the presence of a parastyle. The labial half of the tooth is thus longer than the lingual half, the reverse of the expected situation in *Agriotherium.* The specimen is therefore referred to *Indarctos.* Comparison with the Rattlesnake material is difficult since the known upper fourth premolar from that site is heavily worn and no upper first molar is known. There seems to be a similar degree of development in the parastyle of the upper fourth premolar in the material from the two sites. Because of the close geographic occurrence and the apparent contemporaneous age of the two occurrences along with the presence of similarities where comparisons are possible the Juniper Creek Canyon specimen is assigned to *Indarctos oregonensis.*

INDARCTOS cf. *OREGONENSIS*

A complete upper incisor (UO18940) several tooth fragments and the root to an upper canine indicate the presence of *Indarctos oregonensis* at Juniper Creek Canyon locality 2451.

FAMILY MUSTELIDAE

MARTES (PLIONICTIS) OREGONENSIS n.sp.

TYPE: UO26744, right mandible with P_2-M_2, lacking ascending ramus.

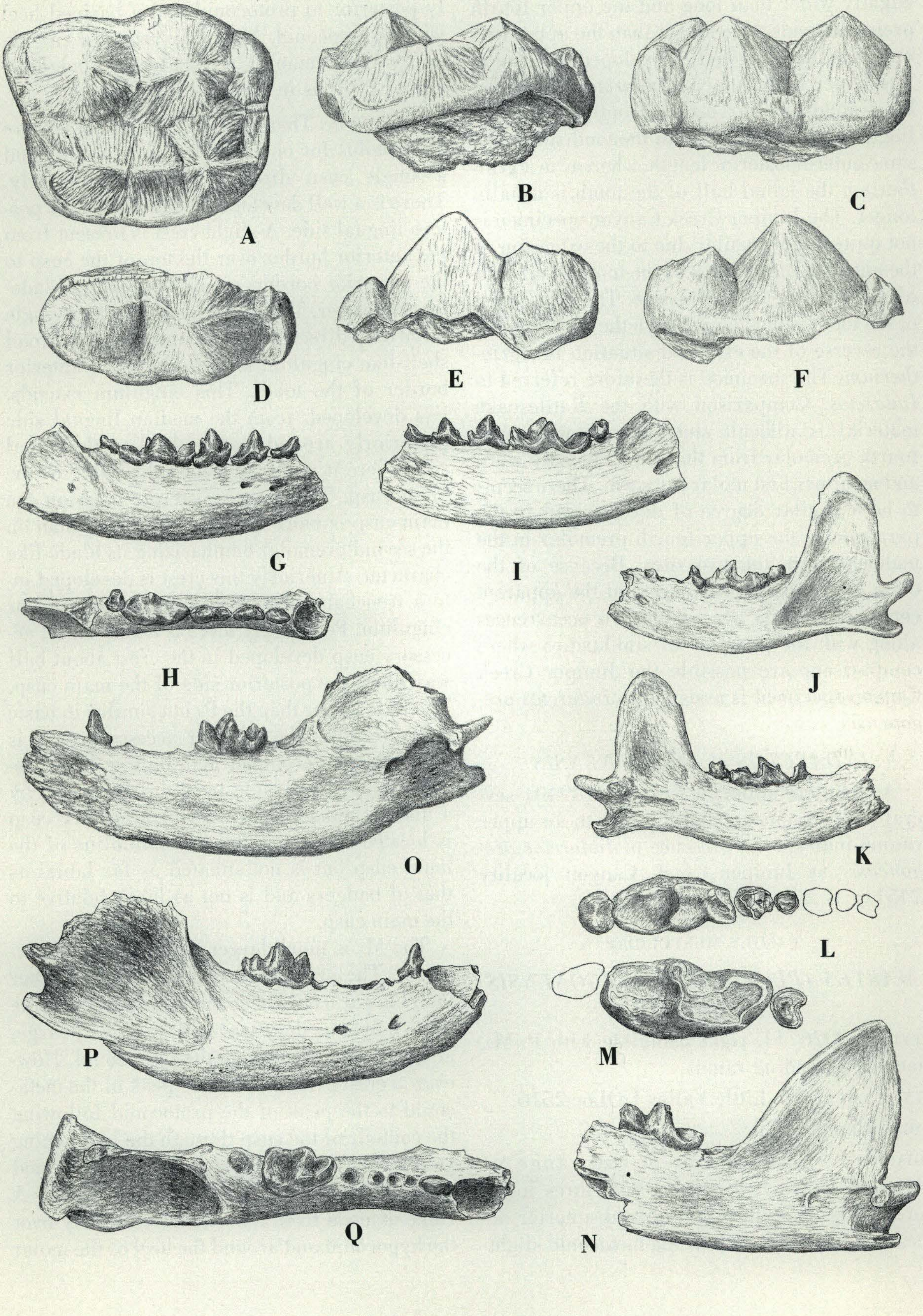
TYPE LOCALITY: Little Valley UOLoc 2516.

AGE: Hemphillian.

DIAGNOSIS: Small species in size range of *Martes (Martes) americana* with three lower premolars. P_4 with posterior and anterior accessory cusps. M_1 with strong metaconid slightly posterior to protoconid and a basined heel with no entoconid. M_2 small. External cingula on P_3-M_1. Premolars crested and blade-like. Upper P^3-P^4 as in *Martes (Martes).*

DESCRIPTION: There is no P_1 present nor is there an alveolus for one. The P_2 has two roots and a single cusp directed strongly anteriorly. There is a well developed cingulum on the postero-lingual side. A slight crest is present from the anterior border over the top of the cusp to the posterior border, giving the tooth a blade-like character. The third premolar has a single large cusp directed slightly anteriorly. A broad shelf-like cingulum is present on the anterior border of the tooth. This cingulum extends, less developed, from the median lingual side posteriorly around a short heel to the labial side where it molds into the labial side of the main cusp. The antero-posterior crest on the main cusp is more strongly developed than on the second premolar emphasizing its blade-like character. Anteriorly this crest is developed into a trenchant accessory cusp on the anterior cingulum. Posteriorly there is a very small accessory cusp developed in the crest about half way down the posterior side of the main cusp. The P_4 is larger than the P_3 but similar in basic configuration. The anterior accessory cusp is more highly developed than on the third premolar and is separated from the main cusp by a distinct notch. The posterior accessory cusp is located slightly labial to the midline of the main cusp but is not situated as far labial as that of badgers and is not as large relative to the main cusp.

The M_1 is much larger than the fourth premolar. The protoconid is only slightly higher than the paraconid. The metaconid is about the same height as the paraconid, relatively large, and well separated from the protoconid. However ,a crest extends from the peak of the metaconid to the peak of the protoconid following the contour of the cusp through the intervening valley. The hypoconid is large and separated from the protoconid by a narrow notch. A ridge extends from this notch posteriorly over the hypoconid and around the heel of the molar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continuing anteriorly to the metaconid enclosing a shallow lingual basin. There is no evidence of an entoconid. A cingulum extends from the protoconid labial to the hypoconid to the posterior border of the hypoconid. Another cingulum extends along the labial side of the tooth beginning at the anterior edge of the paraconid and continuing to the labial side of the protoconid to a point even with the peak of the protoconid. The second molar is small with a greater transverse than antero-posterior diameter. There is a large low lingual cusp present. Three small poorly defined cusps line the broader labial border of the tooth. All the cusps are of low relief. A low loph extends labially across the middle of the tooth from the large lingual cusp but merges into the tooth surface short of the labial border.

The mandible is proportioned similarly to Martes *(Martes)* but with somewhat more curvature of the ventral border posteriorly. Mental foramina are present below the posterior end of the second premolar and the posterior root of the third premolar. The masseteric fossa is deep with well defined borders. The mandible is not massive in relation to the size of the teeth and is nearly the same depth from below the third premolar to the first molar. Measurements of the mandible and dentition will be found in Table 20.

Figure 37. **A-F** *Indarctos oregonensis* Juniper Creek Canyon UOloc 2469 UO19945, **A** M^1 occlusal view, **B** medial view, **C** lateral view, **D** P^4 occlusal view, **E** medial view, **F** lateral view, all x 1.5, **G-I** *Martes* (*Plionictis*) *oregonensis* n. sp. Little Valley UOloc 2516 UO26744 right lower jaw Type, **G** latteral view x 1.5, **H** occlusal view x 1.5, **I** medial view x 1.5, **J-L** *Trigonictis cooki* Jackass Butte UOloc 2404 UO16352 left lower jaw, **J** lateral view x 1, **K** medial view x 1, **L** occlusal view x 2, **M-N** *Trigonictis idahoensis* Jackass Butte UOloc 2404 UO16351 right lower jaw, **M** occlusal view x 2, **N** medial view x 1, **O-Q** *Lutra* (*Satherium*) *ingens* Jackass Butte UOloc 2404 UO11837 right lower jaw, **O** medial view x 0.75, **P** lateral view x 0.75, **Q** dorsal view x 0.75.

TABLE 20

MEASUREMENTS OF THE DENTITION OF *Plionictis oregonensis*

		AP	Tr
UO26744	P^2	3.0	1.7
	P_3	3.8	2.1
	P_4	5.0	2.5
	M_1	8.1	3.6
	M_2	2.5	3.2
UO26745	P^3	3.7	1.8
UO26744	P_2-M_2	21.5	
	(Depth Mandible at M_1	7.0)	

COMPARISONS: In size and in the known characteristics of the skeleton *Martes (Plionictis) oregonensis* most nearly resembles the marten, *Martes (Martes) americana,* of the living mustelids of North America. It, however, has significant differences. The ventral border of the mandible is more curved posteriorly, the metaconid of the first lower molar is much more highly developed and only three lower premolars are present. Other less significant differences are more numerous. The well developed anterior cingulum and presence of anterior accessory cusps on *M. (P.) oregonensis* are not seen in *M. (M.) americana.* The hypoconid is larger and more distinct from the protoconid but less distinct from the ridge which borders the talonid basin on the first lower molar of *M. (P.) oregonensis.* The masseteric fossa is narrower anteriorly in *Martes.*

The differences noted between the Little Valley species and *Martes (Martes) americana* are those typified as the distinguishing characteristics of the subgenus *Plionictis* by Webb (1969). *Martes (Plionictis) oregonensis* is similar in size to *Martes (P.) ogygia (=M. (P.) glareae)* but differs in a broader heel on the M1 and better developed accessory cusps on the premolars.

MARTES (P.) cf. *OREGONENSIS*

An isolated canine, UO26746, and a maxillary fragment containing the P^3 and alveoli for the P^4 of a mustelid of the size of *M.* (*P.*) *oregonensis* (UO26745), and an edentulous man-

TABLE 21

MEASUREMENTS OF THE MANDIBLE AND DENTITION
Lutra (Satherium)

	UO11837	*L. piscinaria**	*L ingens**
Length mandible posterior margin of canine alveolus to median point on posterior surface of condyle	90.9	80	
Depth of mandible			
Posterior to P2	20.9	18.5	23.5
below mid M1	21.7	18.5	24.5
posterior to M2	29.6	21.2	29.0
Thickness of mandible below mid M1	11.7	9.1	12.3
Length premolar-molar series	51.5	45.4	52.5a
AP P2	7.4	6.7	
Tr P2	4.6	4.3	
AP M1	17.0	16.6	18.3
Tr M1	10.2	8.8	11.3

* Measurements from Gazin 1934

dible fragment, UO26747, also occur at the Little Valley locality 2516. The canine exhibits a medial cingula much as is seen in *Martes americana*. The upper third premolar exhibits a lingual cingula which extends around to the labial side but is not complete. The anterior face of the single cusp has a small crest adding to its blade-like configuration. The posterior portion of the tooth appears to have a heel but this may be largely a result of wear. The upper fourth premolar is represented by its two anterior roots and the anterior border of the aveolus for the posterior root. The anterior roots indicate that the protocone was displaced lingually about the same distance as in *Martes*, however, it was situated directly lingual to the parastyle rather than anteriorly directed. There is a single large foramina in the maxilla between the protocone root and the posterior border of the third premolar. The infraorbital foramen opens immediately above the parastyle root of the fourth premolar. The character and size of these isolated specimens agree with those to be expected in *M. oregonensis*. In referring to them as isolated specimens it should be noted that the type specimen and two referred specimens were not over two feet apart in the excavation. They probably do not represent the same individual, however, since the upper third premolar shows more wear than does the lower dentition.

TRIGONICTIS IDAHOENSIS (Gazin 1934)

A fragment of a mandible including the M1 (UO16351) from Jackass Butte (UOLoc 2404) represents *Trigonictis idahoensis* described by Gazin (1934, and 1937) from the Hagerman Fauna. The angle of the jaw in the Jackass Butte specimen is more complete than in the type. They otherwise compare very closely.

TRIGONICTIS COOKI (Gazin 1934)

A nearly complete left lower jaw of a small mustelid (UO16352) is present in the Jackass Butte (UOLoc 2404) material. It is nearly identical with the type of *T. cooki* (Gazin 1934, 1937) of the Hagerman fauna. The angle is complete on the Jackass Butte specimen. Zakrewski (1967) assigned the Idaho species to *Trigonictis*.

Mustelid indet.

A large astragulus from Castle Butte UOLoc 2394 (UO17925) represents a large, wolverine sized, mustelid.

LUTRA (SATHERIUM) INGENS Gazin

Gazin (1934) described the large otter *Lutra (Satherium) ingens* from the California Institute of Technology collections made near Grand View apparently at Jackass Butte. Gazin considered this species to be significantly larger than *Lutra (Satherium) piscinaria* Leidy represented by a large tibia from nearby Sinker Creek. A tibia and mandibles from Hagerman were considered to be more nearly the size of *L. piscinaria* by Gazin and were thus assigned to that species.

The new material from Jackass Butte (UOLoc 2404) includes a mandible (UO11837) but no tibia. Measurements indicate it is closer in size to *L. ingens,* however, smaller than the typical specimen. The present material suggests that only one species may be represented at the three sites, Sinker Creek, Jackass Butte, and Hagerman, but does not demand such a revision in the nomenclature. Comparative measurements of the mandible and dentition are presented in Table 21.

SUPERFAMILY FELOIDEA
FAMILY FELIDAE
SUBFAMILY FELINAE

PSEUDAELURUS sp.

The crown of an upper canine (UO19092) from Juniper Creek Canyon locality 2451 indicates the presence of a large felid. A very minutely serriated edge and its size compares closely with a similar specimen of a more complete series from the Black Butte Fauna representing *Pseudaelurus.*

FELIS LACUSTRIS Gazin 1933

A nearly complete left lower jaw (UO11840) from Jackass Butte (UOLoc 2404) compares closely with *F. lacustris* Gazin from the Hagerman. In his original description Gazin assigned several jaw fragments from Cal Tech localities in the Grand View Fauna to this same species. The Jackass Butte specimen lacks only the incisors and angle of the jaw. A right upper canine of a cat from Castle Butte is the size that might be expected for *F. lacustris.*

SUBFAMILY MACHAERODONTINAE

Genus and Species indeterminate

A section of enamel seriated along one edge (UO27555) from Juniper Creek Canyon locality 2469 apparently represents a fragment of the saber of a machaerodont cat.

? *ISCHYROSMILUS IDAHOENSIS* Merriam 1918

An upper canine (UO11272) and an upper P^4 (UO11276) from Wild Horse Butte (UOLoc 2396) plus a partial left mandible including the M_1 (UO11827) from Jackass Butte (UOLoc 2404) represent a large saber-toothed cat in the Grand View Fauna.

The saber is transversely flattened and broad antero-posteriorly. The tip of the tooth is not present but the total length of the enamel surface must have been about 120 mm. At the base of the enamel the tooth has an antero-posterior diameter of 38 mm and a transverse diameter of 18.2 mm. The posterior edge is serrated to within 30 mm of the base of the enamel. The upper P^4 is 41.7 mm long. The protoconal root is not completely separated from the paraconal root. The specimen is well worn but it is evident that the paracone was slightly larger than the metacone, and that each possessed large stylar cusps anteriorly and posteriorly respectively. In addition there is a small cusp anterior to the parastyle. The posterior portion of the tooth is supported by a large cusp.

The mandible is nearly complete from the posterior border of the canine to the masseteric fossa. The only tooth present is the M_1. Alveoli represent the P_4 and P_3 and indicate that the P_3 had two closely appressed roots. The alveoli indicate that the P_4 was about 20 mm long and the P_3 about 14 mm. The depth of the mandible just anterior to the P_4 is 39 mm. The masseteric

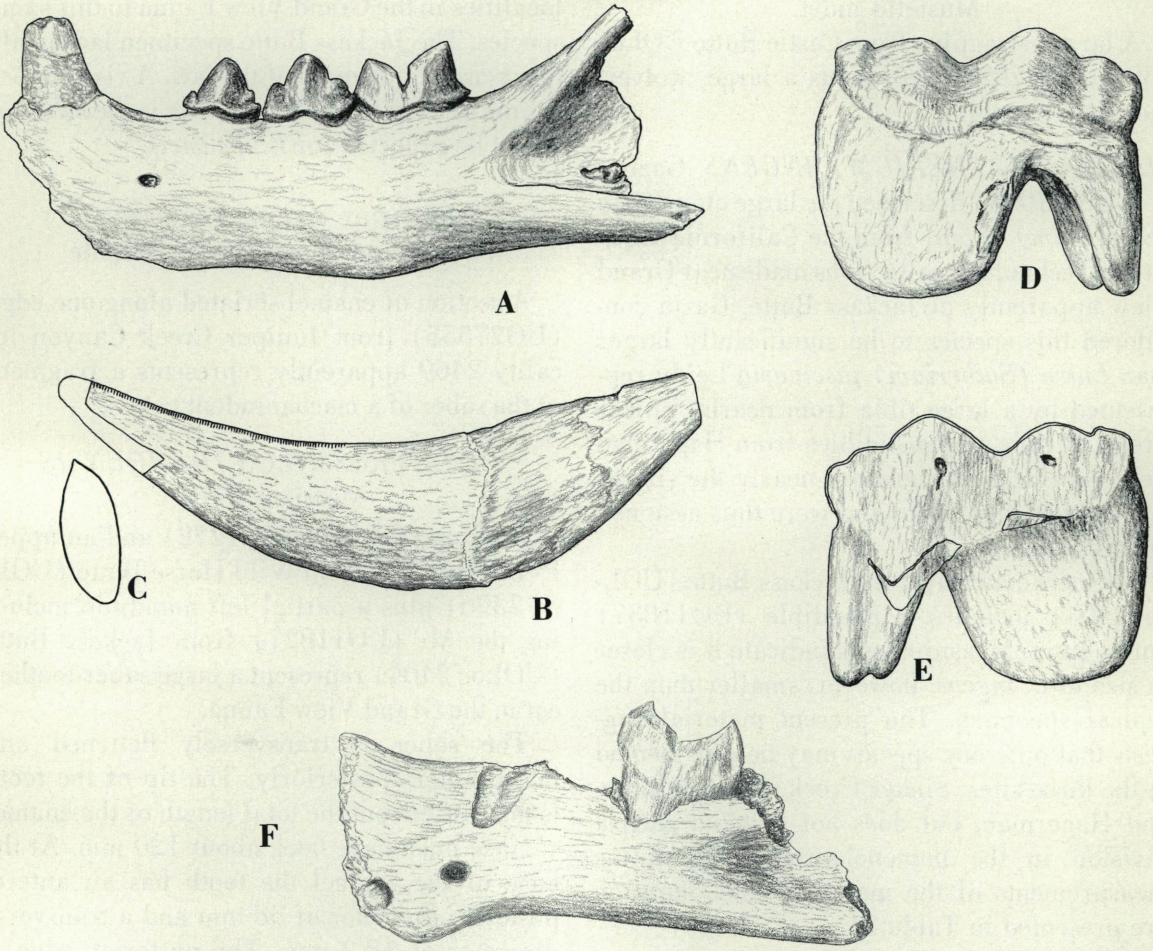
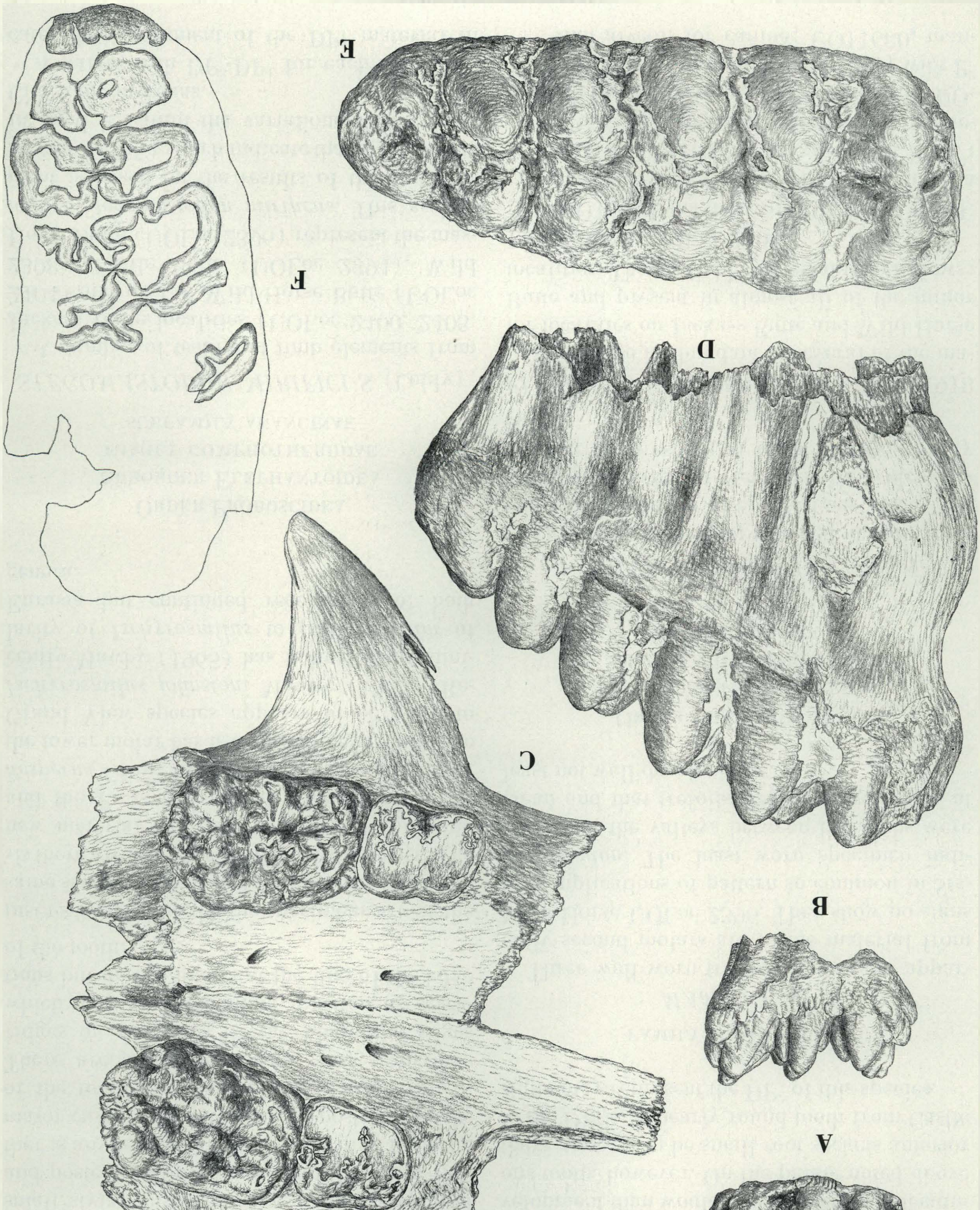


Figure 38. **A** *Felis lacustris* Jackass Butte UOloc 2404 UO11840 left lower jaw lateral view x 1, **B-F** ? *Ischyrosmilus idahoensis*, **B** UO11272 upper canine Wild Horse Butte UOloc 2396 lateral view x 0.5, **C** cross section x 0.5, **D** UO11276 P^4 Wild Horse Butte UOloc 2396 lateral view x 1,**E** medial view x 1, **F** UO11827 fragment left lower jaw M_1 Jackass Butte UOloc 2404 lateral view x 0.5.

fossa extends anteriorly to the middle of the M1. The flange terminates posteriorly just below the P_3 and is inflated in the area of the mental foramina rather than excavate as in *Smilodon*. There are two large mental foramina, one is directly in line with the trend of the roots of the P_3 which angle antero-ventrally while the second is below the center of the diastema and ventral to the first. The M_1 is 33.2 mm long at its greatest antero-posterior diameter and 14.2 mm wide at the paraconid which is the widest portion of the tooth. The tooth has

Figure 39. *Stegomastodon mirificus*, **A** UO16273 DP_4 Jackass Butte UOloc 2404 occlusal view, **B** lateral view, **C** UO16568 palate fragment with DP^{3-4} each side Jackass Butte UOloc 2404 ventral view, **D** UO-16558 M_3 Jackass Butte UOloc 2403 lateral view, **E** occlusal view, **F** UO-27623 M_3 west of Wild Horse Butte UOloc 2398 occlusal view, all x 0.5.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a large V-shaped shearing face consisting of the paraconid and protoconid. The latter is somewhat longer antero-posteriorly but narrower transversely than the paraconid. There is no metaconid. There are what appear to be small stylar cusps anterior to the paraconid and posterior to the protoconid, however, neither is anything more than a pinching in of the major cusps. The anterior and posterior edges of the tooth are blade-like but not serrated. There are, however, several tiny transverse ridges on the sides of the blade-like edges which may have the same function as serrations but do not interrupt the line of the edge of the tooth.

DISCUSSION: Although the specimens are of the same size as the typical *Ischyrosmilus idahoensis* there are several significant differences. The new material has only two mental foramina and the P_3 is two rooted. *Machairodus* (?) *hesperus* Gazin (1933) is much smaller and the lower molar has a vestigial metaconid. The Grand View species appears to be close to *Ischyrosmilus johnstoni* Mawby (1965). Recently Mawby (1965) has indicated the similarity of *Ischyrosmilus* to *Homotherium* of Eurasia but continued recognition of both genera.

ORDER PROBOSCIDEA
SUBORDER ELEPHANTOIDEA
FAMILY GOMPHOTHERIIDAE
SUBFAMILY ANANCINAE

STEGOMASTODON MIRIFICUS (Leidy)

A number of teeth and limb elements from Jackass Butte localities (UOLoc 2400, 2403, 2404) and west of Wild Horse Butte (UOLoc 2398), Castle Butte (UOLoc 2394), Wild Horse Butte (UOLoc 2396) represent the mastodont *Stegomastodon mirificus*. This assignment is based on the results of the study of Savage (1955) which indicate that the material in hand is within the variations shown from Cita Canyon Texas.

A palate with DP^3-DP^4 for each side indicates the assignment of the DP^4 material in question in Savage's study. The well developed roots of the deciduous teeth, as noted by Savage, suggest that they may be part of the permanent dentition. An isolated DP^4 with the roots broken away shows no more dentine development than would be expected in a deciduous tooth, however. On the palate noted above there appears to be small root sockets anterior to the DP^3's. A nearly round tooth from Castle Butte may represent the DP^2 of this species.

FAMILY MAMMUTIDAE

MAMMUT sp.

Three well worn trilophodont teeth, apparently second molars are in the material from Wild Horse UOLoc 2396. They show no signs of complications of pattern so common in *Stegomastodon*. The least worn specimen indicates that the valleys between the lophs were clean and that trefoils were not present or at least not well developed.

ORDER PERISSODACTYLA
SUBORDER HIPPOMORPHA
SUPERFAMILY EQUOIDEA
FAMILY EQUIDAE
SUBFAMILY EQUINAE

PLIOHIPPUS SPECTANS (Cope)

This horse is well represented at both Juniper Creek Canyon sites, UOLocs 2451 and 2469. Fragments of teeth and limb elements indicate its presence at Little Valley locality 2380.

PLESIPPUS IDAHOENSIS (Merriam) 1918

This horse is abundant in several of the major localities on Jackass Butte and Wild Horse Butte and present in almost all of the minor localities. The available material is as follows:

Jackass Butte UOLoc 2404,

UO16569, maxilla with DP^{2-4}; UO11961, maxilla with DP^{2-3}; UO11960, maxilla with P^3; UO16583, maxilla with P^3-M^2; UO16369, premaxillaries including alveoli for the incisors and both canines; UO-11675, maxilla and premaxillary with P^2 and alveoli for canine; UO11680, mandible fragment with DP_{2-3}; fifteen upper deciduous teeth; twenty six upper adult teeth; thirty six incisors; five canines; seven lower deciduous teeth; sixteen lower adult teeth; two hunderd fifty four appendicular skeletal elements;

Wild Horse Butte UOLoc 2396

UO17403, premaxillaries with LI^{1-3} and RI^{1-2}; five upper deciduous teeth; twenty upper adult teeth; two lower deciduous teeth; twenty one lower adult teeth; forty appendicular skeletal elements.

Three other Jackass Butte and two additional Wild Horse Butte localities have produced minor amounts of material representing this horse.

LOWER DENTITION: The parastylid is well developed on the DP_{3-4}; sometimes isolated on DP_3. On the DP_4 a prominent hypostylid is present. The median valley (protoconid-hypoconid valley) extends through the isthmus between the entoflexid and metaflexid to the enamel of the metaconid-metastylid groove on the DP_{3-4}. It is shortened on the DP_2 which has a constricted isthmus. A pli-caballinid is present on all the lower deciduous teeth. In the DP_4 the metaconid tends to be antero-posteriorly elongate and the metastylid rounded. The metaconid-metastylid groove is broadly open but V-shaped at the apex.

Adult lower premolars display a sharp antero-labial edge in the position of the parastylid in little worn teeth. However, with wear a definite parastylid is present and is evidenced by an exterior groove in specimens where the cement is absent. It is not as prominent in the lower first and second molars but often well

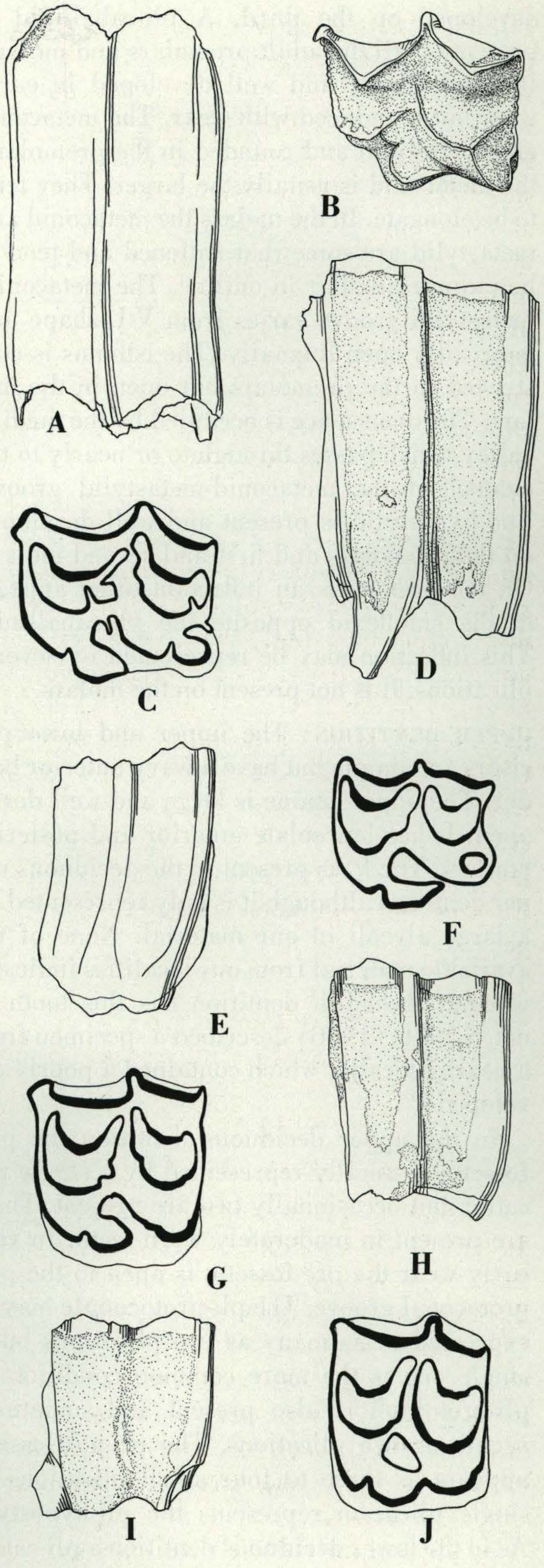

Figure 40. *Pliohippus spectans* Juniper Creek Canyon UOloc 2451 variations in wear, **A** UO18840 P^4 lateral view, **B** occlusal view, **C** UO18828 P^4 occlusal view, **D** lateral view, **E** UO18833 M^3 lateral view, **F** occlusal view, **G** UO18830 P^4 occlusal view, **H** lateral view, **I** UO-18835 M^1 lateral view, **J** occlusal view, all x 1.

developed on the third. A pli-caballinid is present on all the adult premolars and molars. It is prominent and well developed in early wear but is reduced with wear. The metaconid and metastylid and rounded in the premolars, the metaconid is usually the larger. They tend to be elongate. In the molars the metaconid and metastylid are somewhat flattened and tend to be more triangular in outline. The metaconid-metastylid groove varies from V-U-shape and is broadly open lingually. The isthmus is constricted in the premolars but open in the molars. The open space is occupied by the median valley which passes through to or nearly to the enamel of the metaconid-metastylid groove. The hypostylid is present and well developed on the premolars and first and second molars. On the premolars an inflection often appears in the entoflexid opposite the pli-caballinid. This inflection may be represented by several plications. It is not present on the molars.

UPPER DENTITION: The upper and lower incisors are simple but have a wavy anterior border. The upper canine is large and well developed. It has lanceolate anterior and posterior borders. The P^1 is present in the deciduous upper dentition although it is only represented by a large alveoli in our material. None of the available material from our localities indicates whether the adult dentition has this tooth or not. Schultz (1936) described a specimen from a nearby locality which contained a poorly developed P^1.

In the upper deciduous dentition the prefossette is usually represented by a single plication but occasionally two are present. These are present in moderately worn teeth. In very early wear the pre-fossette is open to the post protoconal groove. The pli-protoconule may be expressed in as many as two plications but a single one is the more common condition. A pli-protoloph is also present and sometimes occurs as two plications. The pli-postfossette appears as three to four small plications. A single plication represents the pli-hypostyle. As in the lower deciduous dentition a pli-caballin is present on all teeth. The hypoconal groove is open the full length of the tooth. The protocone is rounded with a slight lingual groove in early wear and very little anterior extension.

The adult upper premolars are considerably larger than the molars. The parastyle and mesostyle are narrow in the molars with the parastyle only a litle larger in the premolars. The valley between the parastyle and mesostyle is convex flattening somewhat with wear. The valley posterior to the mesostyle is flatter. The pli-prefossette often consists of three plications but as many as five are present in some specimens. Occasionally it is represented by one complex plication. In older individuals the pli-prefossette is represented by a simple wavy line. The pli-protoconule is seen as a single well developed plication appearing into old age and occasionally bifurcate. Until mid-wear a pli-protoloph is present and well developed sometimes represented by two plications. The post fossette is open posteriorly until mid wear in some specimens of the third molar. A single deep plication with three to four small ones labial to it occur in the position of the pli-postfossette. By old age only a single deep invagination is present. In the upper third molar the hypostyle is present into late wear while in the other upper cheek teeth it is lost at about mid-wear. The pli-caballin is present in all teeth until late wear. An open hypoconal groove is present the full length of the tooth column in

Figure 41. *Plesippus idahoensis*, **A** UO11770 DP_3 Jackass Butte UOloc 2404, **B** UO16451 P_4 Jackass Butte UOloc 2403, **C** UO-17938 P_4 Wild Horse Butte UOloc 2396, **D** UO17389 M_1 Wild Horse Butte UOloc 2396, **E** UO27554 $M_{1 \text{ or } 2}$ Jackass Butte UOloc 2404, **F** UO17372 M_3 Wild Horse Butte UOloc 2396, **G** UO11745 DP^3 Jackass Butte UOloc 2404, **H** UO-11757 DP^4 Jackass Butte UOloc 2404, **I** UO17374 P^2 Wild Horse Butte UOloc 2396, **J** UO11731 P^4 Jackass Butte UO-loc 2404, **K** UO11738 $M^{1 \text{ or } 2}$ Jackass Butte UOloc 2404, **L** UO11274 M^3 Wild Horse Butte UOloc 2396, **M** UO16583 P^3-M^2 Jackass Butte UOloc 2404 **N** UO-16569 $DP^{2\text{-}4}$ Jackass Butte UOloc 2404, **A-L** x 1.1, **M-N** x 0.75.

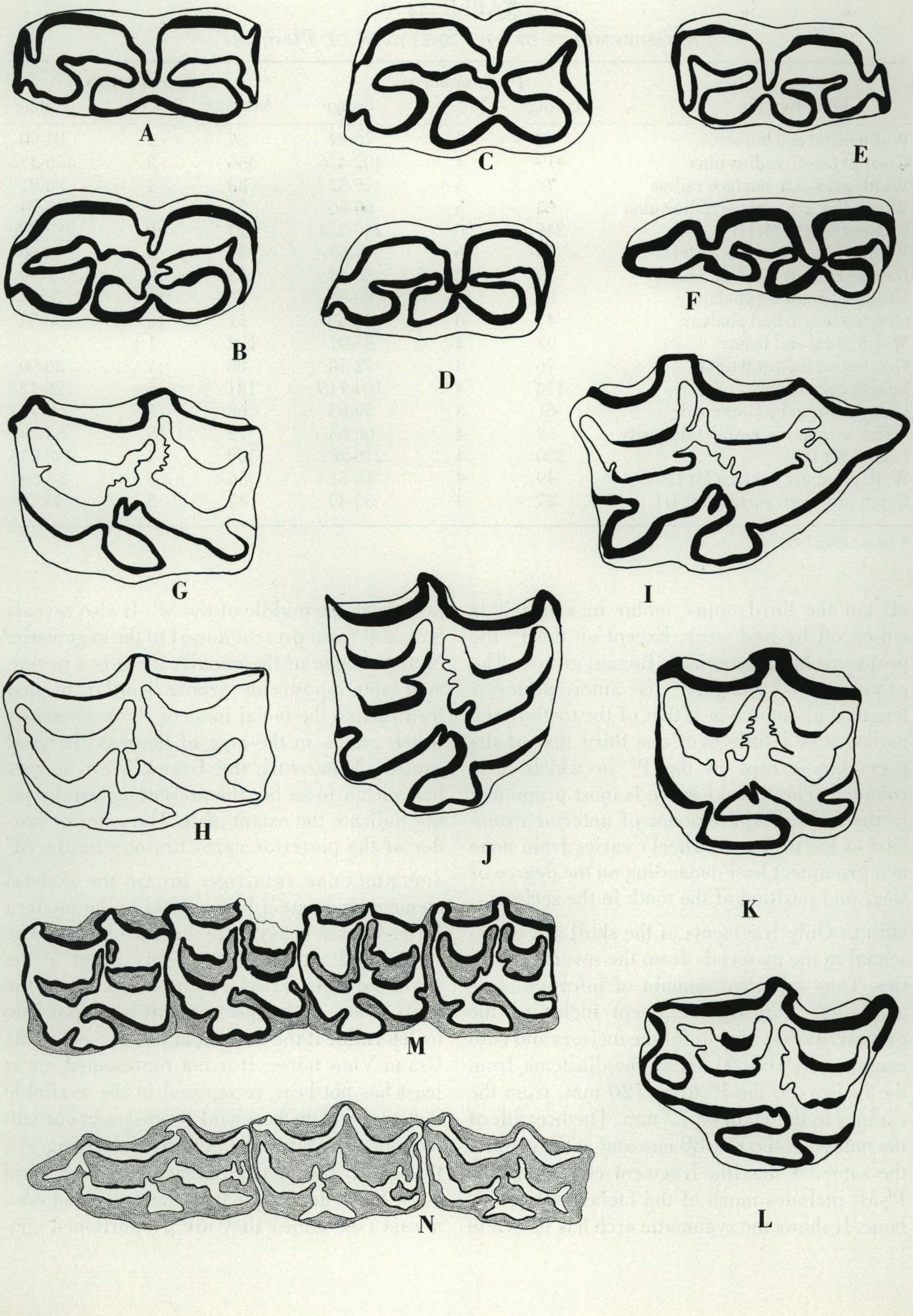
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TABLE 22

MEASUREMENTS OF THE SKELETON OF *Plesippus*

	*P. shoshonensis**			*P. idahoensis*		
Measuremnts	Average	No. sp.	Range	Average	No. sp.	Range
Width distal end humerus	78	5	76-82	87	2	83-90
Greatest length radius-ulna	419	4	402-436	466	2	459-473
Width prox. art. surface radius	78	5	75-82	88	4	83-91
Width dist. art. surface radius-ulna	63	5	60-66	72	5	67-74
Greatest length McIII	246	6	240-254	265	9	225-280
Width prox. art. surface McIII	50	6	47-53	57	9	48-66
Depth prox. art. surface McIII	33	6	30-34	35	9	32-39
Greatest length 1st phalanx	86	6	83-87	88	11	78-94
Greatest length 2nd phalanx	47	6	44-50	52	12	50-55
Width distal end femur	93	4	86-97	102	1	
Greatest width distal tibia	76	4	72-78	85	7	80-90
Length calcaneum	114	4	104-119	131	5	126-138
Length astragalus, inner side	61	3	59-63	68	18	65-74
Width astragalus, across tuberosity	62	4	60-63	72	15	65-78
Length Mt III	280	4	276-282	300	5	298-315
Wdth prox. art. surface Mt III	49	4	48-51	56	5	53-59
Depth prox. art. surface Mt III	37	3	35-39	47	5	45-51

* from Gazin 1936

all but the third upper molar in which it is closed off by mid wear. Except on the P^2 the protocone has a prominent lingual groove. The protocone is elongate. Its antero-posterior length is about one half that of the tooth in the molars and a little over one third that of the premolars except in the P^2 in which it is rounded. The lingual grove is most prominent in the molars. The amount of anterior extension of the protocone (heel) varies from none to a prominent heel depending on the degree of wear and position of the tooth in the series.

SKULL: Only fragments of the skull are represented in the materials from the several localities. Thus a limited amount of information is available. A rostral fragment including the premaxillaries, alveoli for the incisors and both canines (UO16369) shows the diastema from the incisors to the P^2 to be 120 mm, from the canines to the P^2 to be 77 mm. The breadth of the muzzel at the I^3 is 80 mm and at the canines the same. A maxilla fragment containing the P^3-M^2 includes much of the facial part of this bone. It shows the zygomatic arch has its origin just above the middle of the M^1. It also reveals no facial fossa present dorsal to the zygomatic. Near the edge of the maxilla there is a prominent antero-posterior groove similar to that leading into the facial fossa of *P. shoshonensis* which occurs in the area of the maxilla-nasal suture. Apparently the Grand View species had such a fossa but the present material does not indicate the extent of it. The anterior border of the posterior nares lies oposite the M^2

APPENDICULAR SKELTON: In size the skeletal elements indicate a horse equal to the modern forms but not heavy as in the draft horses. The radius and ulna are completely fused in the shaft and distal areas with no indication of the shaft on any of the specimens. It is not possible to determine if the trapezium was present in the Grand View horse. It is not represented, or at least has not been recognized in the available material and no trapezoid is present in our collections to indicate the pattern of faceting. Although all the skeletal elements of the Grand View horse are larger than those of *P. shoshonensis* (see table) they are proportioned similarly. Heavy bodied horses have thick massive bones particularly in the feet, even though the actual length of the elements may be close to those of a lighter animal. This indicates that the Grand View horse was larger than *P. shoshonensis* but similarly proportioned.

COMPARISONS: It is shown bove that the Grand View horse is a larger animal than *P. shoshonensis* as indicated by the longer lengths of the apendicular elements of the skeleton. However, the dental elements do not show such a clear different in size. All of the measurements of dental elements of the Grand View horse fall within the range indicated by Gazin's (1936) measurements of *P. shoshonensis*. It should be noted that Gazin's sample was selected to indicate variations of age in individuals and was not intended to represent the total collection. His measurements do, however, indicate probable range in size but averages may be misleading because of the nature of the sample. This apears to be somewhat contradictory considering the data for the appendicular skeleton, however, Gazin noted a similar problem in comparing *P. shoshonensis* and the zebra *E.* (*Dolichohippus*) *gevyi.* These two species compare closely in size, however, the cheek tooth series of *P. shoshonensis* occupies a longer portion of the maxilla than in *E. grevyi* (Gazin 1936) indicating that it does apparently have a disproportionately large dentition in relation to its total size. See Tables 22, 23, 24.

In curvature of the crown, crown height, complexity of the fossettes and style development the upper teeth of the Grand View horse and *P. shoshonensis* cannot be readily separated, if at all. The protocone of *P. shoshoensis* is apparently less flattened lingually and has a less pronounced lingual groove. These are probably only one characteristic, that is the lingual grove may well be a function of the degree of flattening of the protocone. The degree of elongation of the protocone and its anterior extension (heel) vary similarly in the two horses. Comparison of the development of the upper first premolar is not as yet possible in view of the limited material of that tooth and that portion of the skull of the Grand View horse. I can find no consistent differences in the lower dentitions of these two horses. The metaconid-metastylid grove of the lower teeth of the Grand View horse seems to be more broadly open than in *P. shoshonensis* but when teeth of the same stage of wear of each species are compared they are not consistently different in the development of this groove.

The qualitative differences in these two horses seem so slight that I doubt if individual teeth can be segregated with confidence. The most consistent differences are quantitative. A relationship at the subspecific level is indicated.

DISCUSSION: The above remarks suggest considerable disagreement with the existing impression one might get in reviewing the literature, however, a careful review of these previous studies eliminates much of this. *Plesippus idahoensis* (Merriam 1918) was based on a heavily worn P^4, and an assigned P_4 from Froman Ferry Idaho. The upper premolar is so heavily worn that no estimates of complexity of the fossettes, curvature of the tooth column or height of crown are possible. The lower premolar is a specimen in early year. It has an open isthmus, no evidence of a parastylid in the occlusal pattern and a poorly developed hypostylid. It appears that a parastylid may appear with wear in that a slight groove appears in the tooth column at that point well down from the existing occlusal surface. What little evidence these specimens supply does not agree well with either the Grand View horse or *P. shoshonensis*. It is true that equally worn specimens of the Grand View horse are close to the type of *Plesippus idahoensis* although slightly smaller, this is probably true of any other heavily worn upper premolar of a large late Cenozoic horse. It is thus useless as a basis of comparison. The lower tooth is of considerably more value if it does represent the same horse. The open isthmus and late appearance of a parastylid are not typical of the Grand View horse but these characteristics are seen in the Jackass Butte material. The forty five miles

TABLE 23

MEASUREMENTS OF INDIVIDUAL DENTAL ELEMENTS OF *Plesippus idahoensis*

Locality	Specimen No.	Tooth	Stage of wear	AP	Tr	HC
2396	17938	P_4	E	33.7	18.5	75
2404	27554	M_1	E	29.6	13	83
2396	17389	M_1	E	29.6	19	80
2396	17360	M_2	M	26.5	14.2	65
2396	17374	P^2	E	42.5	30	60
2404	11730	P^3	E	34.1	23a	80+
2404	11731	$P^{3\text{ or }4}$	M	33.0	33	54
2400	17442	P^4	M	35.3	30.2	70+
2404	11749	P^4	L	30.0	30	26a
2403	16445	M^1	L	30.3	30	50
2404	11733	M^1	E	28.3	26.6	71
2404	11732	M^1	E	30.4	27.5	80
2404	11738	M^1	M	29.0	27.3	53
2404	11737	$M^{1\text{ or }2}$	L	29.3	29.4	47
2396	17404	$M^{1\text{ or }2}$	E	32.1	23	99
2396	17382	$M^{1\text{ or }2}$	E	32.4	27.4	93+
2396	17403	I^1	M	13.4	17	
2396	17403	I^2	M	12.5	19.7	
2396	17403	I^3	M	23.2	11.2	
2404	16369	C^1	E	16.9	11	23

E—early, M—mid, L—late stage of wear
a—measurement approximate

TABLE 24

COMPARATIVE MEASUREMENTS OF THE TEETH OF *Plesippus*

	*P. shoshonensis**			*P. idahoensis*		
Tooth	Average	No. sp.	Range	Average	No. sp.	Range
P^3 AP	33	6	31-37	33	1	
P^3 Tr	31	6	29-32	25	1	
M^2 AP	30	6	27-33	29	4	26-30
M^2 Tr	28	6	26-30	29	4	25-31
P_3 AP	32	5	30-35	33	4	31-35
P_3 Tr	17	6	15-19	21	4	20-22
M_2 AP	30	6	25-34	28	6	26-30
M_2 Tr	14	6	14-15	19	6	18-20

* from Gazin 1936

of complex late Cenozoic geology between the two localities obviates any stratigraphic interpretation of the occurrences. The Payette specimen referred to *Equus idahoensis* by Merriam came from a locality thirty five miles north of Froman Ferry. There is really no reason to believe that it represents this species or is even contemporaneous with it.

The Froman Ferry specimens were the basis of Gidley's (1930) comparisons with *P. shoshonensis* and thus do not reveal anything of the relationships of the Grand View horse and *P. shoshonensis*. Gazin in his discussion of *P. shoshonensis* and its relationships with *P. idahoensis* used the same material. In addition he examined specimens from a locality on Sinker Creek about ten miles west of the then known Grand View Fauna localities. These specimens could have been derived from the same stratigraphic unit as those at the Grand View localities. They consisted of an upper third molar and foot elements. Gazin commented that the tooth could be closely matched with those in the Hagerman collection but that the foot was larger. The same type of reaction the present author has with considerable more material representing the Grand View horse.

The first comparison of the Grand View horse and *P. shoshonensis* was that of Schultz (1936). His material consisted of a fragmentary skull and lower dentition and an upper cheek tooth series from the original Cal Tech Grand View localities. In addition he included the Froman Ferry horse in his discussion. Although he does not discuss the assignment of the Grand View horse to *P. idahoensis* his entire discussion of *Plesippus* demands this conconclusion of the reader, because the Froman Ferry and Grand View materials are lumped together in his comparisons with *P. francescana* and *P. shoshonensis.* It should also be pointed out that the purpose of his study (both 1936 and 1937) was to determine the relationship of *P. francescana* to the other plesippine horses. His later paper (1937) continued this study but with the advantage of less worn material representing *P. francescana.* This enabled him to recognize a number of characteristics common to both *P. francescana* and *P. shoshonensis* but he noted that *P. francescana* appeared to vary between *P. proversus* and *P. idahoensis.* In his earlier paper Schultz emphasized that the prefossette in teeth of *P. shoshonensis* occasionally opened through the post protoconal valley. He considered this as strong evidence of its primitive nature. This characteristic is also seen in the Grand View horse.

Merriam (1915, 1918) considered *P. proversus* to be close to *P. simplicidens* and *P. cumminsi.* This was at a time when these species were assigned by him to *Equus* (*Pliohippus*), and before the discovery of *P. francescana, P. idahoensis* and *P. shoshonensis.* Savage (1951) recognized the similarities of many of the plesippine horses and suggested that *P. shoshonensis, idahoensis, proversus,* and *francescana* are at most racial subdivisions which can be referred to *P. simplicidens.* At this time Savage considered *Plesippus* as a category of subgeneric rank.

Most authors in referring to size of a given species have based this on measurements of the dental elements. Gazin (1936, Tables 1, 2, 4, 5) made comparisons between *P. shoshonensis* and *P. simplicidens.* His data indicate that measurements of both dental and appendicular skeletal elements of *P. simplicidens* fall within the range of those for *P. shoshonensis.* The present work indicates a significantly larger body size in *P. idahoensis* over *P. shoshonensis* but little if any significant size differene in the dentition. Although appendicular skeleton elements of *P. francescana* were referred to by Frick (1921) and Schultz (1936, 1937) no measurements were published so that a comparison is not now possible. This suggests that even though the species of *Plesippus* are very close in most characteristics of the dentition, adequate samples including appendicular skeletal elements of the various species can be segregated.

The Grand View horse is referred to here as *Plesippus idahoensis* with some reservations. The type specimen is wholly inadequate for characterizing the species. The apparently topotypic specimen is more nearly of value. It must be clear that in only the most unique species of horse can two specimens, no matter what their condition, provide a useful basis for assignment. However, the Grand View horse has long been referred to as *idahoensis* and the introduction of a new name would only be a source of confusion particularly when there is a chance that additional topotypic material might alleviate some of the difficulties in making confident assignments under the present conditions. Rather than suggest an accessory type at this time from the Grand View material it may be most practical to simply understand that the characteristics of *Plesippus idahoensis* are those of the Grand View horse.

Plesippus was proposed by Matthew (1924

A) as a subgenus of *Equus*. It included those species intermediate between *Pliohippus* and *Equus*. Schultz (1936) emphasized "the unity of characters" of the species of this genus and used the name as a genus. Gazin (1936) also used *Plesippus* as a genus comparing his material with the zebra. *Plesippus* has been commonly used as a genus since that time but it still occasionally appears in a subgenus combination. Stirton (1940, 1942) did not feel that either as a genus or subgenus *Plesippus* provided a useful concept because it raised variants to a taxonomic level not otherwise segregated in the Equidae. Savage (1951) agreed with Stirton's reasoning but emphasized that if *Plesippus* were to be used a much greater splitting of the Tertiary genera would be necessary. McGrew (1944) itemized the zebrine character of the dentition of *Plesippus* and urged the recognition of its apparent identity with *Hippotigris*. Hibbard, Ray, Savage, Taylor and Guilday (1965) recognize the zebrine horses of North America as *Plesippus* and the other late Cenozoic equines as *Equus* s.s., *Equus* (*Asinus?*), *Equus* (*Hemionus?*) and "smaller horse-like forms." Quinn (1955) recognized *Hippotigris*, *Asinus*, and *Equus* in the late Cenozoic.

There has been an equal variety of views on the origin of *Plesippus* and its relationships to *Equus*. They are not necessarily related to the variety of usages noted above. For instance; Stirton recognized these horses simply as a transition between *Pliohippus* (*Astrohippus*) and *Equus* (in a very broad sense). Schultz (1936) employed a similar phylogenetic picture but designated the transitional forms as *Plesippus*. Lance (1950) followed a similar approach to the problem but recognized *Plesippus* as a subgenus and although he designated *Pliohippus osborni* as on the ancestral line to *Plesippus* (similar to Sirton except for the use of *Plesippus*) he assigned *osborni* to the subgenus *Pliohippus* rather than *Astrohippus*. McGrew (1944) considered *Plesippus* to be representative of the zebra line and not a progenerator of *Equus* at all. Quinn (1955) also concluded that *Hippotigris* (= *Plesippus*) and *Equus* s.s. had common ancestors but were not in an ancestor-descendant relationship. Hibbard *et al.* (1965) refer to *Plesippus* as being replaced by *Equus* s.s. as well as other horses denying any ancestor-descendant relationship. I am using the genus *Plesippus* in this latter sense, that is, a line with a common ancestory with *Equus* s.s. and not in an ancestor-descendant relationship. The characteristics of *Plesippus*, its time of occurrence, and spatial relationships with the other late Cenozoic and living equines as these factors are now understood, require this conclusion.

If *Plesippus* is not the ancestor of *Equus* s.s. then presumed *Equus*-like characteristics attributed to some species of *Plesippus* must have some other significance than relative age since this genus is no longer considered as a transitional form toward *Equus*. They may be useful in recognizing a diversity (if one exists) within *Plesippus*. In view of McGrew's conclusions on the validity of many of the characteristics usually employed in such attempts this seems to be a meaningless procedure. It is certain to be irrelevant in relative age discussions. McGrew (1944) did indicate other characteristics which seem to hold up within reasonable limits as means of segregating broad groups within the equinae.

SUBORDER CERATOMORPHA

SUPERFAMILY RHINOCEROTOIDEA

FAMILY RHINOCEROTIDAE

SUBFAMILY TELEOCERATINAE

? *TELEOCERAS SP.*

Tooth fragments from Bartlett Mountain locality 2517 representing upper molars are similar to complete molars in a skull of *Teleoceras* previously reported from this fauna and collected a few feet from the sample at locality 2517.

A number of enamel fragments of large teeth from Juniper Creek Canyon locality 2451 undoubtedly represent a rhinocerotid but it is not possible to determine if it is *Teleoceras* of *Aphelops*.

Order Artiodactyla
Suborder Suiformes
Infraorder Suina
SUPERFAMILY SUOIDEA
FAMILY TAYASSUIDAE

PROSTHENNOPS SP.

Locality 2451, Juniper Creek Canyon, produced a single M_3 of *Prosthennops*, UO27542 plus several tooth fragments. Specific assignment is not possible.

PLATYGONUS SP.

Jackass Butte locality 2404 produced several tusks, calcaneum, radi-ulna, and an M_3 all representing a large peccary. Wild Horse Butte locality 2396 yielded a P^2 in a maxillary fragment also representing a peccary. The P^2 is a relatively simple tooth. Two large cusps are situated lateral to each other. A heavy posterior cingulum is present forming a heel-like shelf. A small accessory cingular cusp is situated on the anterior face of the tooth at the base of the juncture of the two major cusps. The tooth has three roots. The M^3, UO16287, is high crowned with the cusps nearly completely separated antero-posteriorly. The upper third of the cusps are separated transversely. A heavy anterior cingulum is present but does not extend to either side of the tooth. A cingular cusp blocks the transverse valley on the lingual side. The heel consists of a central cusp flanked by a small lingual cingular cusp and a large labial cusp slightly posterior to the central cusp. The M^3 is relatively high crowned and unworn.

Gazin (1938) described the peccary *Platygonus pearcei* from Hagerman Idaho. Simpson (1949) later placed a number of species of *Platygonus* in synonyomy with *P. compressus*. However, only post-Blancan species were considered and so no comparisons were made with *P. pearcei*. In the course of the discussion the variability of size and character of minor crests cingula and heels is emphasized and illustrated. Gidley (1920) had previously noted a wide variation in certain dental characters, but did not dsecribe these variations. The present material is close to *P. pearcei* in size of the

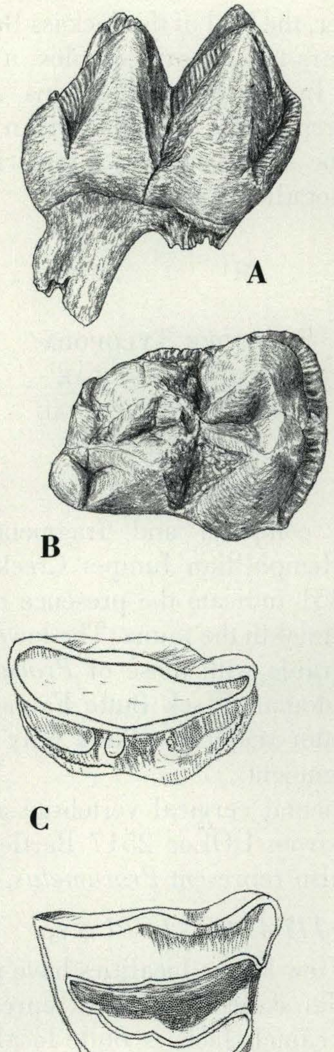

Figure 42. **A** *Platygonus* sp. UO16287 M^3 Jackass Butte UOloc 2404 lateral view x 1.5, **B** occlusal view x 1.5, **C-E** *Megatylopus* sp., **C** UO6025 P^3 Black Butte UOloc 2326 occlusal view x 1.1, **D** UO6173 P^4 Black Butte UOloc 2343 occlusal view x 1.1, **E** UO11005 P_3 Black Butte UOloc 2448 occlusal view x 1.1.

M^3, however, the heel of the Jackass Butte specimen appears to be more complex, a variable character. In all probability this specimen probably represents the Hagerman species, however, the small amount of material available does not allow an assignment.

		AP	Tr
UO16287	M^3	24 mm	17.7

SUBORDER TYLOPODA
FAMILY CAMELIDAE
SUBFAMILY CAMELINAE
Tribe Camelini

? PROCAMELUS

Isolated complete and fragmental teeth from the Hemphillian Juniper Creek Canyon locality 2451 indicate the presence of a middle-sized camel in the fauna. The lower molars are comparable with those of *Procamelus* of the Clarendonian Black Butte Fauna but the lack of better material allows only a provisional assignment.

A fragmental cervical vertebrae and tooth fragments from UOLoc 2517 Bartlett Mountain may also represent *Procamelus.*

TITANOTYLOPUS sp.

Grand View Fauna localities have produced appendicular skeletal elements representing a very large camel. Jackass Butte locality 2403 contained a complete humerous, UO 16561, and tibia, UO16559, and a partial metapodial, UO16446. Jackass Butte locality 2404 is represented in the materials by a large calcaneum, UO11855, the distal half of a humerus, UO 16555, an unciform, UO11845, a fibula, UO 11860, a scaphoid, UO11873, a lunar, UO 12021, and a lower molar, UO11858. A large phalanx, UO17463, was collected as float at Jackass Butte.

The tibia is considerably shorter than that of *Megatylopus* but represents an equally massive animal. The body of the calcaneum is broad proximally rather than tapered as in *Megatylopus*. In these characteristics the Jackass Butte species is similar to *Titanotylopus*. See Table 25

Tribe Camelopini
MEGATYLOPUS sp.

A large camel is present at most localities producing the Black Butte Fauna. However, it is only well enough represented to characterize at a few sites. At quarry 3 (UOLoc 2448) a mandible with P_4-M_3 and the alveoli for P_1 and P_3 was collected. In the same collection were isolated upper teeth and nearly all elements of the appendicular skeleton. This material provides useful information as to the character of this large camel and is supplemented by material from other nearby localities. These specimens were previously reported and assigned to *Megatylopus* cf. *gigas* by Shotwell and Russell (1963). At this time the material will be described in more detail.

DENTITION: The mandible, UO 10287, (Fig. 94, Shotwell and Russell 1963) indicates that the first premolar is relatively small and that the third premolar had two roots. The second premolar is absent in the species represented. A lower third premolar, UO11005, from the same site provides information on that tooth. Upper third and fourth premolars are present in the collections from other nearby localities. Thus the information on the dentition is, in part, dependent on a composite.

The lower incisors have two indentations on their external borders giving a scalloped appearance to the tooth. The lower third premolar is wedge-shaped in cross-section anterior to the mid-point. The tooth is blade-like in early wear. Internal stylids are present anteriorly, just posterior to the mid-point and at the posterior edge. The middle stylid is connected by a lophid which extends antero-medially and postero-lingually to the base of the posterior stylid. A closed lake may appear in very late wear.

The upper third premolar consists of a relatively straight ectoloph with moderate posterior and anterior external styles and a rounded mid-rib. Three styles of varying size are present along the lingual side of the tooth; one just anterior to the mid-point, one just posterior to it and a large posterior stylid. The anterior

TABLE 25

Lengths of Skeletal Elements of Several Large Camels

Genus	Locality	Humerus	Radius-ulna	Tibia	Metatarsal	Metacarpal
Megatylopus	2448		643	650	500	542
Megatylopus	2469				482	
Titanolopus	2403	508		541		

TABLE 26

Measurements of the Dentition of *Megatylopus*

Specimen No.	Locality	P_1	P_3	P_4	M_1	M_2	M_3	P^1	P^3	P^4	M^1	M^2	M^3
UO 10287	2448			26.4	34.5	40.8	51.4						
UO 10279	2448						56.3						
UO 11005	2448		22.7										
UO 6173	2343									25.0			
UO 6025	2326								25.0				
UO 5874	2338			27.8	33.9								
UO 5782	2326		21.4										
UO 10338	2448										39		
UO 10981	2448										44		
UO 11007	2448											44	
UO 10326	2448												41
UO 20325	2469			29+		40.0	57+						
UO 10316	2448						54						

Note—localities 2326, 2338, 2343 and 2448 are of the Black Butte Fauna—See Shotwell and Russell 1963

style is connected to the anterior edge of the tooth by a thin loph. The others are connected to each other at their base. A poorly developed cingulum extends around the lingual base of the tooth. The tooth had three roots which are broken away.

The lower fourth premolar has a sinuous external lophid. Posteriorly an internal lophid forms a complete crescent with the external lophid. The tooth is much higher crowned than the third premolar. There is a strong antero-lingual stylid. The internal ribs are low and rounded.

The upper fourth premolar consists of a relatively straight ecotoloph with a strong anterior style and somewhat weaker posterior style and a low mid-rib. The internal crescent connects high on the postero-internal edge of the ectoloph and low on the antero-internal edge of the ectoloph. The seleno is therefore open anteriorly until very late wear. There are two plications along the internal crescent. One is near its posterior connection with the ectoloph, the other is just posterior to its mid-point. The fourth premolar is close to the third in anterio-posterior measurement. The tooth had three roots.

The lower molars have very slight buttresses, apparent only in early wear and consisting of a sharpened antero-labial corner with a slight flat area immediately posterior to it. The ectoloph is smooth except for the poorly developed stylids.

The upper molars have well developed styles and moderate rounded mid-ribs. The ectoloph is not continuous from one selene to another but interrupted by the overlapping mesostyle. An internal cingula is present on some of the upper molars. It extends around the posterior and anterior ends of the teeth rising abruptly towards the occlusal surface. There is no development of intercrescent pillars.

SKELETAL ELEMENTS: The mandible is heavy and relatively shallow. The angle is not inflected. The radius-ulna is long and slender, about the same length as in *Titanotylopus.* The tibia is very long and slender for such a large animal, and nearly 100 mm longer than *Titanotylopus* or *Camelops* (see Figs. 95, 96, 97, 98, in Shotwell and Russell 1963). The body of the calcaneum tapers to the proximal end. The metapodials and phalanges are similar to those previously described. The skeletal elements indicate a very tall animal with a disproportionately small head. See Table 25

COMPARISONS: The Black Butte species differs from *M. gigas and M. matthewi* in its more equal-sized P_3-P_4. It is apparently similar in the development of the P_3 and the presence of plications on the P^4 to *M matthewi.* It does not have the intercrescent pillars present in *M. gigas.* The Black Butte species may be characterized as one with; unreduced third premolars, slightly retarded first premolars, second premolars absent, cingula on some upper cheek teeth, long slender limbs, and large size.

MEGATYLOPUS sp.

Two of the Hemphillian sites in Juniper Creek Canyon have produced specimens of a large camel. UOLoc 2469 provided a fragmentla mandible, complete and fragmental metapodials, isolated teeth and other fragmental skeletal elements. The mandible includes; incisor, P_1, P_4, M_{1-3}. Although the teeth are moderately worn the P_1 is not yet erupted, only a small tip of the tooth protrudes from the alveoli. The other dental elements are similar in both character and size to the Juntura species at Black Butte. This is also the case with the appendicular skeletal elements.

Locality 2451 produced a number of fragmentary and complete teeth. They cannot be distinguished from those available from UO Loc 2469. The species represented at these localities apparently is close to the Black Butte species but with a more retarded P_1. Occurrences of *Megatylopus* at other Hemphillain localities to the west were reported by Shotwell and Russell (1963).

? *MEGATYLOPUS* sp.

A large camel is represented at the Hemphillian Little Valley locality 2380 by the distal epiphysis of a radius-ulna, UO10798, and an astragalus, UO10821. These specimens were collected as float on the surface of the exposure. The radius-ulna measures 111 mm transversely at the distal end which is within the known range of *Megatylopus* as well as *Titanotylopus.* The astragalus is 105 mm in its longest dimension and compares closely with those from other Pliocene localities in Oregon.

Tribe Lamini

TANUPOLAMA sp.

Grand View fauna localities produced a number of specimens representing *Tanupolama.* Jackass Butte locality 2404 yielded isolated teeth and fragmental foot elements. Jackass Butte 2400 produced a phalanx and Wild Horse Butte locality 2396 a lower molar and incisor. Materials from Wild Horse Butte locality 2397 included an upper molar and Castle Butte locality 2394 a phalanx.

The well developed lama-buttress on the lower molars, their high crown and the long delicate phalanges indicate that the camel represented is *Tanupolama.*

SUBORDER RUMINATA

INFRAORDER PECORA

SUPERFAMILY CERVOIDEA

FAMILY CERVIDAE

CERVUS sp.

The Jackass Butte (UOLoc 2403, 2404) and Wild Horse Butte (UOLoc 2396) localities have produced a number of elements of the skeleton of an elk sized cervine. A mandible fragment, UO16417, (UOLoc 2403), provides the best estimate of the characteristics of the species represented. The P_2 is not as broad as the P_2 in *Cervus.* Lophids are more distinct than in *Cervus* and more like those of *Odocoileus* with the exception of the palalophid which is very weak. In the P_3 the paralophid is branched, each branch reaching the lingual bor-

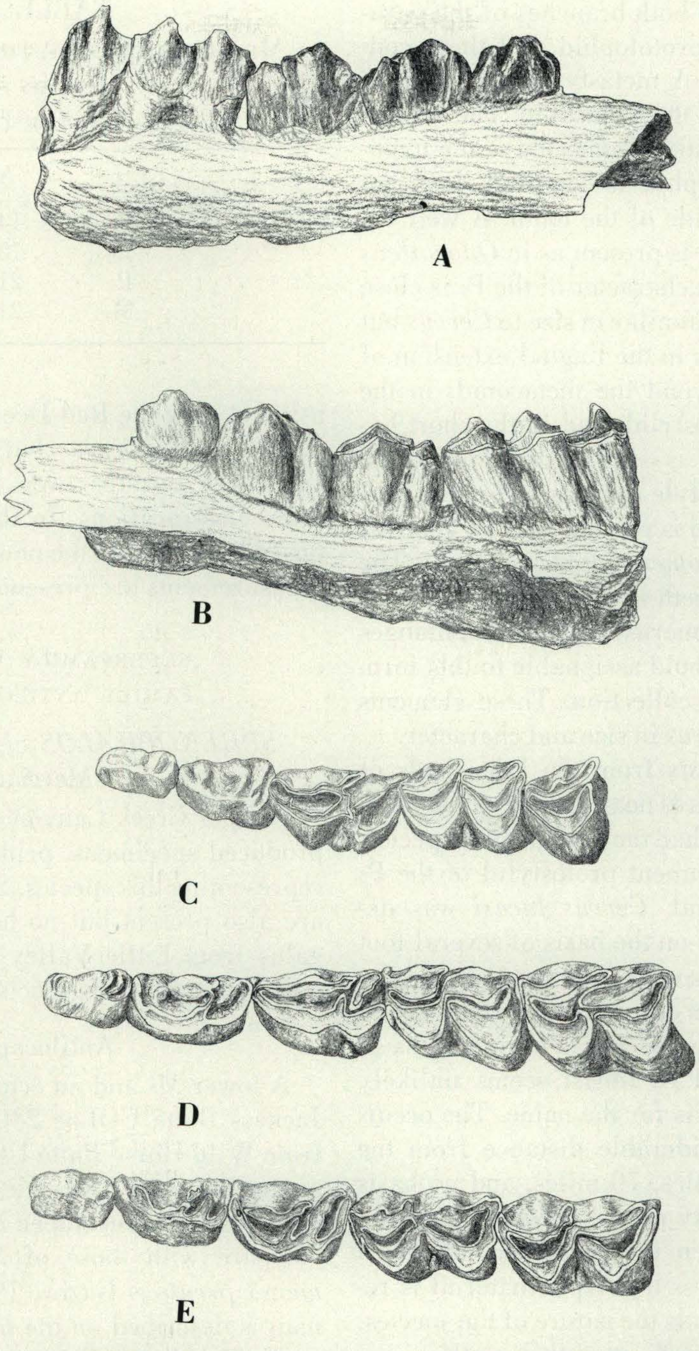

Figure 43 **A-C** *Cervus* sp. UO16417 lower jaw fragment P^2-M^2 Jackass Butte UOloc 2403, **A** medial view x 0.75, **B** lateral view x 0.75, **C** occlusal view x 0.75, **D** *Odocoileus* recent occlusal view x 1.4, **E** *Cervus* recent occlusal view x 0.75.

der of the tooth. The protolophid is well defined and terminates in a columnar metaconid. The entoconid is similar in size to the metaconid and weakly attached to the hypoconid by a loph which becomes heavier with progressive wear. The hypolophid is low and connects to the entoconid in late wear. The P_4 is dominated by an antero-posteriorly broad metaconid. The metaconid is attached to both branches of the paralophid and to the protolophid. All these connections are weak. A metastylid is present at the posterior end of the metaconid. The entoconid is large and weakly connected to the hypoconid. The hypolophid is low and does not reach the lingual side of the tooth. A well developed protostylid is present as in *Odocoileus* but not *Cervus*. The character of the P_4 is close to *Odocoileus*. It is similar in size to *Cervus* but differs from *Cervus* in the lingual extension of the paralophid beyond the metaconid, in the presence of a protostylid, and in the short hypolophid. The M_1 is similar to *Odocoileus*, however, the mesostyle appears to be stronger. A strong protostylid is present as is an anterior cingulum. No *Paleomeryx* fold is present. The enamel of all the teeth is crenulated.

Astragali, a humerus fragment, phlanges and a navicular-cuboid assignable to this form are present in the collection. These elements are all close to *Cervus* in size and character.

Procoileus edensis from the Eden beds of Southern California is near the size of *Odocoileus*, much smaller than the Grand View species, and lacks the prominent protostylid of the P_4 in the new material. *Cervus lucasi* was described from Idaho on the basis of several foot elemtns. Although some of the comparable elements are present in our collections they are of little use in making specific determinations so that recognition of *C. lucasi* seems unlikely considering the basis for the name. The occurrence is at a considerable distance from the Grand View localities, 70 miles, and no basis for contemporaniety exists. *C. lucasi* is probably a nomen nudem and certainly not useful taxonomically unless topotypic material is recovered which reveals the nature of the species. Hibbard (1959) indicates that antlers are known from the Grand View localities.

The new material indicates a cervine with dental characteristics close to *Odocoileus* but in size similar to *Cervus*. Its assignment to either genus seems unlikely unless the genus *Cervus* is viewed in the broadest way. In Eurasia not only the Red Deer and Wapiti are included under *Cervus* but a number of other subgeneric groups even including *Dama* in some classifications. In this broad sense it is possible to include the new material in *Cervus*. Measurements are presented in Table 27

TABLE 27

MEASUREMENTS OF THE DENTITION OF *Cervus* sp.

JACKASS BUTTE UOloc 2403

		AP	Tr	HC
UO 16417	P_2	14.2	8.7	11.6
	P_3	18.2	11.3	16.6
	P_4	21.1	13.2	
	M_1	21.9	14.8	

SUPERFAMILY BOVOIDEA

FAMILY ANTILOCAPRIDAE

SPHENOPHALOS cf. NEVADANUS

Merriam

Juniper Creek Canyon sites 2451 and 2469 produced specimens, primarily isolated teeth, representing this species. Several foot elements are also present but no horn cores. An astragalus from Little Valley locality 2380 probably represents this species.

Antilocaprid

A lower M_2 and an ectoloph fragment from Jackass Butte UOLoc 2401 and an upper M^2 from Wild Horse Butte UOLoc 2397 represent an antilocaprid. The styles of the upper molar are not as well developed as in *Antilocapra* but compare with those of *Stockoceras*. *Ceratomeryx prenticei* Gazin (1935B) of the Hagerman is described on the basis of a fragmental skull. The dentition has not been described in detail. It is tempting to assign this material to *Ceratomeryx* but there is no direct evidence that it represents this form.

	AP	Tr	HC
UO17971 M^2	12.3	10.7	21.8
UO17448 M_2	13.7	6.6	33.5

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