



MIocene MAMMALS
OF
SOUTHEAST OREGON

Shotwell

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INTRODUCTION

The late Miocene fauna described here represents the earliest step in a sequence of late Tertiary faunas studied as a part of a long range investigation into the interrelationships of the factors of faunal change. The study is deliberately provincial to reduce biogeographic effects and to allow independent time controls to be developed through detailed geologic mapping.

The concept of the bulk fauna is used to indicate the entire fauna of the Northern Great Basin at any particular time. The association or community is the basic unit of study, the bulk fauna is the whole of which the associations are the overlapping parts.

The recognition and description of associations are dependent on quantitative data. Thus excavation must be carried out in such a way that useful quantitative information is retrieved. Previous studies of late Miocene, Barstovian, occurrences in the immediate area of study, Skull Spring (Gazin 1932), Sucker Creek (Scharf 1935), and in nearby areas, Virgin Valley (Merriam 1911), Beatty Butte (Wallace 1946), Mascall (Downs 1956), were based on float materials and limited excavations, lumped together as faunas. These studies provide material and conclusions useful in the taxonomic assignment of species occurring in samples but do not contribute quantitative data nor do they reflect the environmental diversity apparently present.

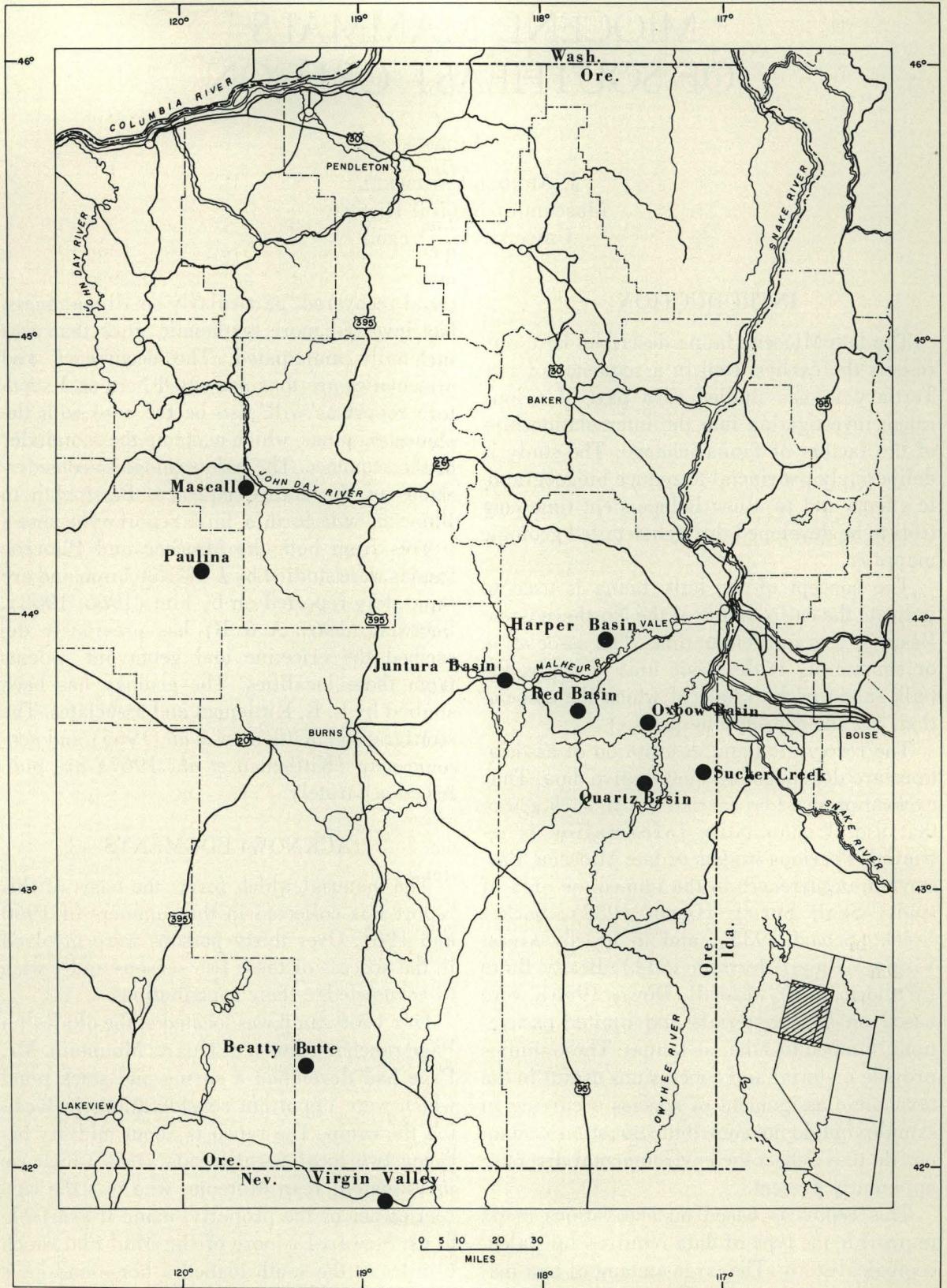
This report is based on excavations made to provide the type of data required for paleoecological study. The large amount of new ma-

terial recovered, particularly small mammals, has involved more taxonomic work than was originally anticipated. The occurrence and systematics are thus presented here as a separate report as will also be the case with the Pliocene faunas, which make up the remainder of the sequence. The paleoecological considerations of the entire sequence, Barstovian to Blancan, will form a final report. The insectivores from both the Miocene and Pliocene faunas were studied by J. H. Hutchison and are separately reported on by him (1966, 1968). Shotwell (1967 A & B) has previously described the cricetine and geomyoid rodents from these localities. The geology has been studied by L. R. Kittleman and associates. The stratigraphy (Kittleman *et al.*, 1965) and geologic map (Kittleman *et al.*, 1967) are published separately.

ACKNOWLEDGMENTS

The material which forms the basis of this report was collected in the summers of 1960 and 1961. Over thirty persons were involved in the success of these two seasons and I wish to acknowledge their contributions.

Our 1960 camp was located at the old Ralph Page ranch northwest of Quartz Mountain. Mr. Page had developed a spring and stock pond which were important considerations in locating the camp. The ranch is about midway between two local fossiliferous areas which we investigated. Jean Morcom, who was the current owner of the property, made it available to us. Stewart Elsinore of Big Mud Flat ranch 6 miles to the south loaned a horse and gave



other assistance. The crew was made up as follows: Excavation crew, Richard Wilson, Jon Jacklet, Fred Crafts, Fred Cole, Jim Haight, Garry Millhollen and Gene Winters; Geologists, L. R. Kittleman, Robert "Pete" Russell and Arvid Johnson; Cook, Lillian Wells; Cook's helper, Charlene Wells.

The 1961 camp was located at "Millers Cow Camp" on Dry Creek, the former site of Littlefield. Julian Arian of Juntura made the line shack there available to us. A very good spring is also present. Drex Williams, also of Juntura, made facilities available for the geologists both during the 1961 season and 1962. Bud Rogers put up our spring recon crew for several days when we were caught in a late snowstorm. The crew consisted of, geologists L. R. Kittleman, Art Green, Jay McMurray, and Allen Hagood; excavation crew, Richard Wilson, Stuart Shininger, Loren Cox, Don Landenberger, Gary Kessler, Allan Heinrichs, Gary Shaeffer and Gary Millhollen; Lillian Wells was cook and Charlene Wells her helper.

The Laboratory work was completed by Richard Wilson, Jon Jacklet, Stuart Shininger, George Howe and Janet Mack. The illustrations in this report are by Mildred Detling with the exception of figure 10 which was prepared by Pamela Parsons. The photography is by Bernard Freemesser of the University of Oregon photo bureau, Richard Wilson and Fred Crafts.

The field and laboratory work was primarily supported by NSF grant G 10684 (environmental biology). Four students were supported in each of the two field seasons under the NSF, URP program, grants G 12023 and 15861. NSF grant G 21820 (facilities and special programs) provided new facilities and resources which aided in the study of the materials and in subsequent field work. NSF grant GB 3971 (environmental biology) provided funds for the analysis and publication of the results of the entire previous program. To these individuals and the National Science Foundation I am deeply indebted.

Figure 1. General location map.

OCCURRENCES

Previously known Barstovian collections from the Northern Great Basin are all very similar, representing possibly two associations; one which might be termed the *Merychippus-Dromomeryx* association and the other, usually more poorly represented, the *Hypohippus-Ticholeptus* association. None of the expected members of a pond-bank association, so common in the Pliocene, were known such as beavers, *Peromyscus*, turtles, fish, etc. The Paleobotanical evidence indicated, however, that such an association could be expected. The problem then was not only to find suitable sites for the excavation of quantitatively useful samples of those associations which were obviously present, but to also find samples of other associations which were expected and to find them within the geographic limitations imposed.

Together a number of the known Barstovian localities, including Skull Springs and Beatty Buttes and many other less well known sites, form a large contiguous area in southeastern, south central Oregon and northern Nevada. Within this large area no post-Barstovian sediments occur although post-Barstovian igneous rocks are present. Younger sediments are encountered in numerous localities peripheral to this area but lower topographically. This line of evidence led to a working hypotheses that the topographically higher area of thin Barstovian sediments had been continually high since the Barstovian and that the peripheral younger sediments represented the location of a number of small, and some rather large basins. Typically when descending into these basins from the "Barstovian high" Hemphillian sediments were first encountered in contact with those of Barstovian age. If the basin had been deeply cut, Clarendonian sediments were seen and finally Barstovian again but of different lithology than those on the high. In some of these basins still earlier rocks were present. The Barstovian sediments in the basins on the west and southwest side of the "high" had been carefully examined. This was disappointing in that they commonly consist of diatomite and

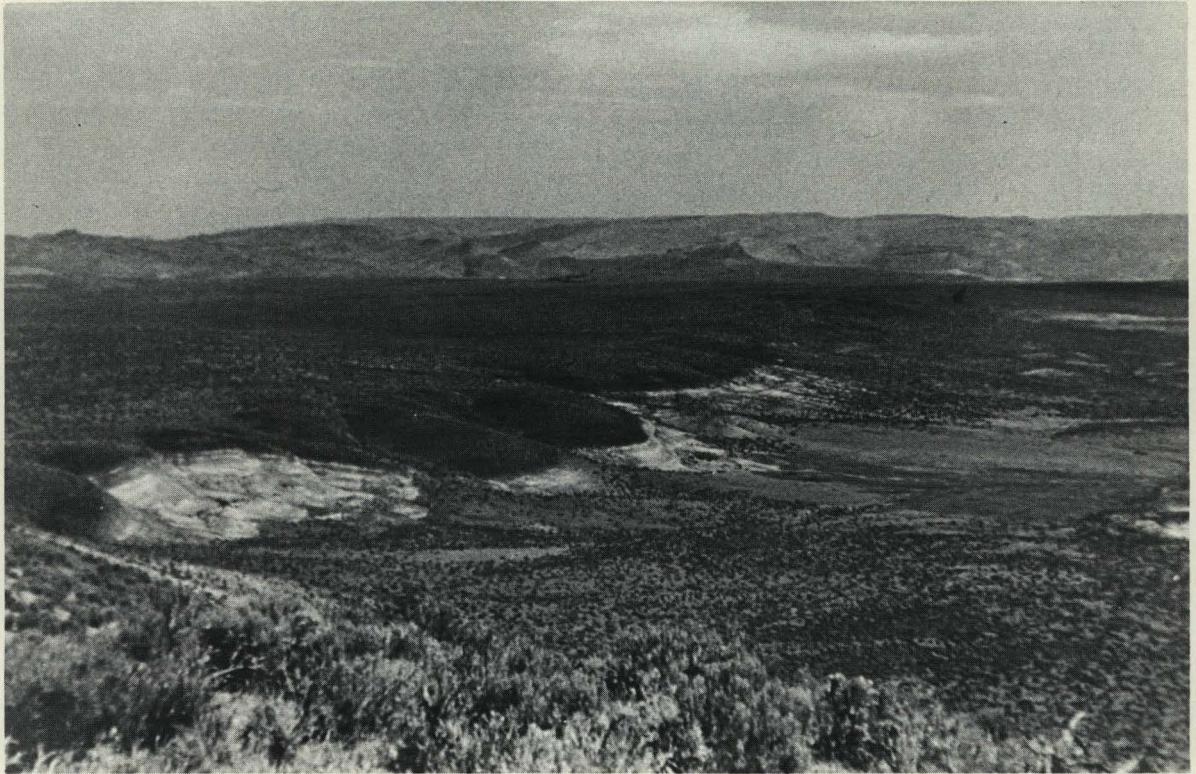


Figure 2. *North end of Quartz Basin.*

very fine ash. Very few vertebrates were to be seen in them, however, plant fossils were frequently present. The same failure had occurred on the north side of the Barstovian high in the Juntura Basin (see Shotwell 1963). To the east, in Malheur County it was believed that an extensive series of Barstovian sediments were present, however, the area was virtually unknown and relatively inaccessible. On the east and south it is bounded by the 1000 ft. deep Owyhee gorge occupied by a reservoir. On the north it is nearly isolated by a deep east-west branch canyon occupied by Dry Creek. On the west the distance from any sort of all-weather road had discouraged previous investigations. Study of air-photos of the area showed the sediments to be apparently fine grained but probably not diatomites. This then seemed to be the mostly likely area in which we might expect to find the associations of mammals we felt were missing and would be expected to be best developed in a lowland environment.

In the spring of 1960 two attempts were made to reconnoiter the area. The first one aborted due to a sudden thaw of a heavy snowfall and a fire in our vehicle. The second one was successful in that we reached the area and found evidence that a Barstovian stream-bank association was present and apparently abundantly represented. This was in the northern end of Quartz Basin. In the summer of 1960 a base camp was established a few miles to the west at the then unoccupied Page Ranch.

From the Page Ranch camp three geologists mapped the surrounding area, while the author and seven students made test excavations in Quartz Basin to the east and Juniper Creek Canyon to the west.

Quartz Basin is an erosional feature excavated in the lower members of the Deer Butte formation. The south and east borders of the basin are composed of low hills of the Red Butte and Orlando Springs Members while the west and northern borders consist of the some-

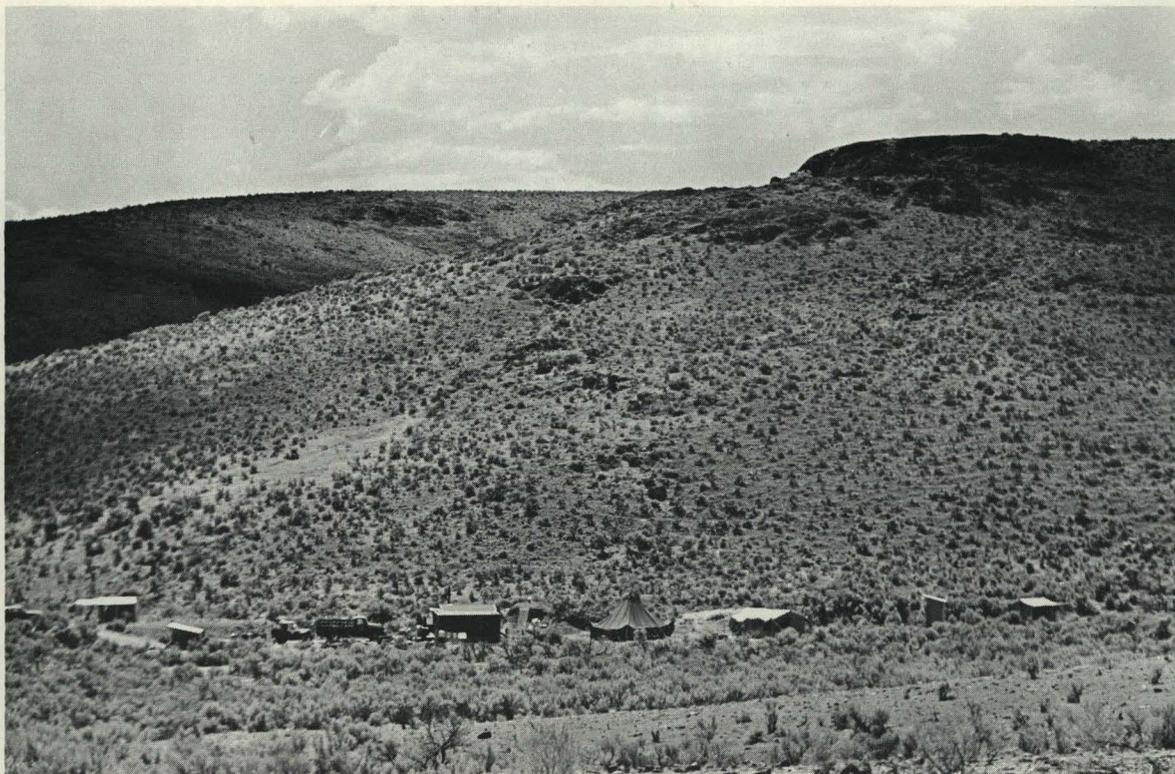


Figure 3. 1961 camp at Millers Cow Camp.

what higher hills of the Holdout and Quartz Mountain Members. The basin is shallow and drains into the Owyhee River to the south and the Owyhee Reservoir to the east over a thousand feet lower topographically. Vegetation in the basin is sparse and consists primarily of grasses with low brush around the borders of the basin and along drainage courses. There are no permanent streams in the basin although a year round spring, Ferguson Spring, flows at its northwest edge. The floor of the basin is between 3700-3800 feet in elevation with the surrounding hills at 4000 feet. Quartz Mountain rises from the west side of the basin to a height of over 5100 feet.

Fossils were collected from the Holdout Member of the Deer Butte Formation at sixteen localities along the northwest border of Quartz Basin. The Holdout Member is overlain by the Quartz Mountain Member. One of these localities, UOloc 2465, was developed into a quarry which produced a quantitative sample

from a productive level less than a foot thick. Some faunal elements were recovered from the other localities which did not occur in the quarry. These are described in order to provide a more complete faunal list although they will not appear in the eventual quantitative analysis which is restricted to UOloc 2465.

The productive level of the Quartz Basin locality was completely removed, sacked and hauled about 8 miles to the Page Ranch where it was alternately soaked in the stock pond and dried in the sun using screens of 14 x 18 mesh. The concentrate from this screening was hauled to the museum where the bone was segregated from the remaining matrix. A little over three tons of productive level was so worked using 80 screens.

An additional small sample was taken from the east end of the quarry in the fall of 1965 and submitted to the kerosene treatment (see Wilson 1965) and 24 mesh screen in order to derive an estimate of the difference in results

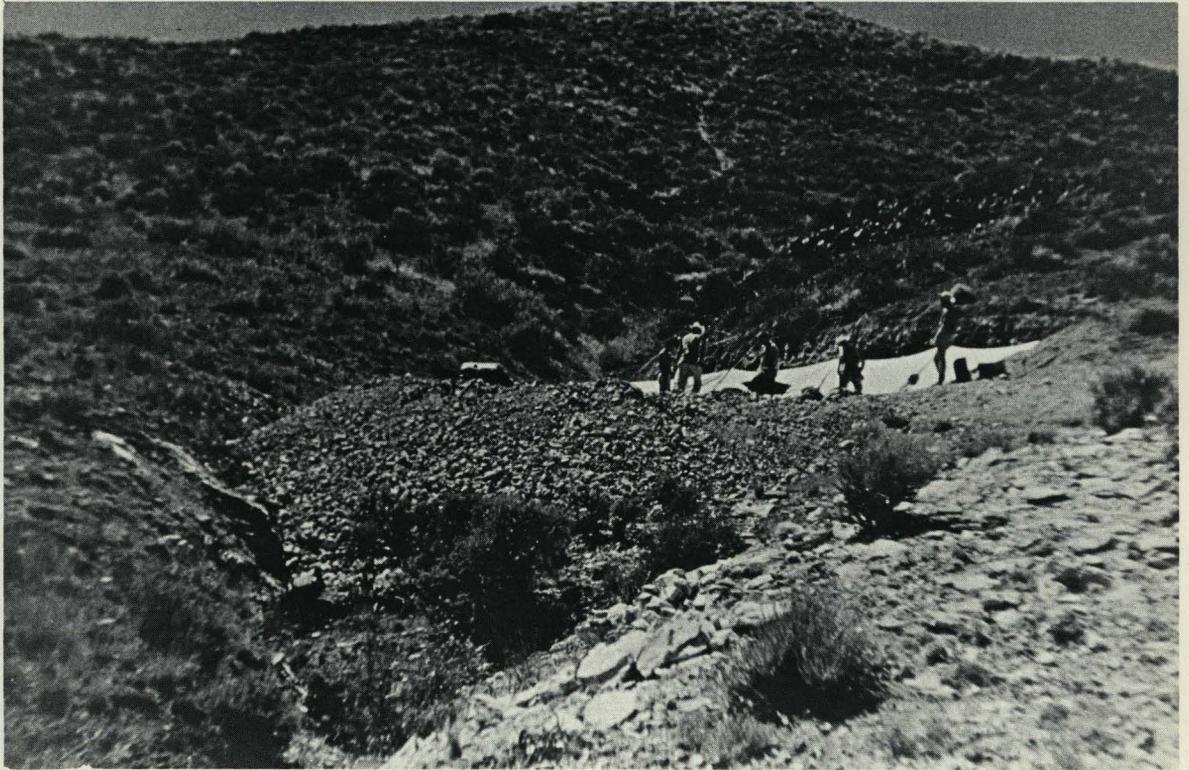


Figure 4. *Locality UOloc 2465 Quartz Basin.*

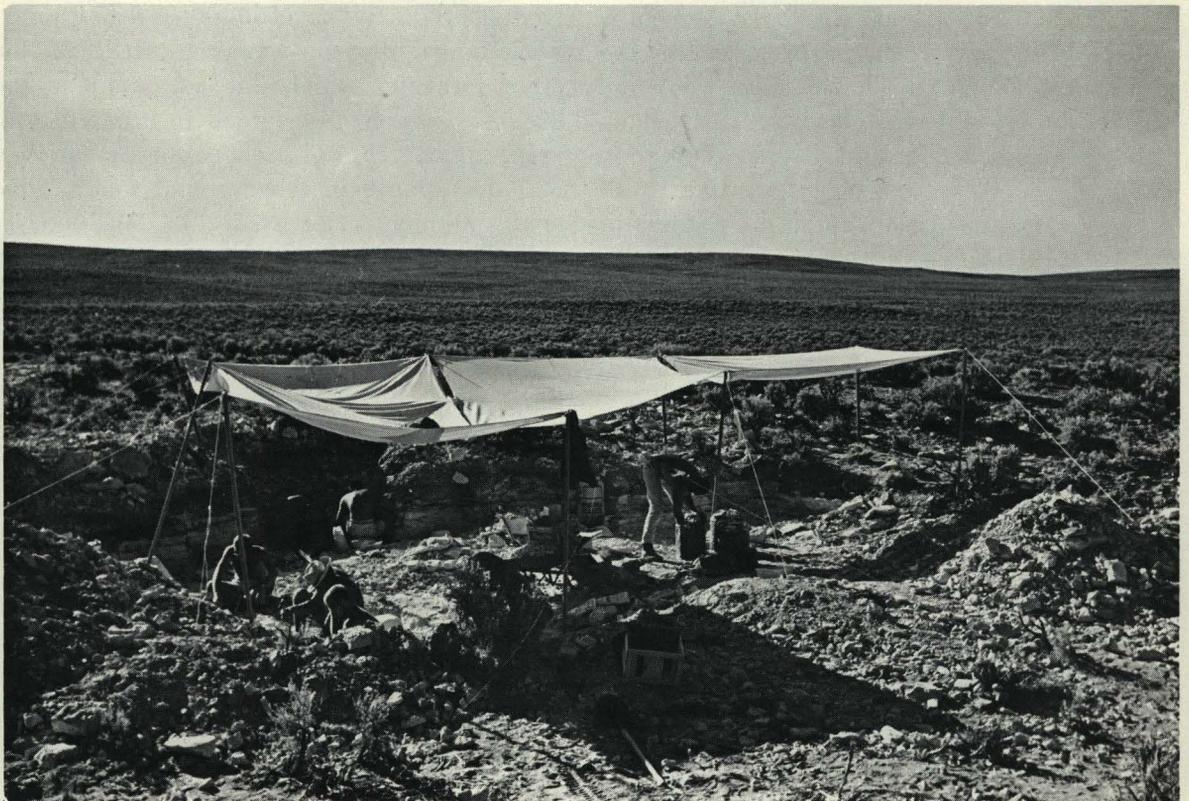


Figure 5. *Locality UOloc 2495 Red Basin.*



Figure 6. *Washing matrix from Quartz Basin locality.*

which might be expected due to the variation in this recovery technique which had been applied in subsequent excavations.

Float material is abundant in a number of localities in the vicinity of Skull Springs and in Red Basin. The description of the Skull Springs Fauna (Gazin 1932) is based on such material from Red Basin indicating that a rather complete faunal list, at least of the larger mammals, may be obtained in this way. However, such material presents serious handicaps to any quantitative analysis other than very crude estimates. To acquire quantitatively useful samples searches for possible excavation sites in this area were made during the course of seven field seasons. These efforts were for short periods of time but produced little in the way of encouragement. Assuming that a concerted effort over a longer single period of time would be successful, a large camp was established at Miller's Cow Camp on Dry Creek in the summer of 1961. A number of productive

areas, north, east, and south of this point were examined. Eventually a dry wash in the northern half of Red Basin was examined in which large amounts of fragmental and complete vertebrate skeletal elements were found, UOloc 2493. Preliminary excavation produced specimens in place but also indicated that much of the concentration was already gone probably represented by the float as a lag deposit from the sediment removed by the dry wash. To test this conclusion another excavation was started just to the east and above the dry wash in the thin soil (UOloc 2495). Weathered specimens were soon encountered in the soil horizon and once unweathered sediment was reached a considerable amount of material was obviously present. Sagebrush was then cleared away and excavation started on the site. Screening of the well consolidated matrix was attempted using wetting and drying but was completely unsuccessful. Excavation was carried out by removing blocks of sediment whenever specimens

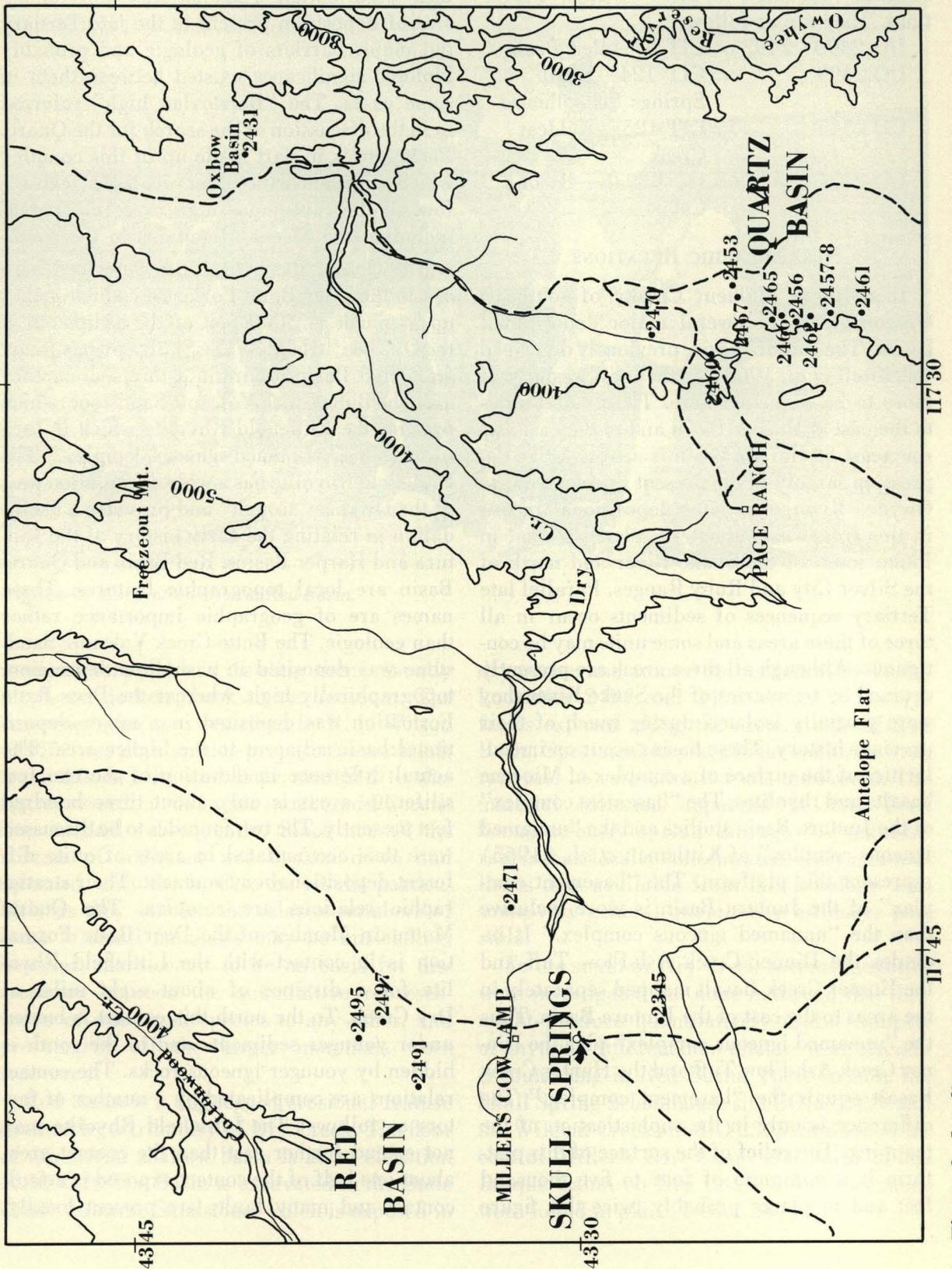


Figure 8. Locality map.

the contact is in an area of about 1000 ft of relief and very difficult to reach and work in. Apparently at no point is the relationship of the Littlefield Rhyolite and the Deer Butte Formation unquestionable. The Quartz Mountain Member of the Deer Butte appears to, at least in part, overlie the Littlefield Rhyolite but may actually interfinger with it. Thus the Butte Creek Volcanic Sandstone containing the Red Basin faunule and the Deer Butte Formation with the included Quartz Basin faunule appear to occupy similar stratigraphic positions.

A previously described fauna, the Sucker Creek fauna (Scharf 1935), is not involved directly in the present report but is significant in any discussion of faunas of this region. This fauna occurs in the Sucker Creek Formation (see Kittleman *et al.*, 1965). Both the Sucker Creek Formation and the Deer Butte Formation are in the Owyhee "trough." Their stratigraphic relationships are, however, complex. The Deer Butte Formation overlies the Owyhee Basalt in its northern and eastern extent. The Owyhee Basalt overlies a rhyolite at Owyhee Dam which in its southeastward extent appears to overlie the Sucker Creek Formation. Upper members of the Deer Butte Formation unquestionably overlie the Sucker Creek Formation to the northeast and the lower members overlie the Leslie Gulch Ash-Flow Tuff, a member high in the Sucker Creek Formation, to the south. The field evidence thus indicates that all of the Deer Butte Formation lies stratigraphically

above the Sucker Creek Formation (see Kittleman *et al.*, 1965, 1967).

The physical geology of the region thus indicates that the Red Basin and Quartz Basin localities occur at about the same stratigraphic level whereas the Sucker Creek localities appear much lower in the local section.

FAUNAL RELATIONSHIPS

Thirty six species of mammals were collected in Red Basin of which thirty three were found in the main quarry, UOloc 2495. Twenty two species were previously known from Red Basin as the Skull Springs fauna (Gazin 1932, Hall 1931, Bode 1934, Downs 1956). Five of the previously recorded species were not recognized in our collections; four carnivores, *Pliocyon*, *Euoplocyon*, *Hemicyon*, and *Tomicetus* and a chalicothere. The total known Skull Springs fauna thus includes forty two species. About one half of these are insectivores or rodents. Fourteen species collected in Red Basin were previously unknown in the Northern Great Basin.

Quartz Basin localities produced thirty four species of mammals, of which thirty one were recovered from the main quarry UOloc 2465. Seventeen species occurring in Quartz Basin were previously unknown in the Northern Great Basin.

The Quartz Basin localities were deliberately established to reveal an aspect of the Northern Great Basin fauna previously unknown but

TABLE 1
SPECIES PREVIOUSLY UNKNOWN IN THE NORTHERN GREAT BASIN

Order	Red Basin	Quartz Basin	Both	Total
Marsupalia.....	0	1	0	1
Insectivora.....	9	9	3	14
Lagomorpha.....	0	0	0	0
Rodentia.....	5	6	2	9
Carnivora.....	0	1	0	1
Proboscidea.....	0	0	0	0
Perissodactyla.....	0	0	0	0
Artiodactyla.....	0	0	0	0
Total.....	14	17	5	25

TABLE 2

Species	Red Basin All Sites	Red Basin 2495	Red Basin 2497	Quartz Basin All Sites	Quartz Basin 2465	Sp. in Common
Marsupalia						
Didelphid sp.....				X	X	
Insectivora						
Erinaceidae <i>incertae sedis</i>				X	X	
<i>Lantanotherium</i> sp.....	X	X				
<i>Meterix</i> cf. <i>latidens</i>	X	X		X	X	X
<i>Mystipterus pacificus</i>	X	X		X	X	X
<i>Scalopoides ripofodiator</i>	X	X		X	X	X
<i>Domninoidea</i> sp.....				X	X	
<i>Scapanoscapter simplicidens</i>	X	X				
<i>Scalopina</i> sp.....	X	X				
<i>Achlyoscapter longirostris</i>				X	X	
Talpidae <i>incertae sedis</i>				X	X	
<i>Paradomnina relictus</i>	X	X				
<i>Heterosorex</i> sp.....	X	X				
<i>Alluvisorex arcadentes</i>	X	X		X	X	X
<i>Ingentisorex tumidens</i>				X	X	
<i>Limnoecus</i> sp.....	X	X				
Lagomorpha						
<i>Hypolagus</i> sp.....				X	X	
Rodentia						
<i>Liodontia alexandrae</i>	X		X			
<i>Mylagaulus</i> cf. <i>laevis</i>	X	X	X			
<i>Protospermophilus malheurensis</i>	X	X				
<i>Spermophilus tephurus</i>	X	X		?X	?X	?X
<i>Eutamias</i> sp.....	X	X				
<i>Sciuropterus</i> sp.....	X	X				
<i>Monosaulax typicus</i>	X	X				
<i>Monosaulax progressus</i>				X	X	
<i>Monosaulax</i> sp.....				X	X	
<i>Adjidaumo quartzi</i>				X	X	
<i>Pseudotharidomys pagei</i>	X	X		X	X	X
<i>Peridiomys oregonensis</i>	X	X		X	X	X
<i>Prodipodomys mascallensis</i>				X	X	
<i>Peromyscus pagei</i>	X	X		X	X	X
<i>Peromyscus</i> sp.....				X	X	
<i>Macrogathomys</i> sp.....				X	X	
Carnivora						
<i>Tomarctus kelloggi</i>	X	X	X			
<i>Tomarctus rurestris</i>	X	X				
Canid sp.....				X	X	
<i>Pliocyon</i> sp.....	X					
<i>Euoplocyon</i> sp.....	X					
<i>Hemicyon</i> sp.....	X			?X	?X	?X
<i>Amphicyon</i> cf. <i>frendens</i>	X	X				
<i>Martes gazini</i>	X					
<i>Mustella</i> sp.....				X	X	
<i>Brachypsalis</i> sp.....	X	X		X	X	X
<i>Bassariscus</i> sp.....				X	X	
<i>Pseudaelurus</i> sp.....	X	X				

TABLE 2 (cont.)

Species	Red Basin All Sites	Red Basin 2495	Red Basin 2497	Quartz Basin All Sites	Quartz Basin 2465	Sp. in Common
Proboscidea						
Mastodont.....	X					
Perissodactyla						
<i>Hyphippus</i> cf. <i>osborni</i>	X	X	X			
<i>Parahippus</i> cf. <i>avus</i>	X		X			
<i>Merychippus severus</i>	X	X	?X			
<i>Merychippus relictus</i>				X		
<i>Merychippus brevidontus</i>	X	X	X			
<i>Merychippus</i> sp.....				X	X	
Chalicotheridae.....	X					
<i>Aphelops</i> sp.....	X	X	X	?X	?X	?X
Artiodactyla						
<i>Prosthennops</i> sp.....	X		X	X	X	?X
<i>Ticholeptus obliquidens</i>	X	X	X			
Camelid.....	X	X		X		?X
<i>Dromomeryx borealis</i>	X	X		X		X
<i>Rakomeryx americanus</i>	X	X				
<i>Merycodus</i> cf. <i>nevadensis</i>				X	X	
<i>Merycodus</i> sp.....	X	X	X			
<i>Merycodus</i> sp.....				X	X	

believed to be present. The representation of mammals is quite different between Quartz Basin and Red Basin. Of the total sixty three species known from the two areas only nine are positively recognized in both, four insectivores, three rodents, one carnivore and one artiodactyl. Five others, are poorly represented. Generic assignment may be sound but species assignment is not reliable either at both basins or in one or the other. In numbers of specimens, large mammals are more abundant at Red Basin and small mammals at Quartz Basin. However, this apparently does not account for the low resemblance between the two faunas. Forty different species of small mammals are known in the two faunas, twenty at Red Basin and twenty one at Quartz Basin, but only eight species are common to both faunas (see Table 3). Sciurimorph rodents are rare in the Quartz Basin fauna whereas six species of six genera are present at Red Basin. Seven species of six genera of myomorph rodents occur in Quartz Basin whereas only three are present at Red

Basin, all are species found at Quartz Basin. (see Table 4) Fifteen species of insectivores occur in the two basins but only four are common to both areas. Each basin has nine species of insectivores represented. (see Table 5)

In general the carnivores of Quartz Basin are small and those of Red Basin large. Ungulates are represented by eight species at Quartz Basin. Three species are apparently present in both basins although two of these are questionable.

The large ungulates with their associated large carnivores of Red Basin are not common at Quartz Basin. Insectivores, rodents, small carnivores and the smaller ungulates are best represented.

Three of the sixteen genera of mammals in common to Quartz Basin and Red Basin are represented by different species. *Monosaulax*, *Merychippus* and *Merycodus*. The species of two of these genera are well enough known to allow comparisons to be made which may be of value in better understanding the relation-

TABLE 3
RESEMBLANCE OF THE RED BASIN AND QUARTZ BASIN SAMPLES
ALL MAMMALS

Order	Red Basin	Quartz Basin	Species in common	Resemblance
Marsupalia.....	0	1	0	0
Insectivora.....	10	9	4	44.4%
Lagomorpha.....	0	1	0	0
Rodentia.....	10	10	4	40%
Carnivora.....	9	5	2	40%
Proboscidea.....	1	0	0	0
Perrissodactyla.....	6	3	1	33%
Artiodactyla.....	6	5	2	40%
Totals.....	41	34	13	38.2%

TABLE 4
RESEMBLANCE OF THE RED BASIN AND QUARTZ BASIN SAMPLES
RODENTS

Suborder	Family	Red Basin	Quartz Basin	Species in Common	Total
Sciurimorpha	Aplodontidae.....	1	0	0	1
	Mylagaulidae.....	1	0	0	1
	Sciuridae.....	4	1	1	4
Castorimorpha	Castoridae.....	1	2	0	3
	Eomyidae.....	1	2	1	2
Myomorpha	Heteromyidae.....	1	2	1	2
	Cricetidae.....	1	2	1	2
	Zapodidae.....	0	1	0	1
Totals.....		10	10	4	16

TABLE 5
RESEMBLANCE OF THE RED BASIN AND QUARTZ BASIN SAMPLES
INSECTIVORA

Family	Red Basin	Quartz Basin	Species in Common	Total
Erinaceidae.....	1	1	0	2
Metacodontidae.....	1	1	1	1
Talpidae.....	4	5	2	7
Soricidae.....	4	2	1	5
Total.....	10	9	4	15

ships between the faunas. *Monosaulax typicus* is found at Red Basin. *Monosaulax progressus* is present at Quartz Basin. These two beavers are of the same size and height of crown. The striids of the lower fourth premolar are more persistent in *M. progressus* and it possesses a short parastriid not seen in *M. typicus*. However, the degree of development of stria and striids on the molars are similar in the two species. Accessory lakes appear on the teeth of *M. progressus* and a butress-like stylid is on the anterior face of the lower fourth premolar. The presence of a parastriid on the premolar of *M. progressus* might suggest advancement over *M. typicus* but in this case it appears to be a function of the more complex nature of the occlusal pattern of the teeth of *M. progressus* and more probably reflects diversity in the genus rather than phylogenetic trends.

Merychippus severus, common in the Red Basin fauna and *M. brevidontus*, a rare form there, are unknown at Quartz Basin. *M. relictus* and *M. sp.* (comparable to *M. californicus*) are present at Quartz Basin and not at Red Basin. The teeth of *M. brevidontus* are very low crowned and tend to be complicated. Those of *M. severus* are higher crowned but less complicated. They represent horses of about the same size. *M. sp.* of Quartz Basin is a high crowned species, similar to the High Rock Canyon *M. cf. californicus*. *M. relictus* is a small horse only poorly known at other localities. It is present, however, in the Crooked River Basin of Central Oregon along with *M. severus* and possibly in the Mascall. *M. severus* and *M. californicus* are considered by Downs (1961) to demonstrate steps in a microevolutionary trend. This is, of course, in part dependent on the temporal relations of these species. Downs considers the Crooked Creek, Gateway, Skull Springs, Beatty Buttes, Sucker Creek, Virgin Valley and Mascall, the sources of the *M. severus* samples, to be equivalent in age and all older than the High Rock Canyon or North Coalinga faunas from which the *M. californicus* samples were obtained. This time relationship, however, is primarily based on the equid

fauna (Downs 1956, p. 325) and thus is circuitous at best, certainly not independent evidence as is suggested in his later paper (Downs 1961, p. 58). The *M. severus*-*M. californicus* "microevolutionary trends" are said by Downs (1961, p. 58) to confirm the "control character trends" in the *Merychippus*-*Nannippus* line. This is not surprising since the *Merychippus*-*Nannippus* "control character trends" were obviously the basis for the establishment of the temporal order of the *M. severus*-*M. californicus* "sequence." Downs (1961, p. 60) allows that *M. severus* and *M. californicus* may represent two parallel lines of development but rejects this as an alternative because he recognized no supporting evidence. Downs gives no evidence that *M. californicus* is younger than *M. severus* nor does he recognize the likelihood that they are not directly related.

Such "sequences" as *Merychippus*-*Nannippus* (see Stirton 1947) are picked in the first place to show what they are purported to prove. For instance if a *Merychippus*-*Hipparion* sequence had been chosen no increase in height of crown over the Coalinga *Merychippus* would be evident. The time order of the forms shown is not established by any means. No two of the elements in the sequence even occur in the same depositional basin or biogeographic area. They represent specimens from Oregon, California, Nebraska, Kansas, and Texas. It is my opinion that five of the Miocene specimens represent "stages of evolution" which were probably contemporaneous or even reversed in time sequence. Certainly only three steps are present in the Pliocene part of the sequence. The so called "control character trends" really have no time control. The order of stages in the sequence is determined largely by the "control character trends." The sequence is not a sequence but is based on the assumption that a continuous gradual progressive change is the evolutionary rule. This same "sequence" is then used as a demonstration of the truth of this assumption.

The use of "control character trends" of such sequences as *Merychippus*-*Nannippus* to

temporally order species within a genus seems unsound to me for the following reasons;

1. Temporal controls are not based on independent sources of information but usually are circuitous.
2. Where absolute dates are available they do not confirm the temporal relationships proposed within provincial ages and even reverse some trends.
3. Such an approach ignores the probability of contemporaneous diversification of characters, something rather common in living mammals. Thus biogeographic and environmental differences are not allowed.

The stratigraphic evidence indicates that the Red Basin, *Merychippus severus*, and the Quartz Basin *Merychippus* sp. are probably contemporaries. Additional evidence is supplied by the occurrence of *Merychippus* sp. in the Butte Creek Volcanic Sandstone at locality 2471 between Red Basin and Quartz Basin. The mutual occurrence of *M. relictis* and *M. severus* in the Mascall fauna and the occurrence of *M. relictis* at Quartz Basin further supports this conclusion.

The differences between the Red Basin and Quartz Basin collections are thus not due to differences in age but most probably reflect synchronous diversity in the mammalian fauna of the region in the Barstovian.

It was suggested earlier that two associations were apparently represented in the previously known samples of the Barstovian Northern Great Basin fauna, the *Merychippus-Dromomeryx* and *Hypohippus-Ticholeptus* associations. The names are derived from the common large mammals present. Previous collections, because of their composite nature, masked the differences but do show that if such associations are real they represented adjacent habitats. Early in the excavation of the main quarry at Red Basin UOloc 2495 it was obvious that *Merychippus* and *Dromomeryx* were the most common large mammals present. *Hypohippus* and *Ticholeptus* were not recognized from there

until the sample was being prepared and then were very rare. A search was begun by part of the crew, as soon as the nature of the quarry was evident, to seek out a site which might produce the expected *Hypohippus-Ticholeptus* association. In this we were only partially successful. Such an occurrence was found but it was not possible to retrieve a quantitatively useful sample. This locality, UOloc 2497, was in a massive volcanic sandstone quite unlike the lithology at UOloc 2495, but within the thin Butte Creek Volcanic Sandstone. Scattered about on the surface were a number of specimens, many partly or wholly incased in concretions. Immediately above this massive sandstone was a conglomerate which also produced fossil vertebrates, some of which had weathered out. Excavation in the conglomerate produced a number of specimens, including *M. severus*, preserved much differently than those encountered in and on the sandstone below. This difference in preservation allowed a simple means of recognizing float from the overlying conglomerate and segregating it from the specimens derived from the sandstone. Only eleven species of mammals were present in the massive sandstone sample. Only three of the species recognized were not present in the large sample from UOloc 2495, *Liodontia furlongi*, a mastodont and *Parahippus avus*. *Merychippus severus* abundant at UOloc 2495 was questionably present and no *Dromomeryx* specimens were found. Complete dentitions of *Hypohippus* and *Ticholeptus* were present and were best represented among the isolated teeth and partial elements. This occurrence strongly suggests that a *Hypohippus-Ticholeptus* association existed, however, *in situ* specimens led me to believe that a local concentration was not present but that the material was homogeneously dispersed throughout the outcrop exposed. No quantitative sample is thus available. A collection of similarly preserved specimens was made by James at Massacre Lake, Nevada and possibly represents this or a very similar association.

The collections described here thus represent at least three associations within the total fauna

of the Barstovian of the Northern Great Basin. The nature of these associations and their quantitative attributes will be discussed later in a more appropriate context.

If the various collections referred to here represent different aspects of the same total fauna it seems inappropriate to refer to them as separate faunas. Rather than re-defining faunas and faunules I will discuss them by locality with the understanding that they all are part of the Skull Spring fauna. Eventually some more realistic basis will have to be developed for reference to mammalian collections.

The birds and lower vertebrates from the localities discussed here will be described separately at a later date.



Figure 9. ?Didelphid UO 22684, occlusal view x 5, UOloc 2465.

SYSTEMATICS
ORDER MARSUPALIA
FAMILY DIDELPHIDAE

(Fig. 9)

A single upper molar from UOloc 2465, Quartz Basin, UO22684, apparently represents a didelphid near the size of *Didelphis*. The posterior labial portion of the tooth is missing. The protocone is prominent. The paracone and metacone are present, the paracone is slightly the larger of the two cusps. At least one styler cusp may have been present at the anterior edge of the labial side of the tooth but abrasion has nearly removed it. A much smaller one appears to be just posterior to it and another just anterior to the point of breakage. The transverse diameter of the tooth is 6.1 mm. An estimate of the anterior-posterior diameter is 4 mm. Until more complete material is available the assignment of this specimen must be tentative.

ORDER INSECTIVORA

The insectivores were studied by J. H. Hutchison. His studies of the shrews and moles have been previously published (1966, 1968). His work on the erinaceids and metacodontids (1964) is included here.

SUPERFAMILY ERINACEOIDEA
FAMILY ERINACEIDAE
Subfamily Echinisoricinae

LANTANOTHERIUM sp. indet.

(Fig. 10 A, B)

This genus is represented in the Northern Great Basin by only one specimen, UO24283, from Red Basin, UOloc 2495. The specimen consists of a slightly worn left second molar. There is a prominent paralophid and high trigonid. The metaconid and protoconid are opposite each other transversely as are the hypoconid and entoconid. The protoconid and metaconid are of equal height with the entoconid only slightly lower. The tooth is less stout than

in *L. longirostrae* and *Ocajila makpiyahe* but otherwise heavier than in other species of *Lantanotherium*. The talonid is slightly narrower than the trigonid. The tooth is 2.38 mm long and 1.77 mm wide.

Of the North American *Lantanotherium*, the Red Basin specimen seems to resemble most closely *L. sawini* (James, 1963) and the form from the Bopesta Formation (Webb, 1961) in the transversely opposite placement of the protoconid and metaconid. The relative width of the talonid to trigonid in the Red Basin specimen more closely approaches the condition of *L. sawini*, however the hypoconid is closer to the metaconid than it appears to be in James' illustration (Fig. 18, p. 56) of *L. sawini*. In this latter respect the Oregon specimen resembles its contemporary from the Bopesta. To make any assignments as to specific relationships on such small differences would be fruitless until the variation within *Lantanotherium* has been demonstrated.

ERINACEIDAE *incertae sedis*

(Fig. 10 C-H)

Two complete upper fourth premolars (UO 22348-UO22349) and the talon of another (UO22347), two second or third upper molars (UO22004, UO22062), and one adult (UO 22305) and one unerupted (UO21971) second lower molar of an apparently undescribed erinaceid were present in the Quartz Basin sample, UOloc 2465. Each specimen seems to represent an animal roughly the size of *Lantanotherium sawini*. These three isolated groups of teeth are here tentatively considered to represent the same species largely on the basis of

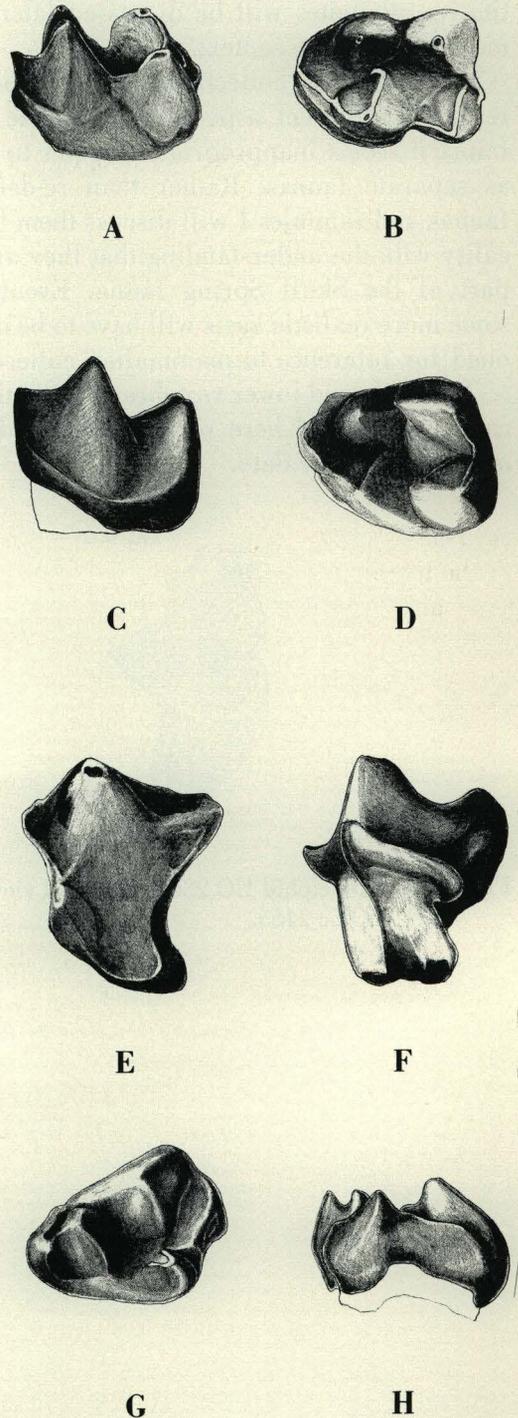


Figure 10. Erinaceidae, *Lantanotherium* sp. left M₂ UO24283 Red Basin, **A** labial view, **B** occlusal view x 10. Erinaceidae *incertae sedis*, Quartz Basin, left M₂ UO 22305, **C** labial view, **D** occlusal view x 10, left P⁴ UO 22349, **E** occlusal view, **F** lingual view x 10, right M² or ³ UO 22062, **G** occlusal view, **H** lingual view x 10.

similar form, relatively equivalent expected size, and exclusion on the basis of size, mutuality, or morphology from assignment to other forms in the fauna.

The P^4 is shaped somewhat like that of *Sorex*. At first it was thought this tooth belonged to a shrew judging from the deeply emarginated posterior border and the lack of a hypocone, but the massive roots and their similarity of coalition to those of the M_2 in conjunction with the massive appearance of the enamel suggest erinaceid affinities. The paracone is similar to that of *Erinaceus*. There is no external cingulum, but a small ridge arises about halfway down the paracone and joins the labial extremity of the anterior cingulum to form a small anterior extension (parastyle?). The protocone is a small swelling of the anterolabial extremity of the tooth quite close to the base of the paracone and separated from it by only a small notch. The posterior portion of the tooth slopes down sharply from the protocone and ectoloph. There is no hypocone, in fact, the region where it might be expected is depressed in relation to the general slope of the talon. This depression is elongate and parallel to the lingual border of the tooth. It appears to be the result of occlusion. The posterior border is sharply indented as in *Sorex*. There is no posterior cingulum, although the occlusal (?) depression appears to create one. The three roots are beneath the center of the ectoloph, anterior region of the paracone, and the talon respectively. All are strongly interconnected with each other by strong crests which fuse at the vertical axis of the tooth.

The numerical assignment of the two molar teeth is difficult since some lines of erinaceids tend to greatly reduce or lose the M^3 . In such species the M^2 then approaches a structural similarity to the M^3 of other erinaceids. The complex morphology of the fossils in company with a reduced hypocone suggest a modified M^2 . This tooth is somewhat like the M^3 of *Galerix*, but the development of the hypocone results in an inflated posterolingual border. The protocone is large and also inflated as in *Erinaceus*

and *Meterix*; it is joined by ridges to the metacone and anterior cingulum. The slight rise and swelling on the anterior ridge probably represents the protoconule. The portion of the cingulum immediately lingual to the parastyle resembles the anterior ridge of the protocone. The paracone is set in from the labial margin and slightly concave labially which results in the formation of ridges connecting it to the parastyle and mesostyle. The parastyle is prominent and as high as the metacone. The external cingulum extending from the parastyle loses its identity beyond the low mesostyle. The metacone is similar to the paracone but is slightly convex labially. The hypocone is transversely elongated, low, and inflated. It connects labially with the posterior ridge from the protocone forming a slight eminence probably representing the metaconule, which, in turn, joins the base of the metacone. In both specimens the roots have been broken away immediately below the base of the crown. The lack of wear and fairly, thin root walls indicate the relatively recent eruption of the teeth.

The M_2 is more than half as wide as long (see Table 6) and bulbous (exodaenodont?) in appearance. The metaconid and protoconid, as well as the entoconid and hypoconid, are directly opposite each other transversely. The talonid is longer and lower than the trigonid but about equal in width. The hypoconid and entoconid are joined by a broad hypolophid and also connected to the cusps anterior to them by the inflated crista obliqua and entolophid respectively. The trigonid is crowded and perched on the tooth. The paracone is compressed and continuous with the protocone as in *Lantanoherium*. The labial walls of the roots coalesce but are cleft just under the center of the crown. There is a large deep, vertical channel on the lingual side of the roots opposite the cleft.

The author was unable to examine specimens or descriptions of all the other genera of erinaceids so that absolute exclusion of these specimens from known forms is not certain, but none described or examined by Butler (1947) or the

author showed the high degree of confluence of the roots as in the P⁴ and M₂ of this form. Lack of better material and positive association make naming and speculation as to its affinities premature.

TABLE 6

MEASUREMENTS OF THE TEETH OF ERINACEID
incertae sedis

Specimen	Length	Width
P ⁴ : UO 22348.....	2.7e	2.68
UO 33459.....	2.69	2.55
M ² : UO 22004.....	1.91	2.72
UO 22062.....	1.86	2.65
M ₂ : UO 21974*.....	2.4e	1.62
UO 22305.....	2.53	2.01

e Estimated measurement.

* Unerupted tooth.

SUPERFAMILY SORICOIDEA

FAMILY METACODONTIDAE

METERIX cf. *M. LATIDENS* Hall

Several teeth and a few mandibular fragments of *Meterix* were recovered from Quartz Basin, UOloc 2465. The skull material is being studied by S. David Webb who has at his disposal the type as well as a fine collection of jaws and teeth from Stewart Springs, Nevada. The Quartz Basin material represents the first *Meterix* from Oregon as well as its most northerly occurrence. A number of peculiar limb bones of an insectivore of the size of *Meterix* were also recovered from the Quartz Basin site. The fragmentary humeri were soon recognized to be identical to a humeral fragment from Stewart Springs described by Reed and Downs (1958) as a "mammal of unknown affinities." The University of California at Berkeley has subsequently reworked the Stewart Springs localities by washing techniques to yield many new specimens of *Meterix* but no additional humeri. There are, however, specimens of a peculiar radius, femur, tibia-fibula, astragalus, and calcaneum which are essentially identical to the above mentioned homologous elements from Quartz Basin. The author believes that the

post-cranial elements represent a single form on the basis of (1) recurrent association from the two sites, (2) relative size, (3) relative abundance, and (4) relative adaptive similarity. The association of the cranial elements of *Meterix* with the post-cranial elements is based on the first three of these criteria. *Meterix* is also present in the sample from Red Basin.

Hutchison is preparing a report on the osteology of *Meterix* in which he will describe the Quartz Basin and Red Basin specimens as well as those from other Great Basin localities.

ORDER LAGOMORPHA

FAMILY LEPORIDAE

HYPOLAGUS sp.

A single upper P⁴ or M¹, smaller than *H. vetus* but about the same size as the larger specimens of *H. furlongi*, was collected at UOloc 2453 Quartz Basin. The re-entrant is crenulated. Dawson (1958) assigned upper teeth from the Tonopah fauna to *H. parviplicatus* a species originally described from the Virgin Valley fauna. The Quartz Basin specimen is only slightly smaller than these. Transverse measurement = 3.75 mm. At locality 2465, Quartz Basin a fragmental tibia representing a small species of *Hypolagus* was found.

ORDER RODENTIA

SUBORDER SCIUROMORPHA

FAMILY APLODONTIDAE

LIODONTIA ALEXANDRAE

(Furlong 1910)

Previously known material from the Skull Springs fauna is described in Gazin (1932) and reviewed by Shotwell (1958). Additional material was collected at UOloc 2459, Red Basin.

FAMILY MYLAGAULIDAE

MYLAGAULUS cf. *LAEVIS*

The Red Basin material was described by Gazin (1932) and reviewed by Shotwell (1958). Additional material was collected at UOloc 2459, Red Basin.

FAMILY SCIURIDAE

PROTOSPERMOPHILUS MALHEURENSIS

(Gazin 1932)

(Fig. 11 A-C)

The type and previously assigned specimens of this species do not include elements of the lower dentition. Isolated lower molars and premolars from Red Basin UOloc 2495 are assigned here primarily on the basis of size and characters expected in the lower dentition, using the lower dentition of other species of *Protospermophilus* as a guide.

The lower fourth premolar is subrounded, quadrate, in occlusal outline and slightly narrower transversely at the anterior end than the posterior. Anteroconid, mesoconid, entoconid, and mesostylid are all distinct. The parametaconid and protoconid are in close contact. No protolophid or metalophid is evident. The posterolophid curves slightly and terminates at the high entoconid.

The lower first or second molar is rhomboidal in occlusal outline. The protolophid does not connect to the protocone in some specimens but bypasses it anteriorly, in others it is complete. The metalophid is low but complete. A small mesoconid is present on the ectolophid. Parametaconid, protoconid, and hypoconid are nearly equal in size, although the parametaconid is highest. The entoconid is buried in the gently curving posterolophid but is distinct. A small mesostylid is present. In some specimens it appears as two small cusps, in others as a prominent single cusp.

The lower third molar is represented by three well worn specimens so that all the characteristics are not clear. A small mesostylid and slightly larger mesoconid can be recognized. The protolophid is apparently complete and the metalophid very short. The tooth is broad at the small entoconid and tapers posteriorly to the hypoconid.

One lower incisor is assigned to this species. In transverse section it is ovoid, flattened medially. The enamel is crenulated. An upper incisor is also present with crenulated enamel. It

is ovoid in transverse section, flattened medially. Black (1963) indicates measurements for the upper incisor of the type specimen of *P. malheurensis* taken from specimen No. 129. However, the type has no incisors so the measurements must have referred to the alveoli.

SPERMOPHILUS TEPHRUS (Gazin 1932)

(Fig. 11 D-K)

Sciurus tephurus Gazin 1932, Carn. Inst. Wash. Pub. 418, p. 59

Citellus ridgwayi Gazin 1932, Carn. Inst. Wash. Pub. 418, p. 61

Protospermophilus tephurus Bryant 1945, Amer. Mid. Nat. Vol. 33, No. 2, p. 349

Citellus tephurus Black 1963, Bull. Mus. Comp. Zool, Vol. 130, No. 3, p. 196

The lower dentition of this species was not represented in the material which was used in the original description. Since the present material was collected from the same stratigraphic unit and since uppers which can be assigned to *S. tephurus* are also present the assignment of the specimens described here is warranted. Three deciduous lower fourth premolars are in the collection. In this tooth the protoconid and parametaconid are conjoined at their base. The upper portions of these cusps are connected by a short metalophid and protolophid forming a small elevated trigonid basin. The hypoconid is about the same size as the protoconid. The posterolophid curves in a circular arc ending just short of the parametaconid. The tooth is much broader posteriorly than anteriorly. In the lower fourth premolar the protolophids is incomplete whereas the metalophid is complete. The small trigonid basin thus opens anteriorly into a groove extending down the anterior face of the tooth. The protoconid and hypoconid are of equal size and separated by a rather straight ectolophid apparently without a mesoconid. The posterolophid forms a parabolic arc and is low just before it connects with the parametaconid. The posterior

TABLE 7
MEASUREMENTS OF THE DENTITION OF
Protospermophilus malheurensis

lower dentition	AP	Tr
P₄		
UO24238.....	1.87	1.71
M_{1 or 2}		
UO24236.....	1.88	1.77
UO24404.....	1.91	2.02
UO24261.....	1.89	2.01
UO24251.....	1.82	1.97
UO24260.....	1.76	2.08
UO24248.....	2.00	2.04
M₃		
UO24252.....	2.09	1.78
UO24239.....	2.38	2.08
UO24263.....	2.23	1.97a
I		
UO24426.....	4.28	1.89
upper dentition		
DP⁴		
UO24221.....	1.93	1.88
M^{1 or 2}		
UO24215.....	2.45	2.52
UO24241.....	2.01	
I		
UO24422.....	4.05	2.52

portion of the tooth is much wider than the anterior.

In the lower first and second molars the protoconid and parametaconid are of about equal size while the hypoconid is smaller. The protolophid connects low and indirectly on the protoconid producing a prominent groove and cusp at that point. The metalophid is very short and only meets a broadened protolophid from the parametaconid. A trench-like open trigonid basin is formed. The ectolophid is straight and on some specimens has a mesoconid. The posterior lophid curves gently around to the entoconid which is submerged in it. A mesostylid is not apparent on any of the specimens.

In the lower third molar the parametaconid and protoconid are of equal size while the hypoconid is greatly expanded. The protolophid is complete and the metalophid very short. The posterolophid ends at the entoconid which is

submerged in it. Some specimens have a small mesostylid. A poorly developed mesoconid is present on some specimens.

Three fragmental lower incisors are present in the collection. Two of the specimens have 4-6 distinct longitudinal grooves near the middle of the enamel face while one has crenulations which are crudely aligned. These crenulations may, in part, represent abraded grooves since the specimen shows some evidence of abrasion. The type specimen and synonym type specimen display well worn and damaged teeth. The new material thus provides some additional data concerning these teeth.

The upper deciduous fourth premolar differs markedly from the permanent fourth premolar in the presence of a large parastyle. The anterior cingulum connects high on the parastyle and low on the protocone. The anterior valley is thus closed off lingually. No protoconule is present but a metaconule is. The metaloph curves anteriorly connecting low on the protocone. A mesostyle is present on the shoulder of the paracone. The central valley is broad at its midpoint. The posterior cingulum is well developed bordering a narrow posterior valley. Two of the specimens have no roots and two have highly divergent roots indicating the deciduous nature of the teeth. The broad parastyle on the deciduous dentition of a form having a much reduced parastyle on the permanent tooth is to be expected since this is characteristic in living sciurids.

Neither of the upper fourth premolars in the collection have mesostyles which occur on the original material. However, the appearance of mesostyles is variable and their absence on the present material does not negate its assignment to the known species. The parastyle is low and poorly developed. The anterior cingulum is low and appears as a narrow shelf low on the anterior side of the tooth. The protoloph is sinuous and a protoconule is either not present or completely incorporated in the protoloph which connects low on the broad protocone. A metaconule is present on one specimen and only poorly developed on the other. The metaloph

is quite narrow at its connection low on the protocone. The posterior cingulum is prominent and may incorporate the hypocone. The cingulum is higher and somewhat broader at this point.

The upper first and second molars are nearly quadrate in outline. The protocone is large and dominates all the other features of the tooth. The parastyle is not separable from the anterior cingulum which is strong and connects abruptly into the protocone adding to the quadrate occlusal outline. The posterior cingulum also contacts the protocone abruptly, a swelling at this point may represent the hypocone. The anterior valley is broader than the posterior. The protoloph drops sharply to a point low on the protocone where it makes a narrow connection. A small protoconule is present on some specimens. A broad mesostyle is present. The metaloph appears to terminate in a relatively large metaconule, however, on some specimens a low narrow connection occurs just beyond the metaconule.

There is no metaloph on the third upper molar. The protoloph is straight and connects low on the protocone. The anterior cingulum is complete and borders a narrow valley. The protocone is bulbous. The posterior cingulum forms an abrupt angle with the protocone and is semicircular in occlusal outline, the talon basin being expanded.

The upper incisors in the type material are crenulated but the tip near the broken end of one on CIT 334 reveals longitudinal grooves. Upper incisors in the new material are finely crenulated. This species is similar in dentition to the living *Spermophilus beecheyi*.

Figure 11. Sciurids, Red Basin, *Protospermophilus malheurensis*, A P₄ UO24235, B M₁ or 2 UO24404, C M₁ or 2 UO24261, *Spermophilus tephros*, D DP₄ UO24420, E P₄ UO24211, F M¹ or 2 UO24218, G M³ UO24419, H DP₄ UO26056, I P₄ UO 26055, J M₁ or 2 UO24246, K M₃ UO 24231, *Sciuropterus* sp., L P₄ UO24269, occlusal view, M lateral view, N P₄ UO 24390 all x 5.

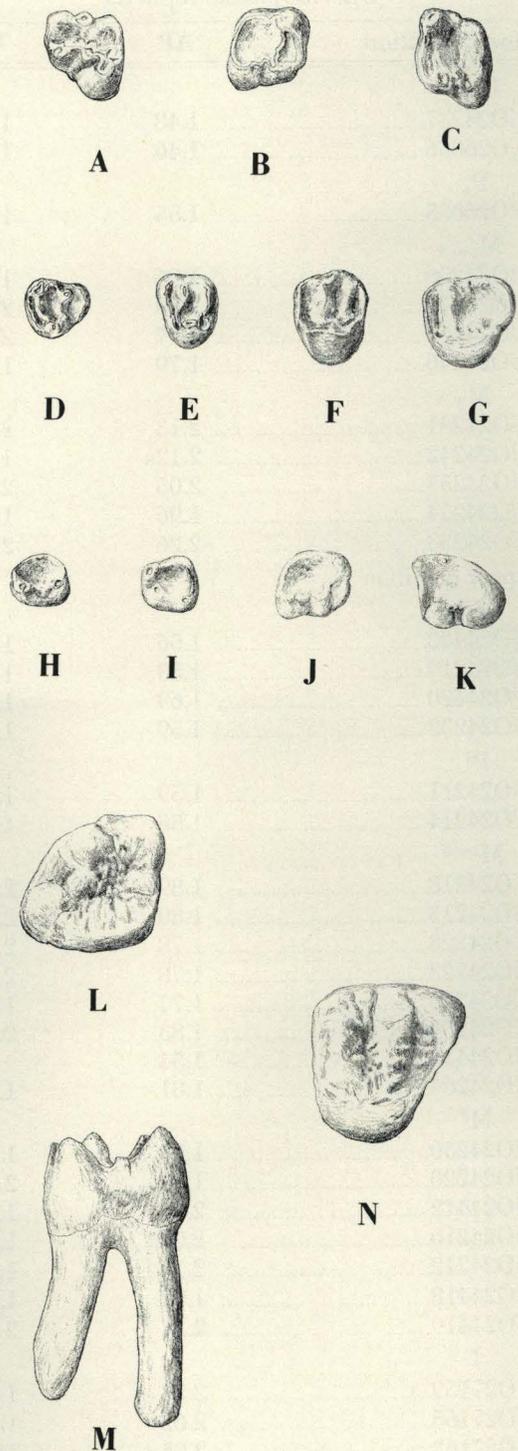


TABLE 8
MEASUREMENTS OF THE DENTITION OF
Spermophilus tephurus

lower dentition	AP	Tr
DP ₄		
UO24237.....	1.48	1.25
UO26056.....	1.46	1.31
P ₄		
UO26055.....	1.55	1.40
M _{1 or 2}		
UO24256.....	1.96	1.93
UO24240.....	2.00	2.08
UO24250.....	1.97	2.01
UO24246.....	1.79	1.67
M ₃		
UO24231.....	2.13	2.00
UO24242.....	2.12 _a	1.97 _a
UO24255.....	2.05	2.08 _a
UO24254.....	1.96	1.95
UO24253.....	2.26	2.06
upper dentition		
DP ⁴		
UO24408.....	1.56	1.35
UO24219.....	1.53	1.52
UO24420.....	1.69	1.52
UO24232.....	1.59	1.64
P ⁴		
UO24211.....	1.59	1.80
UO24214.....	1.58	1.71
M ^{1 or 2}		
UO24218.....	1.89	2.33
UO24213.....	1.80	2.29
UO24228.....	1.78	2.17
UO24223.....	1.78	2.08
UO24226.....	1.77	1.92
UO24234.....	1.83	2.12
UO24410.....	1.54	
UO24264.....	1.81	1.96
M ³		
UO24230.....	1.98	1.99
UO24220.....	1.94	2.00
UO24412.....	2.12	1.94
UO24216.....	2.00 _a	1.84
UO24212.....	2.12	1.94
UO24418.....	1.92	1.91
UO24419.....	2.37	2.32
I		
UO27159.....	2.53	1.50
UO27165.....	2.62	1.42
UO27163.....	2.93	1.67
UO27158.....	2.96	1.72
UO27161.....	2.69	1.39

Black (1963) considered the type skulls of *Citellus ridgewayi* and *Sciurus tephurus* to represent the same squirrel and so placed them in a single species. The name chosen was apparently determined by page priority in Gazin's original description of the material. However, the characteristics of this form are more distinct on the former species *C. ridgewayi*. In using the genus *Spermophilus* I am simply following Hall and Kelson (1959) in its apparent priority over *Citellus*.

SPERMOPHILLUS cf. TEPHRUS

A scapholunar and two astragali from Quartz Basin locality 2465 represent a small species of spermophilid near *S. beecheyi* in characteristics. These are the only specimens assigned to the sciuridae from Quartz Basin.

EUTAMIAS sp.

A single upper fourth premolar of a very small sciurid occurs in the collection from Red Basin, UOloc 2495. The specimen is moderately worn. The parastyle is low. The anterior cingulum extends about one half the transverse width of the tooth. The protoloph is straight whereas the metaloph curves anteriorly joining the protocone at about the same point. Proto or metaconules are apparently not present. It is not possible to determine the nature of the posterior cingulum or whether a mesostyle was present or not. The occlusal outline of the tooth and its size suggests *Eutamias*.

	AP	Tr
UO24225	1.08	1.36

SCIUROPTERUS sp.

(Fig. 11 L-N)

Five teeth or tooth fragments represent this genus in the collection from Red Basin UOloc 2495. They include a little worn lower fourth premolar, two little worn upper fourth premolars, a fragment of an upper first or second molar and a heavily worn upper third molar.

In the lower fourth premolar the parametaconid is the largest cusp and is situated more anteriorly than the protoconid. It exposes a flattened face to the talonid basin. The parametaconid and protoconid are closely appressed. A small accessory cusp appears on the anterior lingual face of the parametaconid which may represent a much reduced anteroconid. There is a groove separating it from the protoconid. The posterolophid is high and terminates at the prominent entoconid. A mesostyle is present as well as a prominent mesoconid. The ectolophid is situated well in from the border of the tooth and is relatively high. The floor of the talonid basin is rugose and crenulated.

The parastyle is the largest cusp of the upper fourth premolar. The anterior cingulum is low and connects the lingual border of the parastyle to the protocone. The anterior valley is therefore open. The protoloph is straight with apparently no protoconule. The metaloph curves slightly anteriorly and only weakly connects to the protocone. A metaconule is present. The paracone and metacone are of about the same size. The posterior cingulum extends nearly straight from the posterior side of the metacone to the hypocone. A mesostyle is present. The tooth is complicated by the development of numerous protolophules and metalophules. Lophules are also present on the parastyle, protocone and posterior cingulum. In one specimen the posterior valley is completely blocked in two places by lophules. Several prominent lophules extend into the central valley and anterior valley from the protocone. The highest development is in the posteriorly directed metalophules. The smaller of these two specimens is either an unerupted tooth or possibly a deciduous tooth. It consists of only the enamel cap.

Several species of *Sciuropterus* were described by James (1963) as the first known from North America. The present material is larger than James' material and apparently more complicated especially in regards to the posterior valley of the upper fourth premolar.

In these two characteristics it is closer to *S. albanensis* judging by James' review. The hypocone does not seem to be as prominent in the new material as in James' specimens but this may only reflect differences in stage of wear.

Whether or not the Tertiary specimens assigned to *Sciuropterus* are really flying squirrels in habitus is not known. The assignment to *Sciuropterus* is a convenience in the same way that assignments in the past of Tertiary specimens to *Sciurus* and *Citellus* was convenient. The occurrence of complicated teeth in paramyids (see Wood 1962) and the marmot *Marmota nevadensis* elicits caution in any conclusions from this occurrence.

		AP	Tr
UO24269	P ₄	3.62	3.31
UO24390	P ⁴	3.80	4.23
UO24270	P ⁴	3.33	3.48

SUBORDER CASTORIMORPHA

FAMILY CASTORIDAE

Subfamily Castoroidinae

MONOSAULAX TYPICUS n. sp.

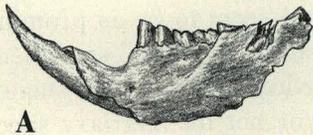
(Fig. 12)

TYPE: UO21677, left mandible with incisor, P₄-M₃, palate with left P⁴-M¹, M³ and right P⁴-M³

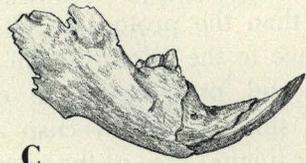
HYPODYM: UO20741, right mandible with complete dentition; UO24395, fragmental left mandible with P₄-M₃; UO24394, fragmental left mandible with P₄-M₁; UO24392, fragmental right mandible with P₄-M₂; UO24393, crushed skull with complete dentition; UO 21558, anterior portion of skull with complete dentition.

TYPE LOCALITY: UOloc 2495, Red Basin

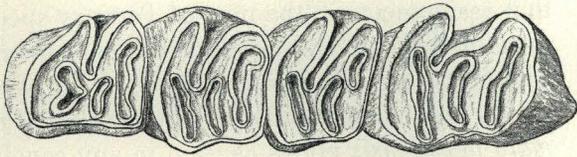
DIAGNOSIS: Small species in which the hypoflexus and paraflexus bypass in the upper fourth premolar resulting in a deep pre-paraflexus area in the occlusal pattern. Lingual striids and labial striae not persistent. Fossettids of the lower teeth tend to be straight. Secondary fossettids and fossettes rarely present. Incisors with rounded enamel face.



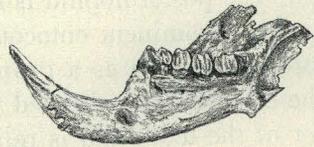
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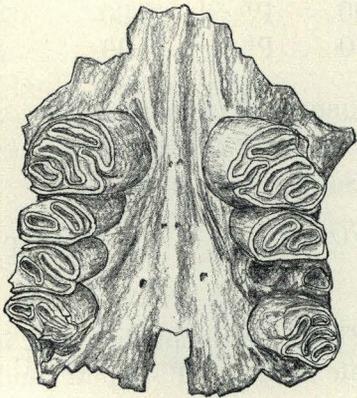
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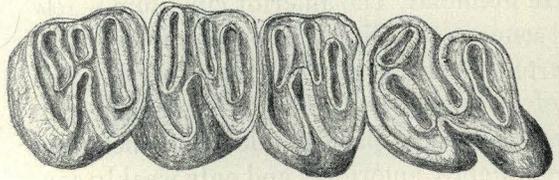
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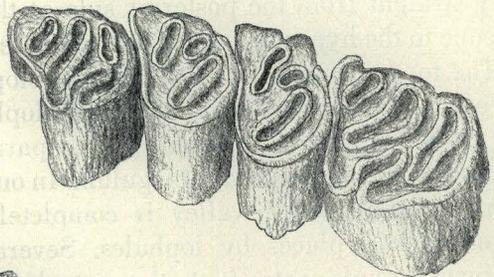
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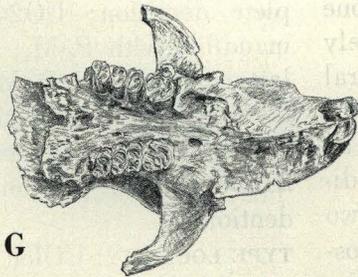
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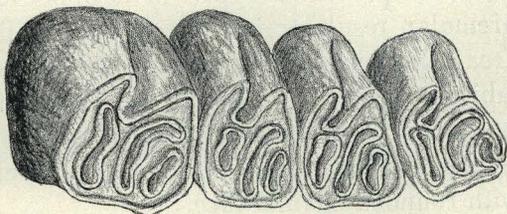
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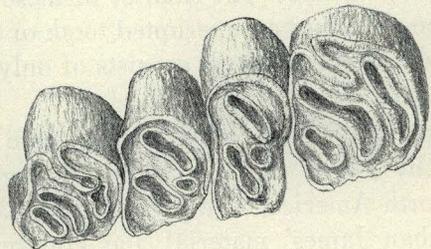
H



G



I



DESCRIPTION: No metastriid or parastriid is present even in unerupted lower fourth premolars. The mesostriid is very short but the hypostriid extends well down the enamel crown. The base of the tooth is not exposed on any of the available specimens. In early wear the para, meso, and meta fossettids are straight and of nearly equal length. In one specimen the metafossettoid is represented by two lakes. In an unerupted specimen there is a notch opening into the parafossettoid anteriorly. In this same specimen there is a prominent invagination of the anterior border of the parafossettoid into the lake. The parafossettoid of some specimens is crescentic. The lower first and second molars are quite similar. The mesostriid is very short and the metastriid only slightly shorter. The para, meso, and meta fossettids are parallel and straight and about the same length in early wear. In the course of wear the parafossettoid becomes very small and is the first lake lost from the occlusal pattern. Soon after the metafossettoid is also lost. Late in wear only the large hypofossettoid and a very small mesofossettoid remain. The anteroposterior diameter reduces with the loss of the fossettids while the trasverse diameter remains little changed. Occasionally the parafossettoid is slightly curved. The third lower molar is a little smaller and shorter crowned than the others. The fossettids are unequal in size with the parafossettoid much larger than the other lingual lakes. The mesofossettoid is the smallest.

The upper fourth premolar is the largest tooth of the superior cheek tooth series. The labial stria of this tooth are closed in all the specimens available even those in apparent early wear. The parafossette is straight and bypasses the hypoflexus. The mesofossette is

straight labially but at about the middle of the tooth it curves sharply posteriorly. The metafossette is straight and small. The upper first and second molars also have closed labial stria in all the available specimens suggesting that they are very short in unworn teeth. The parafossette and hypofossette abut. The parafossette is quite small. The mesofossette curves posteriorly at its lingual end but not as sharply as in the upper fourth premolar and tends to be more symmetrical. The metafossette is small and straight. In well worn specimens the metafossette is absent and the parafossette very small. By very late wear only the meso and hypofossettes are present. The anterior-posterior diameter of the tooth is greatly reduced in the course of wear. The third upper molar is shorter crowned and smaller than the others. The metastria opens posteriorly and the metafossette appears to be more persistent than in the other molars. A small secondary fossette appears between the labial ends of the para and mesofossettes.

COMPARISONS: Only three previously described species of North American *Monosaulax* approach *M. typicus* in its small size, *M. complexus*, *M. curtis* and *M. n. sp.* Wilson (1960). Of these only *M. n. sp.* Wilson from Quarry A in Martin Canyon, Colorado is adequately described. Comparison of upper and lower dentitions of the Colorado species, (augmented by Wilson's description), with the Red Basin species reveals a number of similarities and differences. The two species have similar heights of crown and about equally persistent stria and striids. Secondary fossettes are either not as common or not as persistent in the Oregon species as in the one from Colorado. In the upper fourth premolars of the Colorado species the hypoflexus and paraflexus abut but in *M. typicus* they bypass. This emphasizes the larger proparafossette segment of the occlusal surface present in the Oregon species. In the upper cheek teeth of the Colorado species the mesofossette is symmetrically crescentic whereas in *M. typicus* the mesofossette is crescentic but assymmetrical, the lingual portion extending

Figure 12. *Monosaulax typicus* n.sp., Red Basin, **A** left mandible P₄-M₃ UO 21677 labial view x 1, **B** occlusal view x 5, **C** right mandible P₄-M₃ UO 20741 labial view x 1, **D** lingual view x 1, **E** occlusal view x 5, **F** palate UO21677 x 2.75, **G** skull UO24393 ventral view x 1, **H** dentition occlusal view x 5, **I** upper dentition UO 21558 occlusal view x 5.

TABLE 9
MEASUREMENTS OF LOWER DENTITION
OF *Monosaulax typicus*

	UO21677	UO20741	UO24394	UO24395	UO24392
P ₄ AP.....	3.88	3.95a	3.56	4.42	
Tr.....	3.52	2.82a	3.14	3.33	
Meso.....		0.95	0.33		1.15
M ₁ AP.....	2.70	2.52	2.81	2.41	2.60
Tr.....	3.41	3.29	2.95	3.27	2.92
Hypo.....	0.69	0.68	1.05		1.71
Meso.....					0.25
M ₂ AP.....	2.79	2.76		3.62	2.69
Tr.....	3.47	3.45		3.12	2.84
Hypo.....	0.65	0.94			1.95
Meso.....					0.56
Meta.....					0.54
M ₃ AP.....	3.06	2.77		2.72	
Tr.....	3.14	3.16		2.99	
Hypo.....	0.72	0.86		0.78	
P ₄ M ₃	12.78	11.90		12.28	

AP, Tr, occlusal diameter

a—damaged, Hypo, Meso, Meta indicate striid lengths

TABLE 10
MEASUREMENTS OF THE UPPER DENTITION
OF *Monosaulax typicus*

	UO21558L	UO21558R	UO21677L	UO21677R	UO24393L	UO24393R
P ⁴ AP.....	3.49a	3.46	4.57	4.42	3.99	3.92
Tr.....	3.24	3.36		4.01	3.71	
Hypo.....	3.28	3.14	1.01	1.01	0.61	0.60
M ¹ AP.....	2.76	2.75	2.79		3.17	
Tr.....		3.15	3.11		3.05	
Hypo.....	1.80	1.62				
M ² AP.....	2.83	2.84		3.10	3.03	
Tr.....	2.91	3.05		2.93	3.04	
Hypo.....	1.84	2.04		0.36		
M ³ AP.....	2.45	2.65	3.05		3.13	
Tr.....	2.72	2.93	2.42		3.00	
Hypo.....	2.25	1.87	1.24		0.81	1.22
P ⁴ .M ²	8.75			8.50	8.88	8.48
P ⁴ .M ³	11.26				11.67	11.20

much further posteriorly than the labial. These two species appear to represent a similar stage of evolution.

Specimens of *Monosaulax* from Nevada and Oregon have previously been recognized and assigned to the species *M. pansus* (Douglas 1901, Stirton 1935). This is apparently a much larger species than *M. typicus* and also higher crowned. It lacks the secondary fossettes seen in the Colorado species but otherwise differs from the new species in some of the same characteristics as does the Colorado species.

MONOSAULAX PROGRESSUS n. sp.

(Fig. 13-15)

TYPE: UO21713, right mandible with P₄-M₃; incisor and ascending ramus missing.

HYPODYM: UO19864, right mandible fragment including M₁-M₃; UO19870, right mandible fragment including P₄-M₂; UO19871, left mandible fragment including P₄-M₁; UO19860, right mandible fragment including P₄-M₂; UO19876, maxilla fragment with M²⁻³; UO19873, palate with left and right P⁴-M³; UO21714 palate with left P⁴-M³ and right P⁴-M¹; UO26686 maxilla fragment with P⁴-M¹; UO19863 maxilla fragment with M¹-M².

TYPE LOCALITY: UOloc 2465 Quartz Basin

DIAGNOSIS: Small species with a short parastridium present on the lower fourth premolar which differs from all other previously described species. A strong buttress-like stylid occurs on the anterior face of the lower fourth premolar. On the upper fourth premolar there is a strong anterior lingual groove on the anterior face of the tooth. Secondary fossettes are present in early wear. Incisors with rounded enamel face.

DESCRIPTION: In addition to the hypodym, ninety five isolated teeth and a number of skeletal elements are present in the collection from the type locality.

In the lower dentition the deciduous fourth premolar has no parastridium. The mesostriid and hypostriid are complete. The pattern is dom-

inated by a large metafossettid and equally large parafossettid. The border of the parafossettid is complicated by a number of enamel invaginations into the mesoflexid originating from the mesostylid. The permanent lower fourth premolar has a short parastridium. The mesostriid is more than three fourths the height of the enamel crown. The hypostriid is full length. A well developed buttress-like style extends up the anterior face of the tooth and is reflected in the occlusal pattern after early wear. In early wear a small invagination of enamel projects from the anterior wall of the paraflexid, the metafossettid is very large and only separated by a narrow ridge of enamel from the hypoflexid, and roots are not yet developed. In some specimens a small invagination appears just labial to the stylid on the anterior face of the tooth and results in a small secondary fossettid in the occlusal pattern in early wear. At the same stage of wear another secondary fossettid occurs on the mesostylid.

The first and second lower molars are similar and difficult to separate when isolated from the mandible. In very early wear parastridium, metastridium, mesostriid and hypostriid are all open. Of the lingual striids the mesostriid is the most persistent. The para and metastridia are much less persistent, the metastridium being very short lived. The hypostriid extends nearly to the base of the enamel. As the para and metastridia close with wear the anterior-posterior diameter of the tooth becomes shorter at the occlusal surface. Eventually the parafossettid and the metafossettid are lost through wear further shortening the anterior-posterior diameter of the tooth. In addition to the primary fossettids a secondary fossettid occurs in early wear antero-lingual to the parafossettid. All the fossettids and flexids are very nearly straight. The parafossettid is ordinarily the longest of the lingual fossettids and in the first lower molar often curves slightly anteriorly at its labial end. The third lower molar is similar to the other molars but shorter crowned.

In the upper dentition the deciduous fourth premolar is molariform in overall appearance.

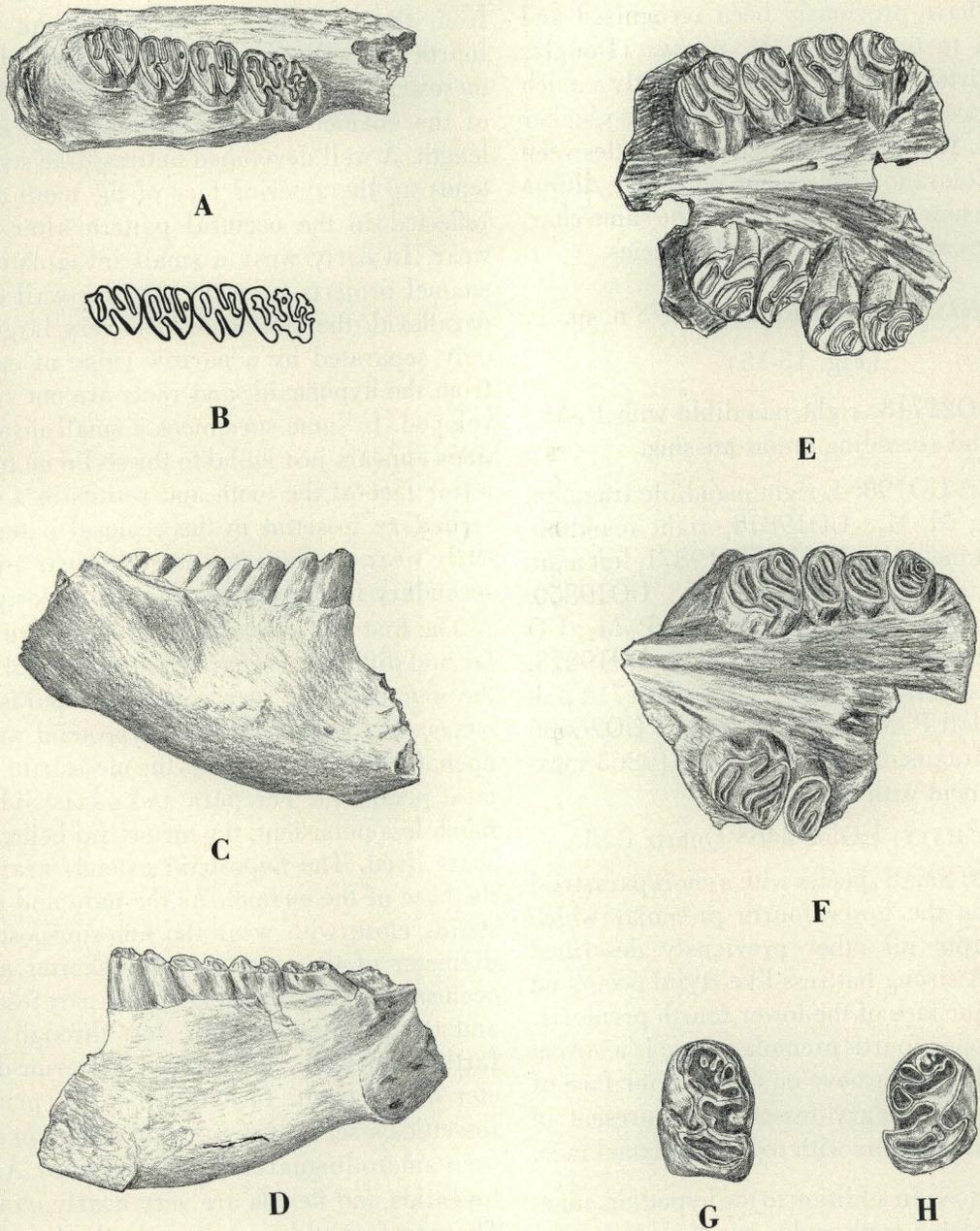


Figure 13. *Monosaulax progressus* n.sp., Quartz Basin, **A** mandible P₄-M₃ UO21713 dorsal view x 2.5, **B** occlusal view dentition x 2.5, **C** lateral view x 2.5, **D** medial view x 2.5, **E** palate UO19873 ventral view x 2.5, **F** palate UO21714 ventral view x 2.5, **G** DP₄ UO22965 occlusal view x 5, **H** DP₄ UO22959 occlusal view x 5.

TABLE 11
MEASUREMENTS OF THE FOURTH LOWER PREMOLAR
OF *Monosaulax progressus*

	AP	Tr	HC	Hypo	Meso	Para
UO22953.....	4.6	3.5	5.27	6.74	3.90	1.70
UO22868.....			4.53		2.95	0.40
UO22955.....	4.7	3.5	4.46	4.62	3.16	0.38
UO22954.....	4.7	3.7	4.45	5.34	2.32	0.72
UO22966.....	4.6	3.4	4.56	3.90	2.65	0.72
UO22943.....	4.7	3.4	4.84	5.30	2.21	

AP, Tr greatest diameter

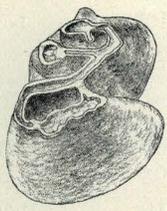
HC—Height of crown on lingual side, Hypo, Meso, Para
indicate striid lengths

TABLE 12
MEASUREMENTS OF LOWER DENTITION
OF *Monosaulax progressus*

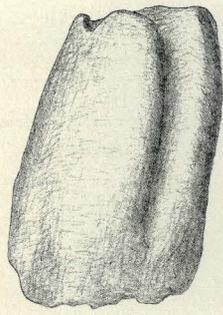
	UO21713	UO19860	UO19871	UO19876	UO19864	UO19870
P ₄ AP	3.63	4.98	4.30			4.04
Tr	2.69	3.82	3.57			3.11
Meso	2.25					2.21
Hypo		1.32				5.30
Para	0.67					
M ₁ AP	2.91	2.39	2.60		3.39	3.08
Tr	2.97	3.59a	3.36		2.54	3.26
Meso	0.22				1.00	0.29
Hypo			0.69			1.99
M ₂ AP	2.79	2.73		2.93	2.99	2.98
Tr	3.08	3.28		3.09	2.99	3.31
Meso	0.79			0.15	1.59	0.53
Hypo		0.45				
Para	0.23			0.44	0.60	Notch
M ₃ AP	2.86			3.18	2.86	
Tr	2.85			2.94	3.27	
Meso	0.86			0.17	1.40	
Para	0.64				0.55	
Met					0.19	
P ₄ -M ₂	9.32	10.37				9.80
P ₄ -M ₃	12.27					

AP, Tr occlusal measurements

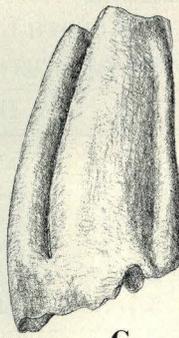
a. damaged, Hypo, Meso, Para, Met, indicate striid lengths



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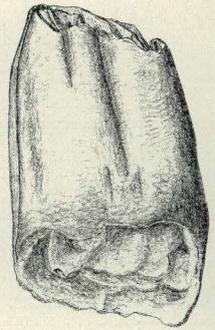
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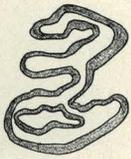
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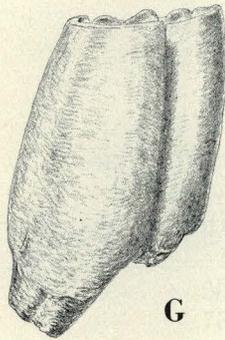
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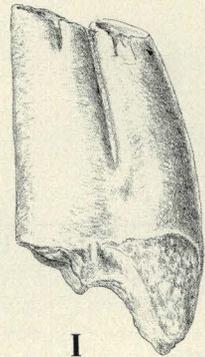
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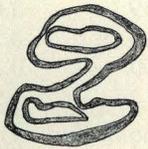
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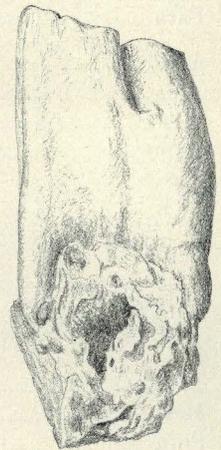
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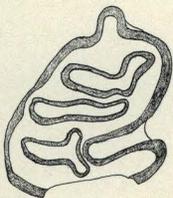
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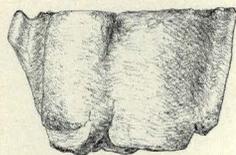
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M



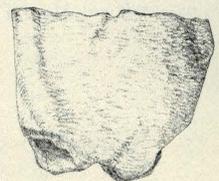
N



O



P



Q

the parafossette and hypoflexus abut in early wear but bypass in later wear. The parastria appears only as a notch even in unworn specimens. The hypostria is full length. The mesostria is short, less than one half the height of the enamel crown. There is a hook-shaped extension of the paracone into the mesoflexus. The occlusal outline of the tooth is square but it is oriented diagonally in the maxilla. In the permanent upper fourth premolar the labial striae are all short. The metastrria is never more than a notch. The para and metastrria are nearly equal and only about 1 mm in length in very early wear. Secondary fossettes occur on each of the transverse lophs, at the parastyle posterior to the paracone and anterior to the mesostyle in early stages of wear. There is a shallow but prominent groove on the anterior lingual face of the tooth which is reflected in the occlusal pattern at most stages of wear. The hypoflexus bypasses the paraflexus. The paraflexus, hypoflexus and metafossette are all straight but become irregular in late wear. The mesofossette is slightly curved asymmetrically. The lingual portion extends posteriorly parallel to the posterior border of the hypoflexus. The fourth premolar is much larger than the other upper cheek teeth.

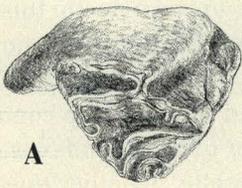
In the upper first and second molars the parastria is very short closing early in wear. The mesostria is less than 1 mm long and the metastrria is apparently closed at all stages of wear. The hypostria is nearly the full length of the enamel crown. Unlike the upper fourth premolar the hypoflexus and the parafossette abut in the upper molars. A secondary fossette appears between the mesoflexus and parafossette

Figure 14. *Monosaulax progressus* n.sp., Quartz Basin, variations in wear right lower fourth premolars, **A** UO229533 occlusal view, **B** labial view, **C** antero labial view, **D** anterior view, **E** lingual view, **F** UO 22966 occlusal view, **G** labial view, **H** anterior view, **I** lingual view, **J** UO19870 occlusal view, **K** labial view, **L** anterior view, **M** lingual view, **N** UO 22957 occlusal view, **O** labial view, **P** anterior view, **Q** lingual view, all x 5.

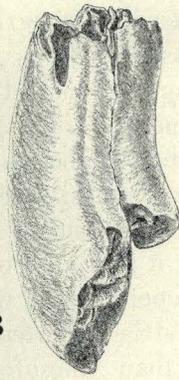
in early wear. In unworn teeth this fossette opens labially. An anterior extension of the mesostyle nearly closes off the mesoflexus on some specimens and forms a loop connecting to the posterior border of the mesoflexus resulting in a secondary fossette. In other specimens a small style appears in the mesoflexus at the point of connection of the subsidiary loph. In early wear the occlusal pattern is reduced to a shortened straight parafossette, crescentic mesofossette, straight metafossette and a relatively straight hypoflexus. With wear the parafossette becomes shorter and the hypoflexus longer accompanied by a reduction in the anterior-posterior diameter of the occlusal surface. The parafossette and metafossette are lost before the base of the hypostria is reached. The third upper molar is similar in pattern to the first and second but is smaller. The anterior-posterior diameter of the occlusal pattern is not so drastically reduced in the course of wear. The metafossette and parafossette are apparently more persistent.

COMPARISONS: The Quartz Basin species differs from all previously known species of *Monosaulax* in the appearance of a short parastriid on the lower fourth premolar, a strongly developed stylid on the anterior face of the lower fourth premolar and a strong anterior lingual groove on the face of the upper fourth premolar. It is a small species comparable in size to *M. typicus*, *M. n. sp.* Wilson, *M. curtis* and *M. complexus*. The character of the fossettes and fossettids is similar to *M. typicus* but secondary fossettes are present as in *M. n. sp.* Wilson. Complications of the basic enamel pattern occur in early wear but are not similar to those present in the known specimens of *M. complexus* and do not persist with wear. The striids of the lower fourth premolar are longer than other species of *Monosaulax* but this is not true of the other teeth, nor is the height of crown significantly greater.

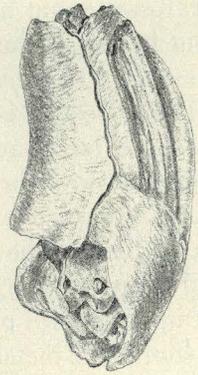
Li (1962, 1963) has described two new species of *Monosaulax* from China and Inner Mongolia. *M. changpeiensis* exhibits secondary



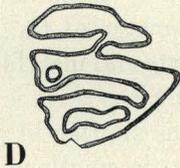
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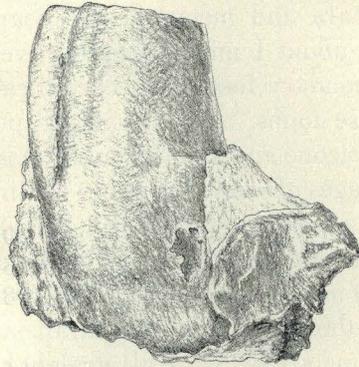
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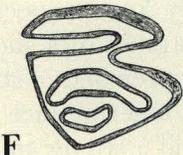
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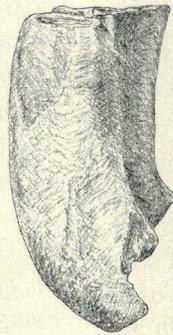
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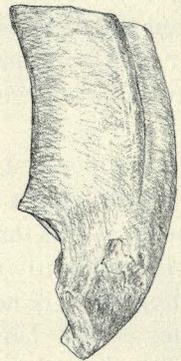
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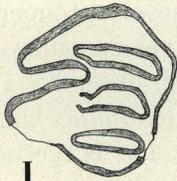
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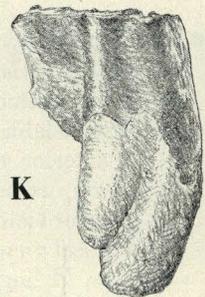
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J



K

TABLE 13
MEASUREMENTS OF THE FOURTH UPPER PREMOLAR
OF *Monosaulax progressus*

	AP	Tr	Hypo	Meso	Para	Met
UO19867.....	3.7	3.8	6.50	0.82	1.19	0.42
UO22951.....	3.7	3.7	2.44			
UO22894.....	3.3	3.3	3.42			
UO22948.....	3.6	3.8	4.91		0.46	

AP, Tr, greatest diameter, Hypo, Meso, Para, Met indicate stria lengths

TABLE 14
MEASUREMENTS OF UPPER DENTITION
OF *Monosaulax progressus*

	UO21714L	UO21714R	UO19873L	UO19873R	UO26686	UO19863	UO19862
P ⁴ AP	3.92	4.00	3.67	3.71	4.12a		3.45
Tr	3.78	3.99	3.49	3.52	4.20		3.52
Hypo	2.13	2.36	3.95	3.53	1.91		5.18
Para			0.28				0.34
Meso							0.33
M ¹ AP	2.22	2.35	2.94		2.68a	2.89	2.59a
Tr	3.29	3.31	3.32		3.31	2.94	
Hypo			2.03	1.40	0.43	3.13	1.91
M ² AP	2.66		2.88			2.80	
Tr	3.03		2.97			3.29	
Hypo			2.34				
Meso						0.43	
M ³ AP	2.85		2.57				
Tr	2.95		2.67				
Hypo			2.06				
P ⁴ -M ²	8.90		9.13				
P ⁴ -M ³	11.64		11.53				

AP, Tr, occlusal

a—damaged, Hypo, Para, Meso, indicate stria lengths

fossettids, lacks a parafossettid and is considerably larger than either of the species described here. *M. tungurensis* is higher crowned

Figure 15. *Monosaulax progressus* n.sp., Quartz Basin, variations in wear upper fourth premolars, **A** UO19867 occlusal view, **B** labial view, **C** lingual view, **D** UO 19862 occlusal view, **E** antero labial view, **F** UO22948 occlusal view, **G** labial view, **H** lingual view, **I** UO22951 occlusal view, **J** labial view, **K** lingual view, all x 5.

than *M. changpeiensis*, has parafossettids as well as secondary fossettids. It is also a larger species. Li considers *M. changpeiensis* to represent an earlier evolutionary stage than *M. tungurensis*.

DISCUSSION: In early wear the lower dentition superficially resembles that of *Eucastor*. The transit "rabbit pattern" of the lower fourth premolar and the straight fossettids give this effect. The deciduous lower premolar is, however, similar to other species of *Monosaulax* in its

single lingual striid. The stria and striids of the molars are short as in other species of *Monosaulax*. In size this species compares closely with the known smaller species of *Monosaulax*. The characteristics which distinguish this species from all previously known species of *Monosaulax* also distinguish it from all known species of *Eucastor*. In addition the molars do not exhibit the S pattern at any stage of wear because of the persistence of the parafossette, (parafossettid) and the early closure of the mesoflexus (mesoflexid). These points argue for the inclusion of this species in *Monosaulax* rather than *Eucastor*. If the diagnoses of these genera as presented by Stirton (1935) are followed literally, *M. progressus* could not be assigned to either genus. I believe the best assignment at this time is to the genus *Monosaulax*. The *Eucastor*-like characteristics present on this low crowned form suggest parallelism rather than transition.

? *MONOSAULAX* sp.

Foot elements of a castoroid beaver nearly thirty percent larger than *Monosaulax progressus* are also present in the Quartz Basin collection from locality 2465. No significant differences are to be seen between these elements and comparable specimens representing *M. progressus* other than size. Since a much larger species of *Monosaulax* is known from the Virgin Valley fauna (Stirton 1935) to the south it is not surprising to see a large castoroid in the Quartz Basin fauna. *Monosaulax* is not the only castoroid beaver that could be expected at this time and place or of the indicated size. The assignment is thus a very tentative one.

SUPERFAMILY DIPODOIDEA

FAMILY ZAPODIDAE

Subfamily Sicistinae

MACROGNATHOMYS sp.

(Fig. 16)

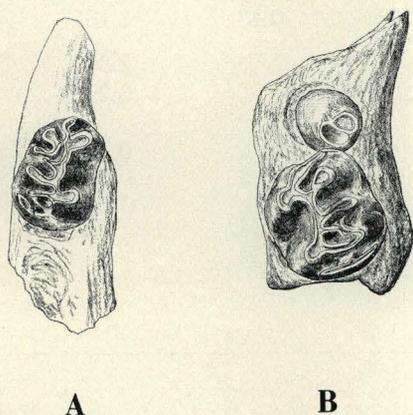


Figure 16. *Macrognothomys* sp., Quartz Basin, A M₁ UO22968, B P⁴-M¹ UO22967, both x 15.

In the Quartz Basin fauna (UOloc 2465) a very small sicistine rodent is present. It is represented by a mandible fragment including a M₁ and a maxilla fragment including P⁴-M¹.

The lower first molar has a small anteroconid but it is connected to the protoconid by a narrow lophid. There is a low but definite ectolophid which extends to the margin of the tooth. A prominent mesostylid is present but is not connected to the short mesolophid, rather an accessory lophid connects the mesostylid to the base of the metaconid. A prominent hypoconulid is present on the posterior cingulum. This cingulum terminates in a styler cusp. Two accessory lophids are present in the post entoconid valley. The tooth is only slightly smaller than that of *Plesiosminthus clivosus* Galbreath (1953) (see also Wilson 1960). It differs from *P. clivosus* in the connected anteroconid, presence of an ectolophid and in the presence of accessory lophids.

The upper fourth premolar is nearly round. On the posterior labial side there is a prominent cusp bounded by two valleys. This elongated

cuspid and its adjacent valleys occupies the labial half of the tooth. The lingual half is nearly as high as the prominent cuspid and has three small cuspid on it. This is somewhat different than the P⁴ of *P. clivosus* in which the pattern is much simpler.

The first upper molar has a prominent anteroloph with an expansion, probably the anterocone. The mesostyle is strongly connected to the central portion of the tooth by a mesoloph and to the paracone by a short cingulum. The metacone is connected by two metalophs, one of which is much smaller than the other and branched. The posterior cingulum connects the metacone and hypocone and has an additional pair of short accessory lophs connecting to the metacone. These lophs do not occur on the M¹ of *P. clivosus*. The presently known material of both species is too scanty to thoroughly evaluate the differences noted between the Quartz Basin species and *P. clivosus*. If the available material is representative of them then the Quartz Basin species may represent a form intermediate between *P. clivosus* and *Macrogathomys nanus* Hall (1930).

	P ⁴		M ¹	
	AP	Tr	AP	Tr
UO22967	0.46	0.57	0.94	0.86

ORDER CARNIVORA
SUPERFAMILY CANOIDEA
FAMILY CANIDAE
Subfamily Caninae

TOMARCTUS cf. *KELLOGGI*
(Merriam 1911)
(Fig. 17 E, F)

Several mandible fragments, including teeth, two maxilla fragments and several isolated teeth in the Red Basin collection represent a canid with narrower and slightly smaller teeth than *Tomarctus rurestris*. The mandibles although slightly crushed are much lighter than *T. rurestris*. The metaconid of the lower first molar is proportionally larger on this canid

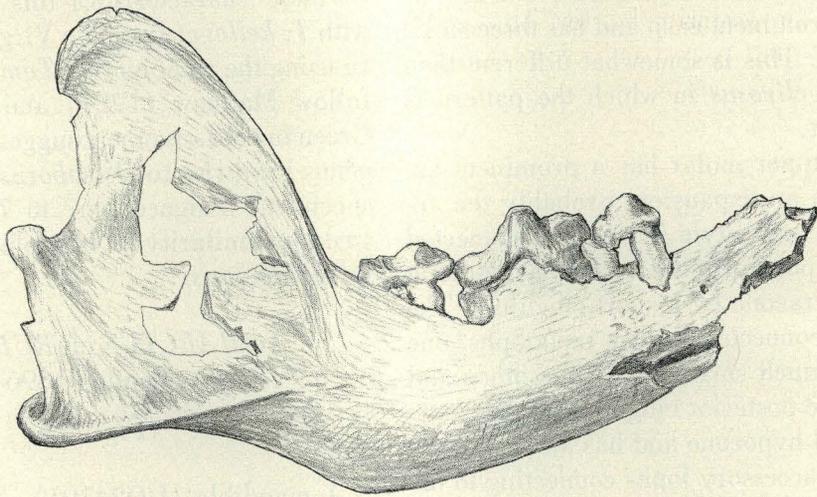
than on *T. rurestris* but the heel is very similar. In these characteristics this material agrees with *T. kelloggi* from the Virgin Valley fauna. In using the combination *Tomarctus kelloggi* I follow Matthew (1924) and Green (1948). Green in his assignment suggests that this broad genus gave rise to *Osteoborus* and *Canis*. The specimens assigned here to *T. kelloggi* show striking similarity to Hemphillian species referred to *Canis*.

TOMARCTUS cf. *RURESTRIS*
(Condon 1896)
(Fig. 17A)

A mandible (UO24191), lacking only the anterior ventral portion, with P₄-M₁ present and a maxilla fragment (UO24192) including the P⁴ apparently represent an old individual of *Tomarctus rurestris*. Isolated teeth and a badly crushed palate are also assigned to this species. These specimens exhibit the heavy jaw, rather broad cheek teeth, and strong curvature of the ventral border of the mandible seen in *T. rurestris*. Measurements of the teeth are close to those of the type specimen. Previously known material from the Skull Springs fauna was assigned to *T. brevirostris* by Gazin (1932). Subsequently Downs (1956) assigned the material to *T. rurestris* after restudying the type.

Canid sp.

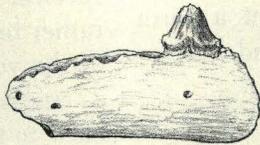
A very small canid is represented at UOloc 2465, Quartz Basin, by a fragmental M₁ in a mandible fragment, a canine and a premolar. The size of these isolated elements indicates a small canid about the size of *Urocyon*. The M₁, UO19752, lacks the heel so that without these characteristics the assignment of the species must be provisional. The trigonid of the M₁ exhibits a high protoconid, much higher than the paraconid, and a small metaconid closely appressed to the protoconid. There is no labial or lingual cingula. The M₁ is estimated as having been 11 mm long when complete. The mandible below the M₁ is 10 mm deep. The canine, UO



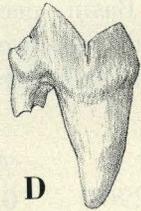
A



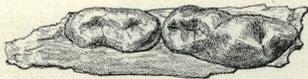
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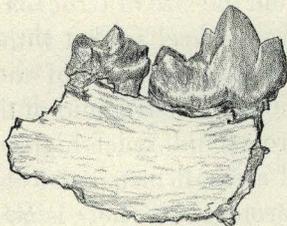
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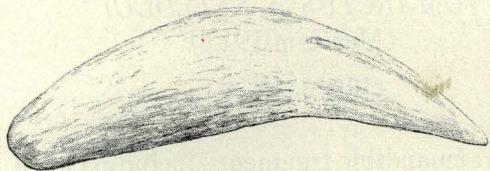
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26748, is laterally compressed. The premolar, UO26749, has a prominent heel with a small cusp close to the posterior border. This small canid differs from *Urocyon* in the lack of an accessory cusp on the labial side of the protoconid. The available materials allows only a family designation.

Subfamily Amphicyonodontinae

? *HEMICYON* sp.

A low crowned second or third lower molar is present in the Quartz Basin fauna as represented at UOloc 2465. The specimen consists of the crown only with no indication of the number of roots which may have been present. The tooth measures 10.9 mm long antero-posteriorly and 8.8 mm transversely. The proportions indicate a tooth too wide proportionately for a canid. The very low crown obviates assignment to any canid. The proportions suggest a bear or bear-dog.

Subfamily Amphicyoninae

AMPHICYON sp.

A large axis vertebrae and calcaneum from locality 2495, Red Basin, are assigned to *Amphicyon*. The characteristics of the vertebrae are similar to those of *Amphicyon riggsi* as illustrated and described by McGrew (1939). The calcaneum, although slightly crushed, agrees with those described by Olsen (1960). Gazin (1932) previously recognized *Amphicyon sinapius* and *Amphicyon* cf. *frendens* in the Skull Springs fauna from fragmental dental elements. The new material does not provide any basis for specific assignment.

Figure 17. Carnivores, **A** *Tomarctus rurestrus* right mandible UO24191 Red Basin x 1, **B** *Brachypsalis* sp. P⁴ UO19753 Quartz Basin, x 1, **C** *Mustella* sp. UO19451 Quartz Basin, x 4.25, **D** *Pseudaelurus* sp. M₁ UO21564 Red Basin x 1, **E** *Tomarctus kelloggi* M₁₋₂ UO21559 Red Basin dorsal view x 1, **F** lateral view x 1, **G** *Pseudaelurus* sp. canine UO23469 Red Basin x 1.

FAMILY PROCYONIDAE

BASSARISCUS sp.

A fragmental upper first molar with the paracone broken away, UO22683, strongly resembles that tooth of *Bassariscus*. This specimen from Quartz Basin, UOloc 2465, has a strong protocone extending as a loph to the paracone. The metacone is small and set in from the labial and posterior borders of the tooth. There appears to be no metaconule. The hypocone is low. The smooth area between the hypocone and protocone extends as a cingulum around the anterior border of the tooth to the paracone. The antero-posterior length of the tooth is estimated at 4.0 mm. The transverse diameter is 5.8 mm from metacone through the hypocone.

FAMILY MUSTELIDAE

MUSTELA sp.

(Fig. 17C)

An anterior fragment of the mandible of a small mustelid including the P₄, UO19451, was recovered at Quartz Basin, UOloc 2457. An isolated P₄ of similar size, UO22302 was recovered from UOloc 2465. Both specimens may represent a single species. The anterior posterior diameter of the P₄ of UO19451 is 2.9 mm, of UO22302 is 2.5 mm. The mandible is 3.7 mm deep below the single tooth present. This species is the size of the weasel *Mustela erminea* and compares closely with it in as much as the scanty material will allow. *Mustela buwaldi* of the Ricardo fauna has accessory cusps on the P₄ and is a larger animal. *Pliogale furlongi* of the Thousand Creek fauna is in the same size range, however, the available material of the two forms does not allow direct comparisons. It seems best to refer the two specimens to *Mustela* noting the strong resemblance to *M. erminea* at least for the present. *Martes (Tomictis) gazini* Hall (1931) from the nearby Skull Springs fauna is a much larger form.

BRACHYPSALIS sp.

(Fig. 17B)

An upper fourth premolar, UO19753, from Quartz Basin UOloc 2465 represents a moderate size mustelid. The protocone is well separated from the paracone and is a broad flat sided cusp facing the paracone. A strong cingulum extends from the protocone to the base of the paracone then posteriorly along the metacone to the posterior border of the tooth. The parastyle area is damaged. The size and character suggest that this specimen represents a species of *Brachypsalis*. A large upper canine, UO19755, may also represent this genus.

A mustelid upper molar from Red Basin, UOloc 2495, is the size of the M¹ of *Brachypsalis* and is similar in characteristics although more triangular in occlusal outline than most. The anteroposterior length is 8.1 mm. The transverse width is 10.7 mm.

SUPERFAMILY FELOIDEA

FAMILY FELIDAE

Subfamily Nimravinae

PSEUDAELURUS sp.

(Fig. 17 D-G)

An upper canine, UO23469, a lower M₁ and a fragment of a P⁴ all from Red Basin locality 2495 are assigned to *Pseudaelurus*. The M₁ has a well developed trenchant heel and is 16.1 mm long.

ORDER PROBOSCIDEA

SUBORDER ELEPHANTOIDEA

Family and Genus indet.

A calcaneum, UO24044, from UOloc 2491, tooth fragments from other Red Basin sites and tooth fragments from the Wildcat Creek locality, UOloc 2345, indicate the presence of a mastodont but do not provide enough information to determine whether it represents *Miomastodon* or *Gomphotherium*.

ORDER PERISSODACTYLA

SUBORDER HIPPIOMORPHA

FAMILY EQUIDAE

Subfamily Anchitheriinae

PARAHIPPUS cf. *AVUS*

Parahippus is sparsely represented in the Red Basin localities. UOloc 2497 produced a lower molar and an upper molar and UOloc 2496 produced a lower DPM. In the upper molar (UO22207) the protoloph does not connect to the protocone. The protocone is well isolated. The protoloph connects very low on the ectoloph. A crochet is present and connects low on the protoloph. No internal cingulum is present. The hypostyle is isolated. Ribs are only slightly developed on the ectoloph between the styles. No cement is present but this is probably an artifact of exposure. On the lower tooth (UO 23870) there is a cingulum only on the antero-

TABLE 15
MEASUREMENTS OF THE DENTITION
OF *Hypohippus* sp.

	Tooth	AP	Tr
UOloc2497			
UO23840.....	M ₁	24.3	17.3
UO23840.....	M ₂	22.1	15.9
UO23840.....	M ₃	23.7	13.8
UO23862.....	P ₂	26.5	15.0
UO23862.....	P ₃	24.3	16.5
UO23897.....	P ₃ ?	22.8	16.0
UOloc2495			
UO20617.....	P ₂	22.8	14.2
UO21539.....	P ₃	23.0	16.8
UO23520.....	M ₁ ?	21.1	16.9

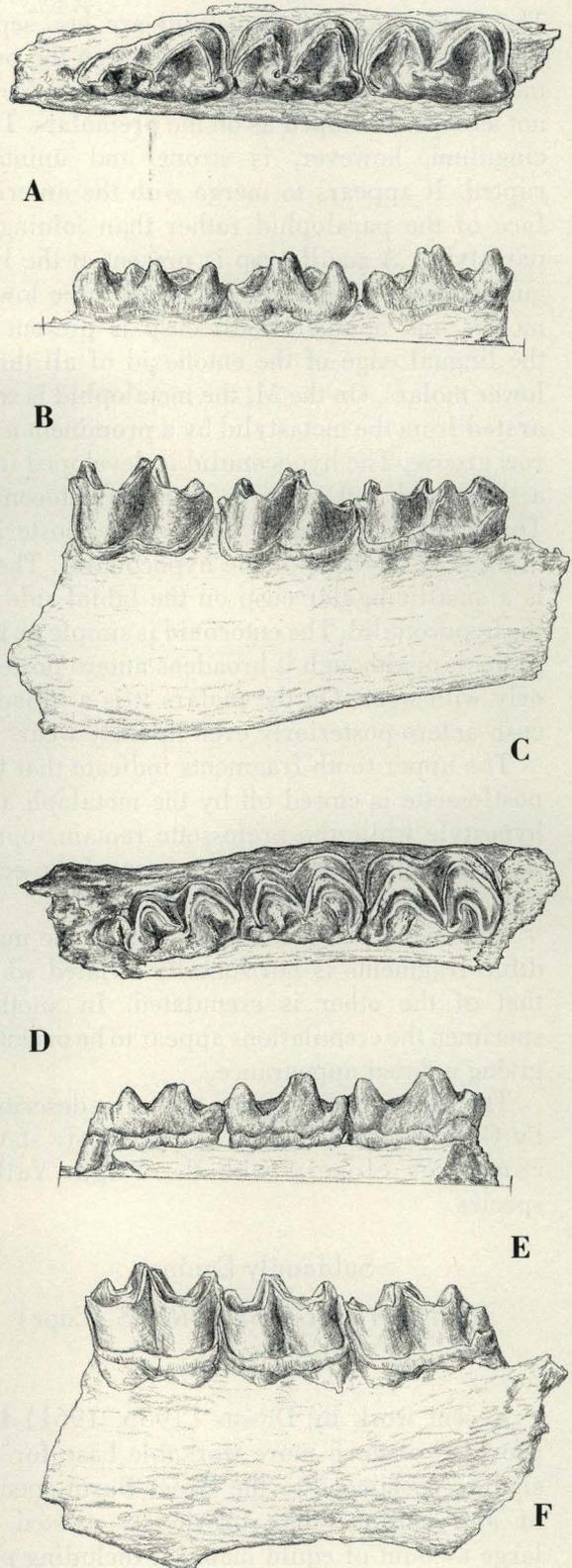
labial side of the tooth between the hypoconid and protoconid. The mesoconid and mesostylid are separated to the base of the tooth. The entoconid is bifurcated forming a complex crown. The hypoconulid is present but damaged. The upper molar measures 16.6 mm antero-posteriorly and 20.8 mm transversely. The lower molar measures 20.9 mm antero-posteriorly. These specimens agree with the revised diagnosis of *P. avus* and are referred to that species.

HYPOHIPPIUS sp.

(Fig. 18)

Three localities in Red Basin have produced specimens of *Hypohippus*, UOloc 2497, 2496 and 2495. The material consists primarily of lower dental elements including several mandibles. Several complete and fragmental isolated upper teeth are present. The P_2 of this species is very narrow anteriorly. There is no apparent metaconid. A cingulum originates in a reduced hypoconulid and extends to the base of the tooth, labially, and then anteriorly around the base of the tooth. It is absent or greatly reduced at the protoconid then continues to the anterior edge of the tooth rising abruptly to the occlusal surface. On the P_3 and P_4 the metaconid and metastylid are separated by a short lingual groove. Below this groove the metaconid and metastylid combine in a broad flat lingual face. A well developed hypoconulid is present and the accompanying cingulum is prominent. It extends around the hypoconid and protoconid to the parastylid without interruption in most specimens. In one, specimen (UO21539) a P_3 , the cingulum is interrupted in the same manner as on the P_2 . The P_4 is the largest lower premolar and apparently larger than any of the lower molars.

Figure 18. *Hypohippus* sp., **A** right mandible P_{2-4} UO23862 Red Basin occlusal view dentition, **B** medial view, **C** lateral view, **D** left mandible M_{1-3} UO23840 Red Basin occlusal view dentition, **E** medial view, **F** lateral view, all x 0.75.



The M_1 is the largest of the lower molars. The metaconid and metastylid are less separated on all the lower molars than on the premolars. The hypoconulid of the M_1 and M_2 is not as well developed as on the premolars. The cingulum, however, is strong and uninterrupted. It appears to merge with the anterior face of the paralophid rather than joining a parastylid. A small cusp is present at the lingual edge of the metaflexid of all three lower molars and another small cusp is present at the lingual edge of the entoflexid of all three lower molars. On the M_3 the metalophid is separated from the metastylid by a prominent narrow groove. The hypoconulid is developed into a third loph but is lower than the entoconid. The cingulum extends around the posterior margin of the base of the hypoconulid. There is a small cingular cusp on the labial side of the hypoconulid. The entoconid is simple on the premolars although it broadens antero-posteriorly with wear. On the molars it is a broader cusp antero-posteriorly even in early wear.

The upper tooth fragments indicate that the postfossette is closed off by the metaloph and hypostyle while the prefossette remains open. A cingulum is present at the base of the ectoloph between each of the adjacent styles.

The enamel of the teeth of one of the mandible fragments is horizontally striated while that of the other is crenulated. In another specimen the crenulations appear to be oriented giving a fluted appearance.

The new material agrees with that described by Gazin (1932) and as he previously stated compares closely with the Virgin Valley species.

Subfamily Equinae

MERYCHIPPUS SEVERSUS (Cope)

(Fig. 19-22)

Recent work by Downs (1956, 1961) has provided a much more workable base for assigning specimens to the Great Basin species of *Merychippus* than previously existed. A large amount of equid material including pal-

ates, mandibles, and appendicular skeletal elements was recovered from UOloc 2495 in Red Basin. Nearly all of this material is assigned to *M. seversus*. Measurements of thirty isolated upper premolars and molars agree with those for specimens from the type area. Downs, in his study of specimens from both the Skull Springs and Mascall faunas, saw no significant differences between these two samples. The new material provides no basis for any other conclusion. Localities UOloc 2497 and 2498, also in Red Basin, have yielded specimens which are assigned to *M. seversus*.

The occurrence of a number of mandibles with deciduous or permanent dentition provides unusually good material for a description of the lower dentition.

The anterior cingulum of the DP_2 extends from the lower labial side of the anterior face of the tooth diagonally upward to the paralophid. The paralophid terminates in a cusp about the same size and shape as the metaconid. The metaconid and metastylid are well separated and ovoid in occlusal outline. The metastylid is slightly the larger. The entoconid has an anterior spur. The hypoconulid and the hypostylid form a cingulum-like structure which is recurved to the lingual border of the tooth. A short protosylid is present between the protoconid and hypoconid. The DP_3 and DP_4 resemble the DP_2 except in the attenuated distal end of the paralophid and the presence of a cingulum at the base of the protoconid.

The deciduous teeth have cement present at the base of the labial side of the teeth. The enamel of the teeth is crenulate.

The adult lower incisors have a shallow broad fossette which on the I_3 opens lingually. The canine is simple but possess a sharp loph on its anterior face. The first premolar is present on young individuals and only occasionally on older adults. It is a simple single rooted tooth. The crown is bulbous, slightly pointed near its crest and has a small loph on the anterior face and also the posterior face.

On the second premolar the paralophid is bifurcate distally. The metaconid is greatly re-

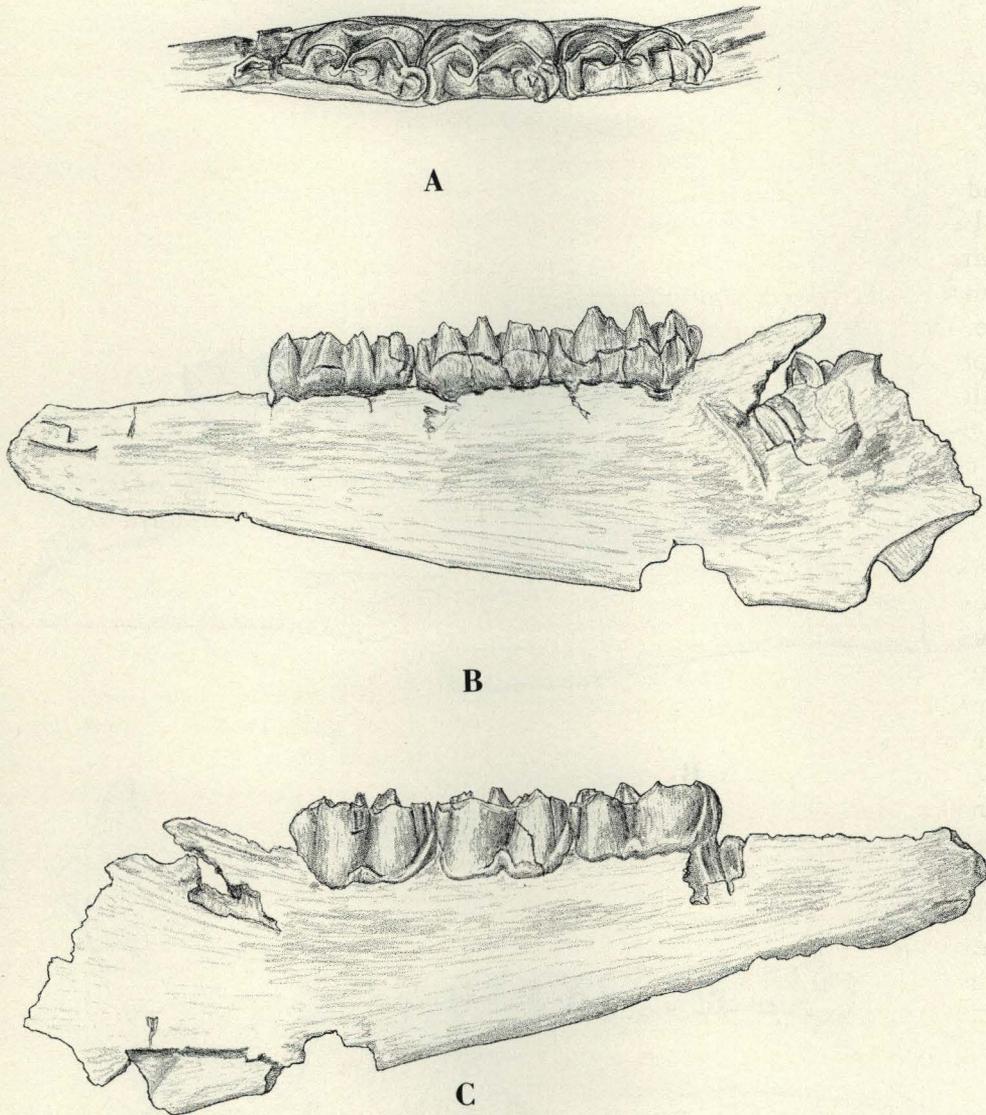
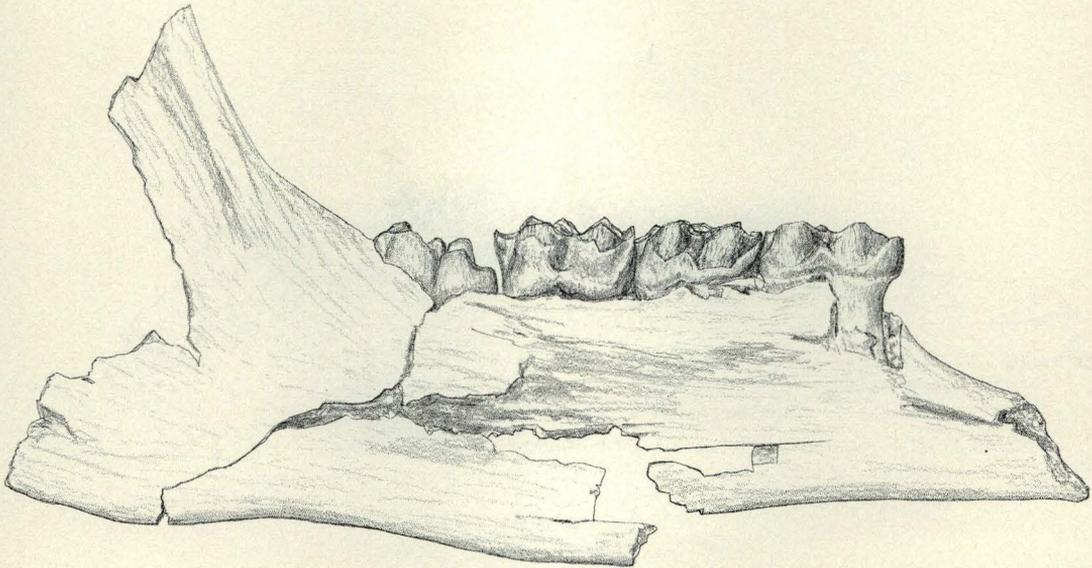


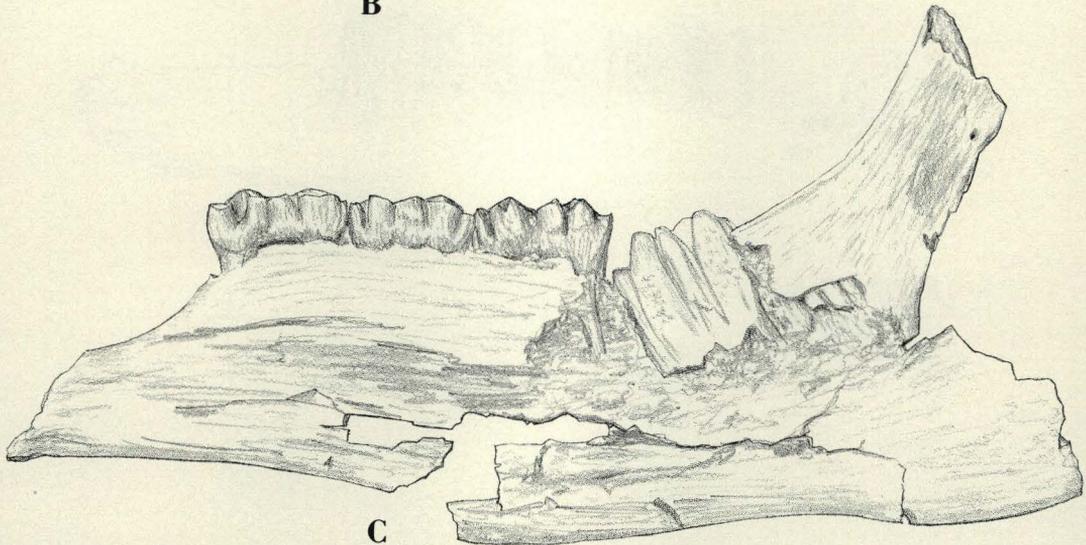
Figure 19. *Merychippus seversus* immature, mandible DP₂₋₄, UO22765 Red Basin, **A** dorsal view, **B** medial view, **C** lateral view, all x 0.75.



A

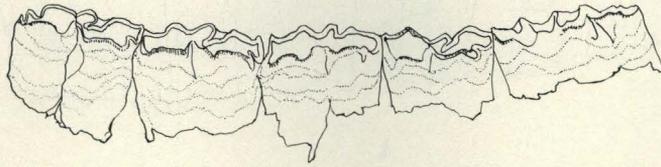


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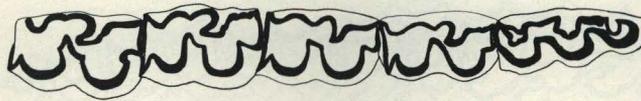


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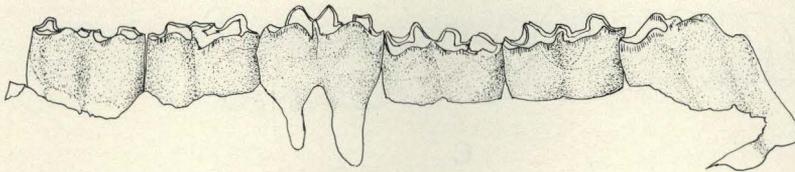
Figure 20. *Merychippus seversus* immature, mandible DP₂₋₄ M₂ UO23216 Red Basin, A dorsal view, B lateral view, C medial view, all x 0.75.



A



B



C



D

Figure 21. *Merychippus severus* lower dentition, Red Basin, A P_3 - M_3 UO 23437 labial view, B occlusal view, C P_1 - M_3 UO21038 labial view, D occlusal view, all x 0.75.

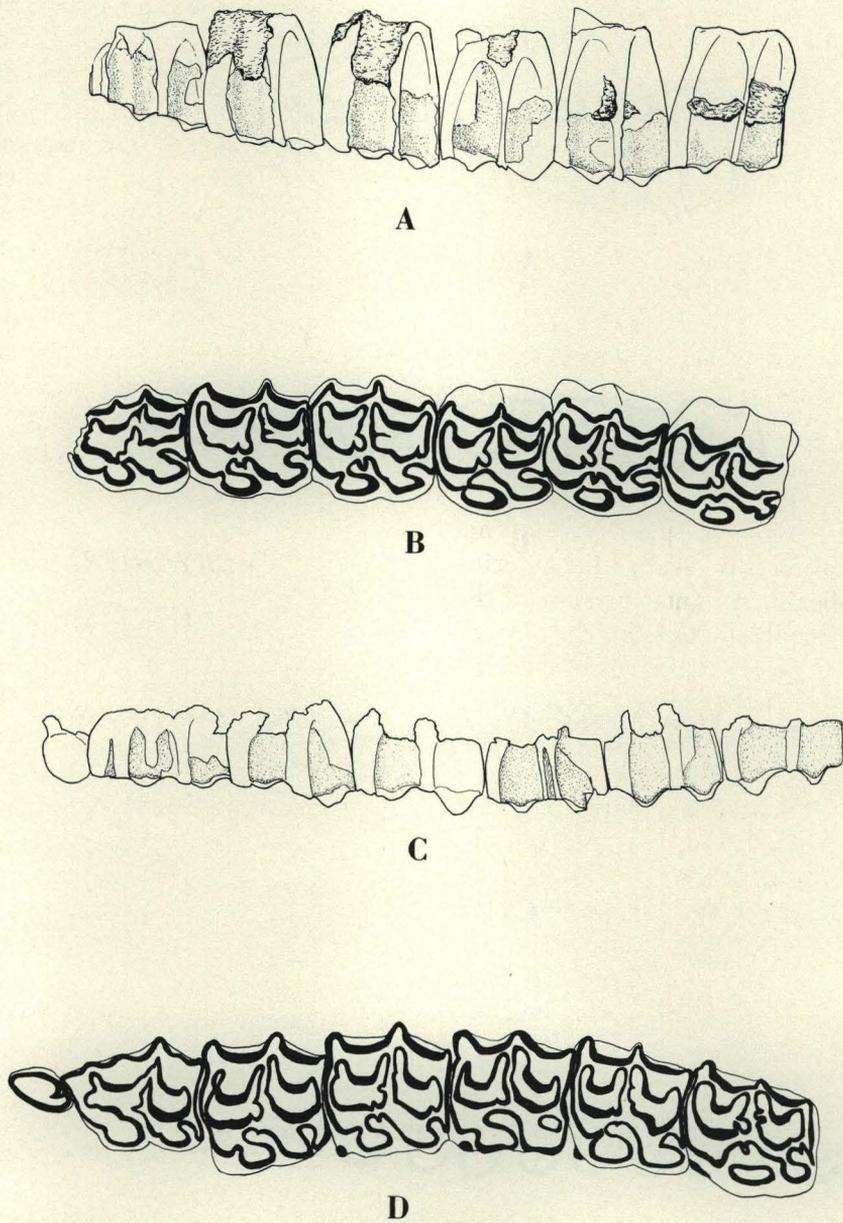


Figure 22. *Merychippus seversus* upper dentition, Red Basin, **A** P²-M³ UO22830 labial view, **B** occlusal view, **C** P¹-M³ UO23440 labial view, **D** occlusal view, all x 0.75.

duced but becomes evident in late wear situated antero-labially to the metastylid and only poorly separated from it. The floor of the metaflexid has a single invagination. The floor of the entoflexid has a prominent invagination or sometimes two small ones. There is an anterior spur on the entoconid. The hypoconulid is well separated from the entoconid. The hypostylid is prominent. The paralophid of the lower third and fourth premolars is straight and attenuated distally. The parastylid proceeds diagonally across the anterior face of the tooth and does not contribute to the occlusal pattern until late wear. The metaconid and metastylid are similar in size and separated by a shallow groove. In some specimens there is a spur on the anterior face of the metaconid. Invaginations of the floor of the flexids are present. In some specimens a plication is present on the anterior wall of the entoflexid. An anterior spur of the entoconid occasionally blocks the opening of the entoflexid. The hypostylid is well separated from the entoconid. The hypoflexid almost completely separates the anterior and posterior moieties of the premolars.

The lower first and second molars differ very little from the third and fourth premolars. The molars are smaller and there is a stronger development of the parastylid on the first molar. The lower third molar has a posterior loph consisting of the hypoconulid and hypostylid and is strongly recurved forming an additional flexure in the tooth.

MERYCHIPPUS cf. *BREVIDONTUS*

Studies of a number of Northern Great Basin Barstovian faunas have revealed the occurrence of a species of *Merychippus* with low crowned teeth. Scharf (1935), Bode (1934, 1935) and Downs (1956) have reported these occurrences from the High Rock Canyon, Skull Springs, Sucker Creek and Paulina faunas. Downs has also recognized this species in the Mascall fauna of the John Day Basin. Bode and Scharf assigned the High Rock Canyon, Skull Springs and Sucker Creek specimens to *M. brevidontus* Bode. Downs, however, pointed

out that although these specimens are low crowned and of the lateral dimensions of *M. severus* they did not appear to be as complicated in dental pattern as the typical *M. brevidontus*. Our localities in Red Basin, UOloc 2495, 2497, and 2498 representing the Skull Springs fauna have produced a small number of specimens representing a species of *Merychippus* of about the size of *M. severus* but with low crowned teeth. An upper molar series (UO22748) (UOloc 2495) displays a large number of plications in the position of the pli prefossette. Other specimens are in early stages of wear so that observations of the complexity of the pattern are of limited comparative value. These specimens are assigned here to *M. brevidontus* with some hesitance.

MERYCHIPPUS sp.

(Fig. 23)

The Quartz Basin fauna includes a species of *Merychippus* with teeth similar in size to those of *M. severus* except in height of crown. A series of twelve upper premolars and molars from UOloc 2465 are little worn to unworn and have an average height of crown of 35.8 mm with a range from 34.6 to 43.9 mm, much higher than *M. severus* but similar to specimens from High Rock Canyon and Virgin Valley (see Downs 1961). The average, although higher than that of *M. californicus*, may not be significantly higher. The protocone, in slightly worn specimens from UOloc 2465, is ovoid and in some specimens lacks a spur. Several additional specimens from other Quartz Basin localities apparently represent this same species. Some are moderately worn and reveal a relatively simple pattern of plications. The hypoconal groove is open and an anterior cingulum is present on the teeth but only poorly developed.

A little worn lower M_2 (UO19711) associated with the upper teeth reveals something of the character of the lower dentition. Other lower teeth are unworn. On UO19711 the metaconid and metastylid are small and rounded but

TABLE 16
MEASUREMENTS OF UPPER PREMOLARS AND MOLARS *Merychippus* sp.

	Stage		Height of	AP	Tr	AP	Tr
	Wear		crown	Protocone	Protocone	Tooth	Tooth
UOloc 2465							
UO19690	P3	U	34.6			19.5	19.8
UO19698	P3	U	35.0			19.2	19.7
UO19680	P3	U	33.9a			18.9	
UO19687	P3	U	34.9			20.2	19.7
UO19691	P4	S	40.5a			21.6	21.6
UO19689	P4	S	39.7			22.2	21.1
UO19692	M1	S	39.1	4.0	2.8	20.0	20.6
UO19686	M1	S	43.9	4.6	2.5	20.6	20.2
UO19693	M1	S	39.6	4.6	2.6	20.3	20.8
UO19694	M2	U	33.7			18.0	18.4
UO19695	M2	U	34.1			17.4	18.4
UO19685	M2	S	32.0	3.7	2.6	18.1	18.9
UOloc 2457							
UO19435	M2	M	23.8	4.5	2.8	17.3	15.9
UOloc 2463							
UO19665	P4	U				22.2	18.5
UO19667	M2	U	25.4			17.1	
UOloc 2455							
UO19272	M2	M	25.9	4.9	3.3	18.7	17.8
UO19271	M2	M	22.7	6.0	3.6		18.7
UO19266	M2	M	23.0	4.5	2.8	17.5	15.2
UOloc 2456							
UO19319	M2	U	32.0			18.6	17.5

U—unworn, S—slightly worn, M—moderately worn.

well separated by a deep groove. There is a spur on the entoconid. The parastylid is well developed extending the full width of the tooth throughout its height. There is an invagination in the floor of the metaflexid. The paralophid is pointed and has a small plication on its posterior border. The hypoconulid extends posteriorly with the hypostylid attached posteriorly.

This material probably represents the same species as does that from either High Rock Canyon or Virgin Valley Nevada. Downs (1961) summation of the characteristics of the known materials from the Nevada localities suggests that the Quartz Basin species is closer to the Virgin Valley form. Too little material is known of either to draw conclusions at this time.

MERYCHIPPUS sp.

Three specimens from the Basque Cabin locality, 2471, represent a species of *Merychippus* similar to *M.* sp. from Quartz Basin. The three specimens are all first or second upper molars. One is slightly worn, UO20373, one is moderately worn, UO20374, the other is incomplete and moderately worn, UO20370. The slightly worn specimen has a height of crown of 31 mm, which is higher than any of the *M.*

Figure 23. *Merychippus* sp. upper dentition, Quartz Basin, **A** P² UO19688 occlusal view, **B** labial view, **C** posterior view, **D** P³ UO19698 occlusal view, **E** labial view, **F** anterior view, **G** M¹ UO19686 occlusal view, **H** labial view, **I** anterior view, **J** M² UO19685 occlusal view, **K** labial view, **L** anterior view, all x 1.



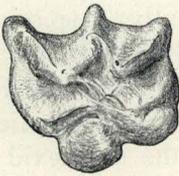
A



B



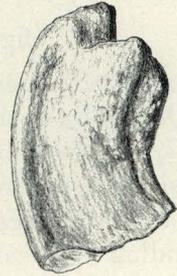
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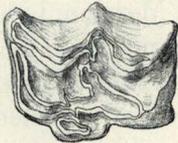
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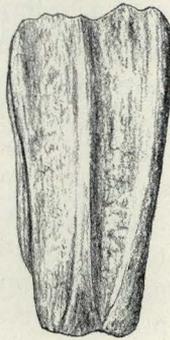
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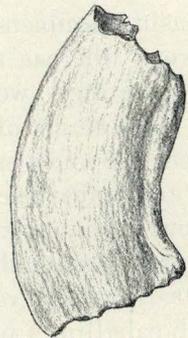
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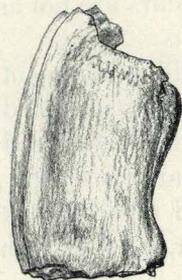
I



J



K



L

seversus specimens from locality 2495 at Red Basin or from the Mascall as reported by Downs (1961). It is similar in height of crown to the Quartz Basin species. These specimens are also similar to the Quartz Basin species in the poorly developed anterior cingulum and reduced protoconal spur. In UO20374 the hypoconal groove is open whereas in UO20373 it is invaded by two anti pli hypostyles. Assignment to the Quartz Basin species does not seem justified with so little material, but is probable.

MERYCHIPPUS RELICTUS (Cope)

(fig. 24)

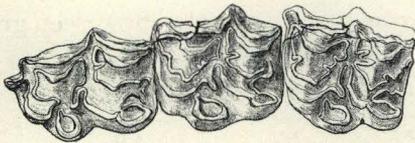
This small rare species of *Merychippus* occurs in Quartz Basin at localities 2458, 2466, and 2467, in Oxbow Basin, locality 2431 and Kern Basin. No specimens from Red Basin are assigned to this species. A partial upper dentition including P²-M¹ and an associated M₁-M₃ were recovered at locality 2467 in Quartz Basin. A similar upper dentition was recovered from Oxbow Basin, locality 2431. The other occurrences are of single specimens. The Quartz Basin specimens are unworn to only slightly worn whereas the Oxbow Basin material is moderately worn. The teeth are of about the same height of crown as those of *M. seversus* but are much smaller in their antero-posterior and transverse measurements. They are of about the same complexity as *M. seversus*. The protocone tends to be round to oval with a spur. All of the available specimens have a single pli caballin. A pli protoloph is present on the premolars. The anterior cingulum is only slightly developed. The crowns of the upper premolars are not as strongly curved as in *M. seversus*.

A mandible fragment (UO19902) from locality 2467, associated with the little worn upper dentition referred to above, includes the lower molar series. The parastylid of the M₁ is strong and reflected in the occlusal pattern in early wear. On the M₂ the upper portion of the parastylid is partially isolated as commonly seen in *Hipparion*. The metaconid and meta-stylid are damaged on M₁ but on the M₂ and

M₃ are present and separated by a deep groove. The lingual border is angular on both of these cusps. On the M₃ the metaconid has a spur. The metaconid is slightly larger than the meta-stylid. The entoconid has no anterior spur on any of the molars. The hypoconulid and hypostylid form a triangular heel on the M₂. On the M₃ they form an open curved loph. The paraloph is attenuated. Cement is well developed on all the teeth. Two isolated lower second premolars (UO21818, UO19616) from localities 2462 and 2453 are referred to *M. relictus*. In these specimens the metaconid and meta-stylid are only partially separated. The paralophid is broad distally. A spur is present on the entoconid of UO21818 but not on UO 19616. No hypostylid is present. The hypoconulid is small. There is a small plication on the anterior border of the entoflexid and a very small plicabellinid.

There has been considerable question about the type locality of this species. Downs (1956) concluded that it is probably a Mascall locality. He arrived at this conclusion through a misinterpretation of remarks attributed by Osborn to Merriam (Osborn 1918). Downs quotes Osborn as stating that Merriam believed the type material may have come from localities not far from the type area of the Mascall Formation. However, Osborn actually quoted Merriam as saying that the material may have come from outlying beds of the Mascall. This remark was apparently based only on the nature of the preservation of the specimens. The material was collected by George C. Duncan of Silver Lake, Oregon and sent to Cope along with a few other specimens of various ages and representing

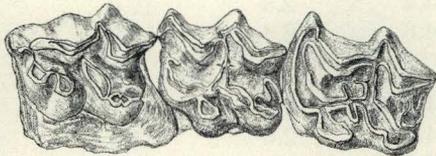
Figure 24. *Merychippus relictus*, **A** P²⁻⁴ UO24182 Oxbow Basin occlusal view, **B** P²⁻⁴ UO 19903 Quartz Basin occlusal view, **C** labial view, **D** M³ UO19900 Quartz Basin occlusal view, **E** labial view, **F** P₂ UO 21818 Quartz Basin occlusal view, **G** labial view, **H** M₁₋₃ UO19902 Quartz Basin dorsal view, **I** lateral view, **J** medial view, **K** upper incisor UO 19901 Quartz Basin labial view, **L** occlusal view, all x 1.



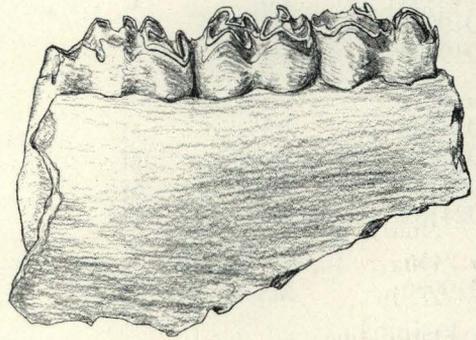
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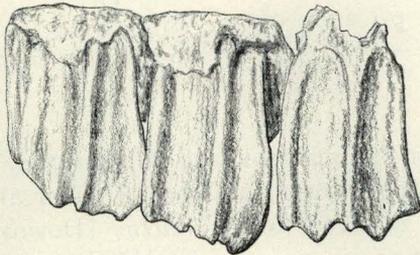
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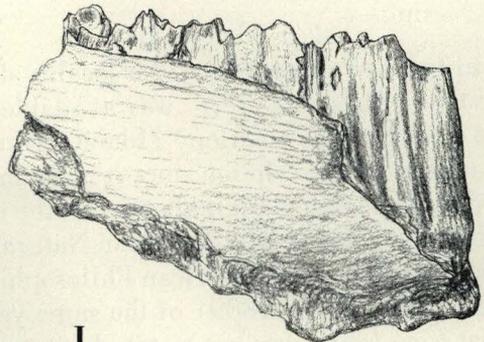
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I



C



J



D



F



E



G



K



L

TABLE 17
MEASUREMENTS OF UPPER PREMOLARS AND MOLARS
Merychippus relictus

	Stage		Height of	AP	Tr	AP	Tr
	Wear		crowns	Protocone	Protocone	Tooth	Tooth
UOloc 2467							
UO19904	P3	U	25.5			16.8	16.7
UO19907	P3	U	26.8			16.8	16.6
UO19908	P4	S	24.5	4.4	2.8	17.0	16.6
UO19903	P4	S	24.9	4.8	2.3	16.9	16.4
UOloc 2431							
UO24182	P3	M	20.6	4.0	2.8		15.9
UO24182	P3	M	24.9	4.1	2.8	16.0a	16.2
UO24182	P4	M		4.0	2.8	15.7	
UO24182	M1	M		4.1	2.9		
UOloc 2466							
UO19900	M3	M	14.8	4.6	2.9	14.2	13.7
UOloc Kern Basin							
UO24189	M1					17.7	
UO24190	M2	M	18.7a	5.0	2.9		15.5

U—unworn, S—slightly worn, M—moderately worn.

several types of preservation. No locality data other than "Oregon Desert" was available. It is not clear how the notation "?Idaho terrane" appeared in the description since it is not mentioned by Cope in his original notice of the material (Cope 1889) in the *American Naturalist* but does appear in his *American Philosophical Society* paper (Cope 1889) of the same year. At that time Idaho was not a state but a territory. It may be that Cope received additional data from Duncan but if so he doesn't mention it. Duncan was not a collector for Cope but a rancher and the postmaster at Silver Lake. It seems unlikely that he collected the material very far from his home area. It also seems unlikely that he collected it from an area where specimens of other species of *Merychippus* were abundant yet found none of them. There is no reason to believe that the type specimens came from the Mascall Formation in the John Day River Valley. Downs, with considerable reservation, assigned some specimens to *M. relictus* from the type area of the Mascall Formation but considered them as integrating be-

tween *M. severus* and *M. relictus*. Several specimens from the Crooked River area have been referred to *M. relictus* (Downs, 1956) and a specimen in the UOMNH from the same area is apparently *M. relictus* (UO16993). The Barstovian sediments in the Crooked River area or Paulina Basin are not now contiguous with the John Day Basin sediments although the sequence there is similar to that of the John Day River Valley in the Picture Gorge-Dayville area. Thayer (1966) suggests that the original sheet of sediments was contiguous. The Paulina Basin is thirty miles southwest of the Mascall area. It is conceivable that Duncan's ranching activities may have brought him into that area, however, Barstovian sediments are also known east and south of Silver Lake. This discussion does not determine where the type locality of *M. relictus* may be, for with the discovery of a number of specimens in the Owyhee area in a stratigraphic unit which extends into Idaho and Copes reference to Idaho terrane the locality seems to be even more obscure.

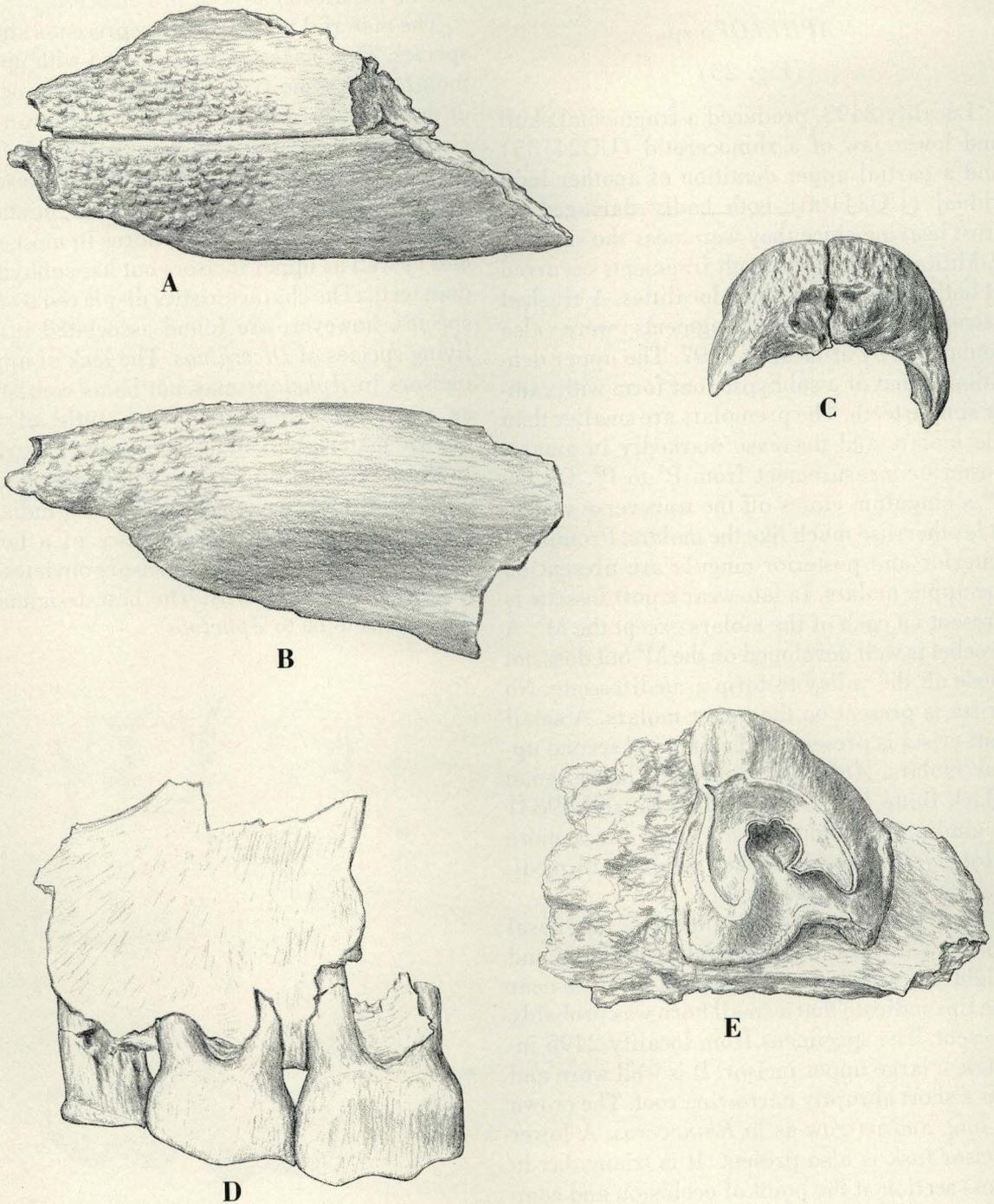


Figure 25. *Aphelops* sp. Red Basin, **A** nasals UO24135 dorsal view, **B** left lateral view, **C** anterior view, **D** premolar series UO24135 left lateral view, **E** M³ UO24160 occlusal view, all x 0.75.

SUBORDER CERATOMORPHA
FAMILY RHINOCEROTIDAE

APHELOPS sp.

(Fig. 25)

Locality 2493, produced a fragmental skull and lower jaw of a rhinocerotid (UO24135) and a partial upper dentition of another individual (UO24160) both badly damaged by frost heaving since they were near the surface. Additional teeth and tooth fragments occurred at both of these Red Basin localities. A crushed astragalus and tooth fragments were also found nearby at locality 2497. The upper dentition is that of a subhypodont form with rather simple teeth. The premolars are smaller than the molars and decrease markedly in antero-posterior measurement from P^4 to P^2 . On the P^4 a cingulum closes off the transverse valley. It is otherwise much like the molars. Prominent anterior and posterior cingula are present on the upper molars. In late wear a post fossette is present on each of the molars except the M^3 . A crochet is well developed on the M^3 but does not close off the valley to form a medifossette. No crista is present on the upper molars. A small anti-crista is present on the first and second upper molars. *Aphelops* from the Clarendonian Black Butte fauna (Shotwell & Russell 1963) is similar in height of crown but has a more strongly developed crochet resulting in medifossettes in the upper molars.

The fragmental skull includes the nasal bones. They are thick and relatively long and slightly pinched in at the ends. Rugosities near the tips indicate that a small horn was probably present. The specimens from locality 2495 include a large upper incisor. It is well worn and has a short abruptly narrowing root. The crown is long and narrow as in *Rhinoceros*. A lower incisor tusk is also present. It is triangular in cross section at the point of occlusion and compares closely with that of *Aphelops* from the Black Butte fauna.

The crushed astragalus compares with that of *Aphelops* in that the neck is not greatly shortened as in *Teleoceras* and the ginglimi are

fully developed. Metapodial fragments indicate no expansion as seen in *Teleoceras*.

The material is believed to represent a single species. The nasals were associated with upper molars, the same type of upper molars occur at the localities where the upper and lower incisors and the astragalus were collected. The joint occurrence of a nasal horn, upper incisors, and subhypodont teeth suggests a mixture. *Aphelops* is believed to lack horns in most species as well as upper incisors but has subhypodont teeth. The characteristics displayed by this species, however, are found associated in the living species of *Dicerhinus*. The lack of upper incisors in *Aphelops* may not be as consistent as previously suggested. Very little of the known material includes the premaxillaries. In those few that do incisors are poorly developed or absent. Some specimens also indicate a small nasal horn. The presence of a horn, elongate nasals, and upper incisors obviates an assignment to *Peraceras*. The best assignment thus seems to be to *Aphelops*.

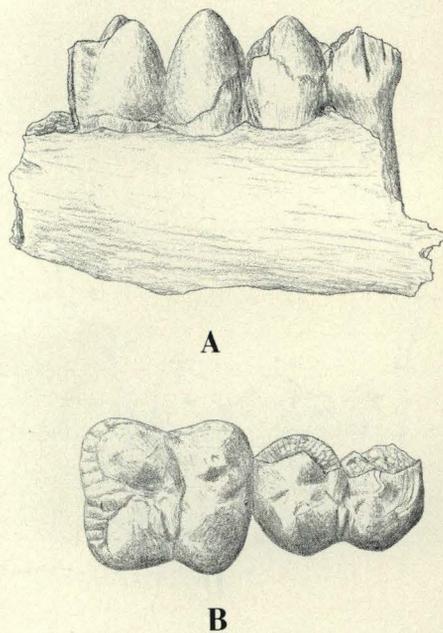


Figure 26. *Prosthennops* sp., mandible fragment with P_4 - M_1 UO22607 Quartz Basin, A side view, B occlusal view, both x 2.

ORDER ARTIODACTYLA
 SUBORDER SUIFORMES
 INFRAORDER SUINA
 FAMILY TAYASSUIDAE

PROSTHENNOPS sp.

(Fig. 26)

A mandible fragment, UO22151, including P_4-M_1 is present in the collection from UOloc 2497, Red Basin. Specific assignment is not possible.

From UOloc 2465, Quartz Basin a mandible fragment, UO22607, with P_4-M_1 is present plus several tooth fragments. Specific assignment is not possible with such limited material.

INFRAORDER OREODONTA
 FAMILY MERYCOIDODONTIDAE

Subfamily Ticholeptinae

TICHOLEPTUS cf. *OBLIQUIDENS* (Cope)

(Fig. 27)

Ticholeptus is represented by upper and lower dentitions, isolated teeth and partial dentitions in the collection from UOloc 2497, Red Basin. A mandible fragment with the premolars occurred at UOloc 2495 also in Red Basin.

A mandible, with left and right little worn dentition, from UOloc 2497, UO26798 best exhibits the characteristics of the lower dentition. The second and third premolars are crowded to the point that they overlap each other and the fourth premolar. They are relatively simple blade-like teeth. The P_3 has a narrow protolophid. In the fourth premolar the protolophid connects to a metaconid which is narrow at the crest but broad at the base. It extends very little anterior to the protolophid but posteriorly it extends to the heel and joins the hypolophid forming an enclosed fossettid. The first premolar is blade-like tooth on UO26798, but on another specimen, UO23835, a mandible fragment with P_{1-4} with P_2 missing, the P_1 is a large caniniform tooth. The other premolars present suggest that the two specimens represent the same species. UO23835 is of much older indi-

vidual. In the lower molars a cingulum closes the intercrestic valleys, but does not support a protostylid. The external ribs of the ectoloph are poorly developed. The stylids are present but not prominent.

The ventral border of the mandible is rather straight and nearly parallel to the dorsal border. A foramina is present at the base of the root of the P_1 .

A maxilla, UO22192, from UOloc 2497 includes P^2-M^3 , alveoli of the canine and P^1 . The infraorbital foramen opens above the posterior root of the P^3 . The nasals are apparently not retracted judging from the character of the maxilla. The P^2 and P^3 appear to have two broad roots while the P^4 has three roots. The P^2 and P^3 each have a strong protocone with an accessory cusp nearly as large and anterior to the protocone. The accessory cusp is connected to the parastyle by a loph from its anterior edge. It is also connected to the paracone by a loph arising from its crest. These two lophs form the boundaries of a small anterior fossette on the P^3 . Another loph connects the paracone and anterior border of the protocone forming an open lingual valley. The protocone is connected to the mesostyle by a posterior loph, which in the P^3 completes the encirclement of a posterior fossette. The P^4 and molars all have a continuous lingual basal cingulum extending from the anterior face to the posterior face. The styles of the molars are very well developed. No external ribs are present on the ectoloph of any of the molars. Protostyles are not present.

Published figures of *Ticholeptus obliquidens* reveal very little of the dental characteristics of the species. The form of the mandible, however, compares closely with the Red Basin material. *T. obliquidens* was described from the Mascall Formation. Gazin (1932) assigned fragmentary material from Red Basin to *Ticholeptus?* sp. Scharf (1935) in his study of the Sucker Creek fauna of the Owyhee region compared material from that fauna to *T. petersoni* but assigned it to *Ticholeptus* sp. At the same time he also examined the Skull Spring material from Red Basin and found that it also

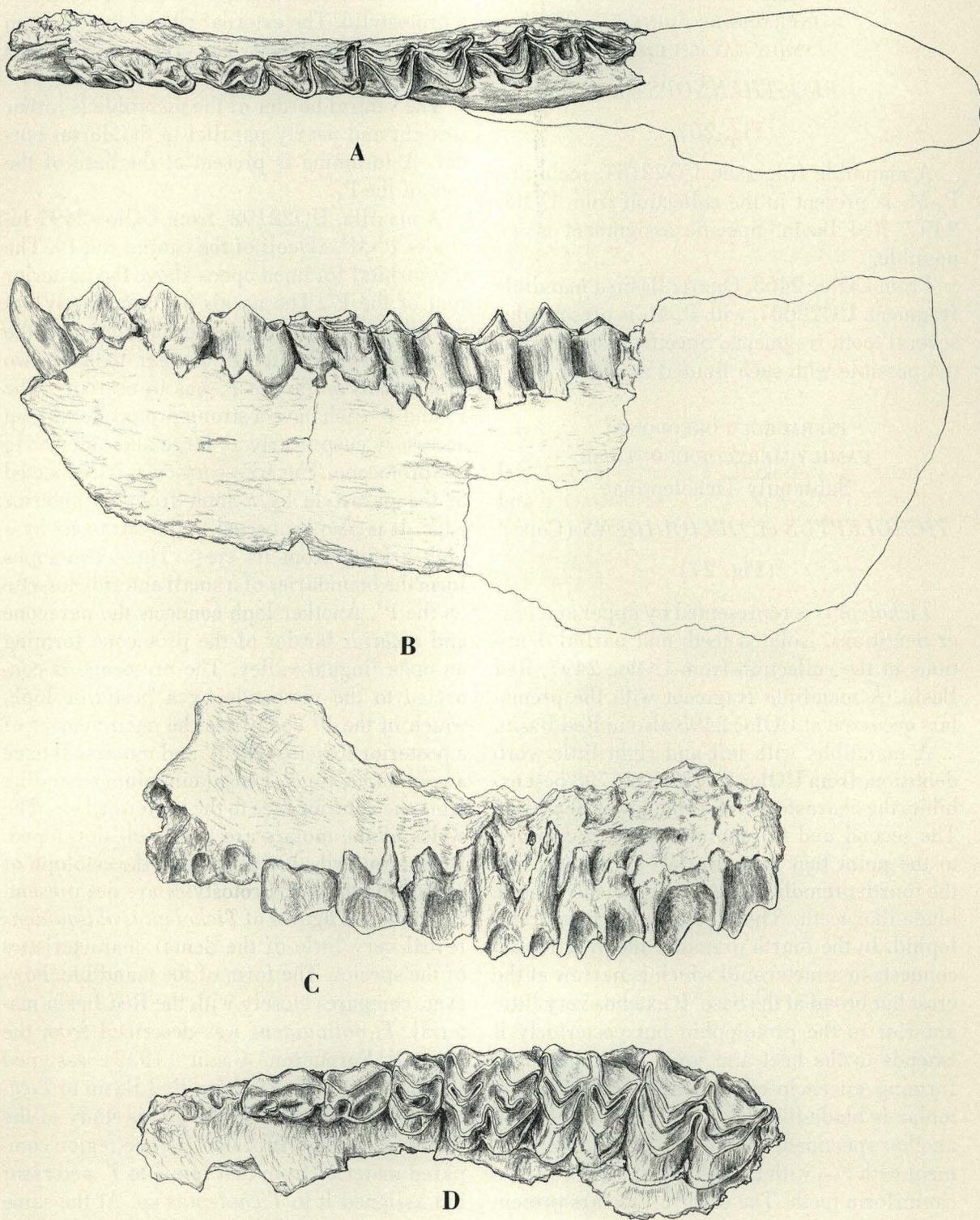


Figure 27. *Ticholeptus* cf. *obliquidens* Red Basin, **A** left mandible UO22798 dorsal view, **B** left lateral view, **C** left maxilla UO22192 left lateral view, **D** ventral view, all x 1.

compared favorably with *T. petersoni*. Thorpe (1937) assigned the Skull Spring (Red Basin) specimens to *Pronomotherium* sp. and noted a similarity to *P. siouense* in the P₃ Schultz and Falkenbach (1941) considered the same specimens to represent *Ticholeptus*. In this paper the authors considered *T. petersoni* to represent a subfamily other than the Ticholeptinae. In an earlier paper Schultz and Falkenbach (1940) had referred *Pronomotherium siouense* to the genus *Brachycrus* of the Merycochoerinae on the basis of identity and priority of name. Thus in the past the fragmentary Barstovian oreodont material from Oregon has been usually assigned to *Ticholeptus* but the species compared with are now to be found in three separate genera and subfamilies. None of the previously known material revealed anything of the character of the skull. The present material indicates that the nasals were not retracted and that the infraorbital foramen was above a point between the P³ and P⁴. These are important characteristics of *Ticholeptus* as restricted by Schultz and Falkenbach (1941). The dental characteristics of *Brachycrus siouense* (= *Pronomotherium*) are indeed very close to those of the Red Basin specimen but so are those of *T. hypsodus*, for instance. Thorpe (1937) and Schultz and Falkenbach (1941) considered *T. obliquidens* and *T. hypsodus* to be very close. Schultz and Falkenbach (1941) considered *T. zygomaticus* to be close to *T. hypsodus* but with a slightly heavier and longer upper and lower dentitions. Some authors have suggested that *T. hypsodus* and *T. obliquidens* are possibly synonymous. Thorpe (1937) attributed their similarities to parallism. If they are synonymous the name *T. obliquidens* has priority. If *T. hypsodus* and *T. zygomaticus* are synonymous as well, then *T. zygomaticus* would prevail for all three of the species.

For the present it seems best to refer the Red Basin specimens to *T. obliquidens* even though that species is not known well from its type locality.

SUBORDER TYLOPODA

FAMILY CAMELIDAE

Camelid

Wildcat Creek UOloc 2345, Red Basin UOloc 2495, Quartz Basin localities 2456, 2461, 2462, and Basque Cabin UOloc 2471 have all produced foot elements of a small camelid. The elements consist of a number of scaphoids, unciforms, fragmental metapodials, two astragali and a single phalanx. None of the material is such that a specific assignment could be made. The most that can be said is that a small camelid is sparsely represented at the above localities.

SUBORDER RUMINANTIA

INFRAORDER PECORA

SUPERFAMILY CERVOIDEA

FAMILY CERVIDAE

Subfamily Paleomerycinae

DROMOMERYX BOREALIS Douglas 1909

(Fig. 29-31)

Dromomeryx near *borealis* Gazin 1932, Carn.

Inst. Wash. Pub. No. 418, p. 82

Rakomeryx gazini Frick 1937, Bull. Amer.

Mus. Nat. Hist., Vol. 69, p. 106

Dromomeryx is one of the most abundant large mammals at UOloc 2495 in the Red Basin. It occurs also at other localities but not so abundantly. Nearly all elements of the skeleton are present and are described below.

MANDIBLE: The mandible is curved, dorsoventrally but not so strongly as in *Dama*. The angle of the jaw is similar to *Cervus* in that it lacks the angular process present in *Dama*. The depth of the jaw is about the same as in *Cervus*. The coronoid process is not complete on any of the specimens but the most complete example indicates that it is much straighter than in living cervids and not curved strongly posteriorly although it may be curved at the distal end. The notch between the coronoid process and the condyle is broad. The diastema is considerably longer than in *Dama* or *Cervus*. It is fifty five

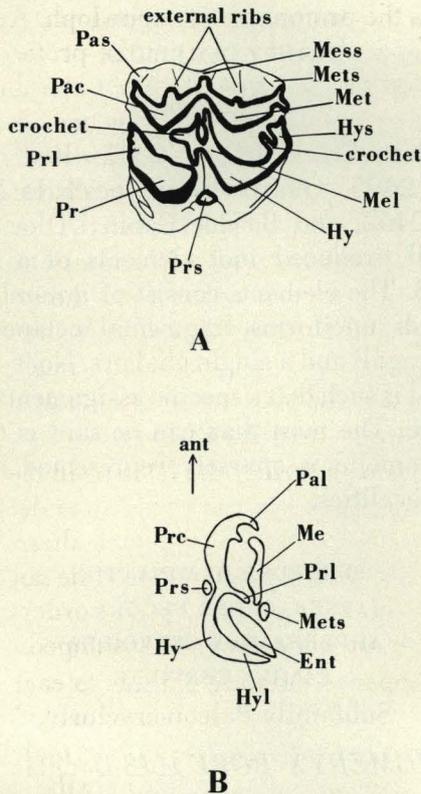


Figure 28. Dental nomenclature used on Artiodactyl teeth.

A upper molar

Hy —Hypocone	Pac —Paracone
Hys —Hypostyle	Pas —Parastyle
Mel —Metaloph	Pr —Protocone
Mess —Mesostyle	Prl —Protoloph
Met —Metacone	Prs —Protostylid
Mets —Metastylid	

B lower premolar

Ent —Ectolophid	Pal —Paralophid
Hy —Hypoconid	Prc —Paraconid
Hyl —Hypolophid	Prl —Protolophid
Me —Metaconid	Prs —Protostylid
Mets —Metastylid	

percent of the total tooth row length (83-90 mm). There is a large mental foramen opposite the posterior border of the symphysis. Another, but much smaller, mental foramen appears below the P_2 with an additional small foramen situated about half way between the others on some specimens. The mandibular foramen is about in line with the occlusal surface of the cheek teeth.

LOWER DENTITION: The incisiform teeth include the three incisors and the incisiform canine. Their relative sizes and morphology compare closely with those of *Dama*. There is a strong rib developed on the inner face of each of the incisiform teeth. It is located closest to the posterior edge of the tooth. The teeth decrease in size from I_1 -C.

An alveolus for the first premolar is present on several mandibles of mature individuals and also on young individuals still possessing elements of the deciduous dentition. No mandibles of old individuals have an alveolus for the first premolar. In no instance is a DP_1 or a P_1 preserved. It is not clear whether this species had only a DP_1 , retained much later in life than the other elements of the deciduous dentition, or whether both deciduous and permanent first premolars were present with the permanent first premolar lost before old age as is the case in some other ungulates.

The P_2 is the smallest and simplest tooth of the lower dentition. Lophids are not as well developed as in *Dama* but more so than in *Cervus*. The protolophid is essentially absent since the metaconid, which is very broad at its base, meets the labial side of the tooth at the crest. The paralophid is very narrow. The hypolophid and ectolophid are well developed but low.

The P_3 is much larger than the P_2 . The paralophid is branched lingually forming a small open valley. The protolophid terminates in the metaconid which is very narrow at its crests but broad, antero-posteriorly, at its base. The hypolophid and ectolophid join lingually forming a small enclosed fossette. An accessory lophid extends into this fossette from the hypolophid. A broad but short accessory lophid extends into the anterior valley. The highest point on the tooth is the protoconid.

Although the P_4 is usually slightly larger than the P_3 it is similar in many of its characteristics. Its primary feature is the anterior-posteriorly enlarged metaconid which closes off the anterior valley between the protolophid and posterior branch of the paralophid. The P_4

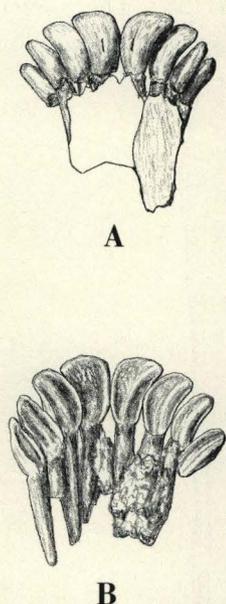


Figure 29. *Dromomeryx borealis*, Red Basin, lower incisors UO 22119, **A** ventral view, **B** dorsal view, both x 0.75.

is broader than the P_3 . The development of the tooth is similar to that of *Dama* but lacks the protostylid and metastylid seen in deer.

The lower molars all possess a protostylid and the *Paleomeryx* fold. The enamel of all the cheek teeth is crenulated. Anterior and posterior cingula are present on all the molars. The anterior cingula is the stronger.

The ratios of individual tooth lengths to total tooth row length are as in *Dama hemionus columbiana*. In seven complete lower cheek tooth series the premolars average sixty five percent of the molars in length, ranging from sixty one to sixty nine. This is similar to that of living cervids.

UPPER DENTITION: The P^2 is triangular in occlusal outline with three roots. The anterior-posterior diameter is greater than the transverse. The protoloph is well developed. It terminates labially in a parastyle and lingually at the protocone. The protocone is a prominent feature of the tooth. Small weakly developed cingula occur on both anterior and posterior sides of the protocone. A complete posteroloph

connects the protocone to the ectoloph. A small accessory loph connects from the protocone to a point on the posteroloph about one third of its length posterior to the protocone. A small fossette is thus formed. The paracone is massive and the highest cusp of the tooth. Its labial surface has a strong style present.

The P^3 is similar to the P^2 in basic pattern. It is broader transversely so that the anterior-posterior and transverse diameters are equal. The cingula of the protocone are much more strongly developed than in the P^2 . It is only slightly larger than the P^2 .

The basic pattern of the P^4 is as in the other premolars, however, the protocone is much more prominent and the transverse diameter of the tooth is much greater than the anterior-posterior diameter. The cingula bordering the protocone are very strongly developed.

The upper molars are similar to each other but increase in size antero-posteriorly, the first being the smallest. In the upper molars the antero-posterior diameter is nearly the same as the transverse. The ectoloph of each of the upper molars exhibits a parastyle, a broad external rib labial to the paracone, a mesostyle, a strong but narrow external rib labial to the metacone and a metastyle which often appears forked in occlusal outline. The protoloph connects high on the parastyle. The metaloph does not connect to the ectoloph. The anterior crescent is completed posterior to the protocone by a large irregularly shaped crochet which connects in some specimens to the protocone, in others to the metaloph, and often to both. A small fossette is often formed between the irregularities in the crochet and the metaloph connection. The posterior crescent is completed by a structure similar to the hypostyle of equids, however, it does not quite connect to the metastyle in some specimens. The hypostyle is often branched and sometimes has several branches. A well developed anterior cingulum is present on all the upper molars. A much less strongly developed posterior cingulum is also present. A protostyle is present on each of the molars.



A number of specimens have cement present on the teeth. It is only recognized on the labial and lingual faces, extending into the open valleys between cusps. It does not occur in the fosses of any of the specimens.

FOREFOOT: The radial facet of the scaphoid is similar to that of *Dama* but broader ventrally. The scaphoid lacks the strong medial protuberance present on *Cervus*. Its manubrium facet is similar to that of *Cervus*, not broad as in *Dama*. The radial facet of the lunar has somewhat less relief than that of *Cervus* or *Dama* and is more elongate. The articulation with the magnum is similar to both *Cervus* and *Dama*. The scaphoid and cuneiform facets are comparable with *Dama*. The only cuneiform present is distorted to the extent that comparisons are of little value. The pisiform is elongate as in *Dama* and is curved slightly dorso-ventrally. There is a heavy rough ridge running from the anterior end of the cuneiform facet to the distal end of the pisiform. The cuneiform facet is long and ovoid in shape as in *Cervus* rather than broad as in *Dama*. The facet is not so strongly curved antero-posteriorly as in *Cervus*. The magnum is very close to *Cervus* and if it were not for the difference in size in the two animals might be mistaken for *Cervus*. The dorsal unciform facet is nearly square as in *Cervus* not rectangular as in *Dama*. The ventral unciform facets differ from both *Cervus* and *Dama* in that they are round. The unciform is also close to that of *Cervus*. It differs primarily in the facets for the magnum which are essentially mirror images of the unciform facets of the magnum. None of the metacarpal fragments are complete enough to provide useful comparative data.

HINDFOOT: The navicular-cuboid groove of the astragalus is similar to that of *Cervus* in that the medial side is not strongly convex at its border. The lateral ginglymus has a greater diameter than does the medial one as in *Cervus*

Figure 30. *Dromomeryx borealis*, Red Basin, A P²-M³ UO23705 occlusal view, B right mandible UO23393 lateral view, C dorsal view, all x 0.75.

rather than in *Dama*. The calcaneum is close to that of *Cervus* in most characteristics. The fibular facet is much more expanded medially in *Cervus* than it is in *Dromomeryx* which is more like *Dama* in this respect. The astragalus and calcaneum facets of the navicular-cuboid are more similar to those of *Dama* than *Cervus*. The ventral protuberance of the navicular portion is low on *Dromomeryx*, even lower than in *Dama*. The foramen between the navicular and cuboid portion opens into a well defined groove which extends in a curve through the gap between the ventral protuberances of the articular surface. In *Dama* and *Cervus* the foramen is isolated from the interprotuberance groove. The articular facet for the calcaneum is similar to that in *Dama*. The meso-cuneiform and metatarsal facets of the navicular-cuboid are nearly parallel in *Dromomeryx* somewhat as in *Cervus* rather than diverging as in *Dama*. The metatarsal facets are only slightly separated by a slight ridge in *Dromomeryx*. The ventral facet of the two is a continuation of the form of the dorsal facet. In *Dama* and *Cervus* the ventral facet is separated by a deep groove. It is long and narrow, oriented transversely. The mesocuneiform facet is more rectangular in outline than in either *Dama* or *Cervus*. Of the foot elements studied the navicular-cuboid is least like *Dama* or *Cervus*. The mesocuneiform is rectangular in outline. A small facet is present on its lateral side. This facet articulates with a matching facet on the cuboid portion of the navicular-cuboid. In *Cervus* this articulation is accomplished by a curved proximal surface on the mesocuneiform. In *Dama* this articulation apparently does not occur.

One metatarsal present in the collection is complete enough to indicate its length but is so fractured that little else is clear. It is elongated to the same degree as in *Dama* and *Cervus*. A well defined dorsal groove is present. Less complete specimens indicate that this groove terminates at its distal end in a large foramen. Lateral metatarsals or metacarpals are not present in the collection. The phalanges are nearly all crushed so that assignment and description are

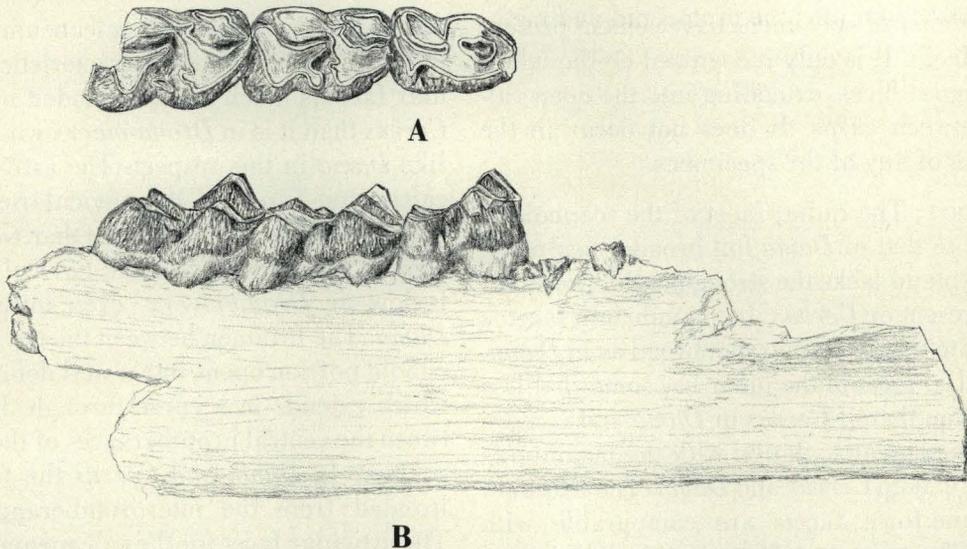


Figure 31 *Dromomeryx borealis*, Quartz Basin, right mandible P₄-M₂ UO19273, **A** occlusal view, **B** lateral view, both x 0.75.

not possible. They appear to be of the same proportions as those of *Cervus*.

SKULL: Two badly crushed skulls are present in the collection from Red Basin. One, UO 22219, is crushed antero-posteriorly. The horn pedicles are complete but flattened by the crushing. The other, UO23705, is crushed laterally. The horn pedicles are broken off at about one third their length above the skull. The portion of the skull anterior to the P² is missing. Details of the skull are largely destroyed by the crushing. The horn pedicles are about 240 mm long. A lateral flange is present. They appear to have been directed forward, however it is not possible to determine to what degree. The recognition of facial vacuities is not possible due to the shattered and distorted nature of that part of the skull.

DISCUSSION: The Red Basin specimens agree in size with *D. borealis*. The upper teeth are complicated by spurs in the same way as those of *D. borealis*. The lower dentition of *D. borealis* was described by Douglas (1909) and illustrated. The P₄ differs from most specimens of the Red Basin species in that the metaconid closes off the valley between the protolophid and entolophid. This only occurs rarely in the Red Basin material.

Frick (1937) assigned previously collected Red Basin specimens to *Rakomeryx gazini*. Gazin had earlier (1932) described these specimens and assigned them *D. near borealis*. The assignment by Frick was based on what he considered to be peculiarities of the horn core. The proportional size of the premolars, the enlarged metaconid on the P₄, and the gross size all strongly favor the assignment of *Dromomeryx*. The differences between the Red Basin specimens and *D. borealis* are so slight that there seems to be no real basis for separation. The name *Rakomeryx gazini* is thus not applicable.

RAKOMERYX cf. *AMERICANUS*
(Douglas 1909)

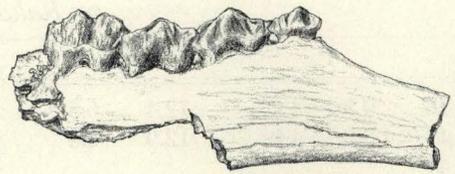
(Fig. 32)

Two fragmentary mandibles are present representing a small paleomerycid in the Red Basin collection. Neither is complete enough to indicate the length of the diastema or the character of the ascending ramus. The relative depth of the jaw appears to be about the same as that of *Dromomeryx*. A large mental foramen occurs below and anterior to the P₂. The P₂ is the smallest tooth of the cheek tooth series.

The protolophid plus the protoconid and metaconid form a single large cusp which dominates the tooth pattern. The paralophid is small and simple. The ectolophid and hypolophid are well developed but low. The P_3 is larger than the P_2 but similar in most characteristics, however the paralophid is much better developed and branched. The protolophid is more distinct than in the P_2 . The P_4 is the largest tooth of the premolar series. It differs from the other premolars in the presence of a distinct metaconid well attached to the protolophid. The metaconid is, however, not greatly expanded anteroposteriorly and does not close off the anterior or posterior valley as it does in *Dromomeryx*. All the lower molars have the *Paleomeryx* fold, a protostylid and an anterior cingulum. External ribs are present on the ectolophs. The enamel of the molars is crenulated.

The upper premolars are all three rooted. The ectoloph of each premolar includes a low parastyle, a strong external rib and a high metastyle. The paracone is the highest cusp. The protocone is prominent and is connected to the parastyle anteriorly and the metastyle posteriorly by narrow lophids. Accessory lophids occur posterior to the protocone and on some specimens form enclosed fossettids against the posterior lophid. Cingula are absent or only very poorly developed. The premolars become proportionately broader transversely from P^2 - P^4 . The molars increase in size from M^1 - M^3 . The ectoloph includes parastyle, external ribs, mesostyle, and metastyle. An anterior cingula occurs on all the molars. Each molar displays a protostylid. The protoloph connects to the ectoloph at the parastyle. The metaloph does not reach the ectoloph. Small crochets are present but are not as well developed as those of *Dromomeryx borealis*.

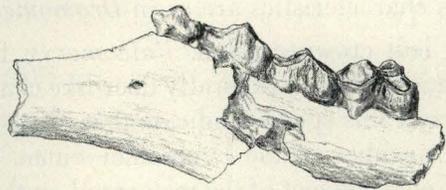
The astragalus is the size of *Dama (columbiana)*. The ginglymi are more nearly the same



A



B



C



D



E

Figure 32. *Rakomeryx cf. americanus*, Red Basin, **A** left P_2 - M_1 UO22147 medial view, **B** dorsal view, **C** lateral view, **D** P^4 - M^3 UO 22089 occlusal view, **E** P^{2-3} UO22089 occlusal view, all x 0.75.

TABLE 18
ANTERIOR POSTERIOR AND TRANSVERSE DIAMETERS OF THE DENTITION
OF *Rakomeryx americanus*

	P ₂		P ₃		P ₄		M ₁		P ₂₋₄		M ₃	
UO22146	9.8	4.3	12.4	6.3	13.0	7.8			34.7			
UO22147	8.8	4.8	12.9	6.4	13.2	7.9	12.5	9.8	34.9			
UO22141											24.7	11.4
	P ²		P ³		P ⁴		M ¹		M ²		M ³	
UO22089	11.9	9.1	12.4	10.7	10.a	15.0	13a	17.0a	15a	18.2	16.4	18a

diameter as in *Dama* than in *Dromomeryx borealis*. The borders of the navicular-cuboid groove are similar to those of *Dama*. The calcaneum is very close to *Dama* in size and most other characteristics. The fibular facet is distally rounded as in *Cervus* whereas in *Dama* it ends abruptly. The mesocuneiform is the size of that of *Dama* but with the lateral articulation seen in *Dromomeryx borealis*. The unciform is the size of that of *Dama* (Columbia Mule Deer) but its characteristics are as in *Dromomeryx*.

The low crowned teeth, *Paleomeryx* fold, cingula, stylids and generally deer-like characteristics of this species indicate that it is probably a member of the Dromomerycinae. The lack of enlargement of the metaconid on the P₄ thus retaining the premolar aspect of that tooth suggests that this species belongs in the genus *Rakomeryx*. Horn cores are not present in the available material so that assignment cannot be based on them. This species is much smaller than *Dromomeryx* from the same site and differs in not only size but in molarization of the P₄ and complexity of the upper dentition. Frick (1937) has assigned the name *Rakomeryx gazini* to specimens reported by Gazin (1932). The type and referred specimens are from Red Basin and represent the larger of the two dromomerycines described here. The assignment of the species *R. gazini* to *Dromomeryx gazini* is discussed under the description of that material. The small species discussed here cannot be assigned to *R. gazini*.

The species described here is much larger than *Blastomeryx mollis* from Virgin Valley Nevada. Specimens of the Skull Spring fauna

assigned to *Blastomeryx?* sp. by Gazin (1932), a D P₄ and an upper molar, are larger than *Blastomeryx mollis* and apparently represent the small dromomerycine described here. The lack of molarization of the P₄ in this species is similar to both *Blastomeryx* and *Rakomeryx*. The size is close to that of *Rakomeryx raki*. The lophs of the upper premolars are complete and attached to the ectoloph in the Red Basin species whereas they are interrupted in *R. raki* as illustrated (Frick 1937). The metaconid of the P₄ of *R. raki* is more antero-posteriorly elongate than in the new species. Although the several dentitions illustrated of *R. raki* indicate variation in this characteristic. *Dromomeryx? americanus* as illustrated by Douglas (1909) is very close to this new material and close to it in size. Frick 1937 assigned *D? americanus* to *?Bouomeryx*. The specimens described by Douglas and the new material appear close. I am assigning them here to *Rakomeryx americanus* (Douglas).

SUPERFAMILY BOVOIDEA
FAMILY ANTILOCAPRIDAE

MERYCODUS sp.

(Fig. 33 A, B)

Red Basin localities 2495 and 2497 have produced incomplete upper and lower dentitions, isolated teeth and fragments of skeletal elements of *Merycodus*. No horn core specimens were recovered. An upper dentition, UO 22215, from locality 2497 and a partial lower dentition, UO22150, from the same locality best illustrate the characteristics of this form. The lower second and third molars have ac-

cessory pillarlike cusps between the crescents of the teeth. In the upper dentition P^2 - P^4 are three rooted. On the molars a small accessory fossette occurs at the head of the intercrestic valley.

MERYCODUS cf. *NEVADENSUS*

(Fig. 33 C-F)

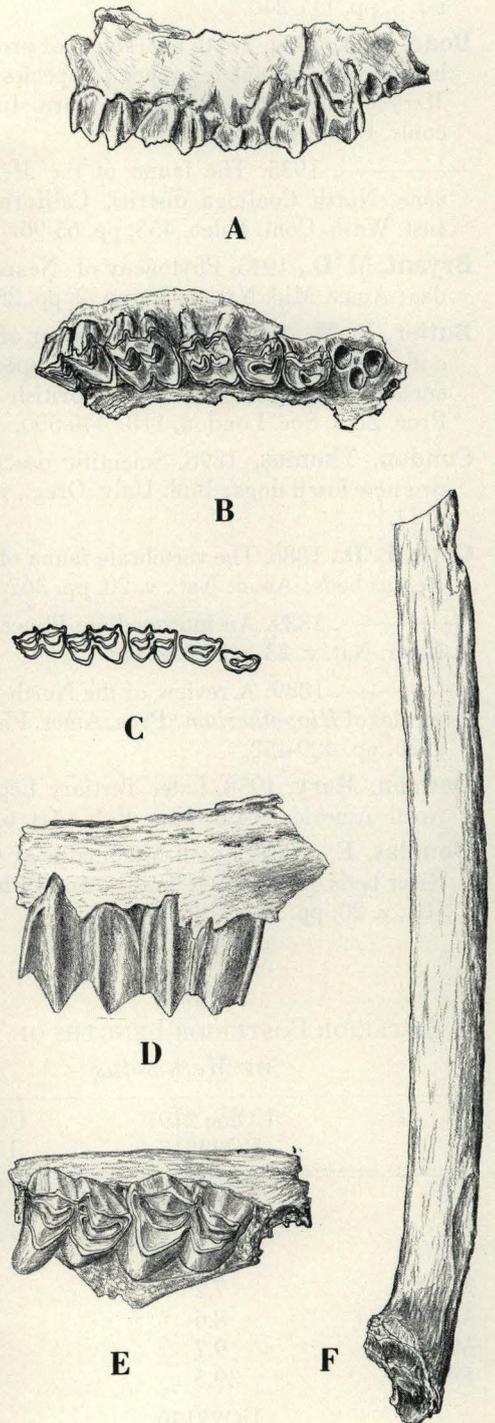
A small species of *Merycodus* is represented at locality 2465, Quartz Basin, by a large portion of the upper dentition, probably of a single individual, a partial horn core, and a fragmental metapodial. The lack of lower dental elements makes comparison with other species difficult. The horn core is compressed on its medial side so that the cross-sectional outline is roughly triangular. No evidence of a burr is present. The horn core fragment is unbranched and is 105 mm long above the base. A small fragment present in the collection indicates that the horn core of this species is branched but the tines are very short.

In the upper dentition the premolars are three-rooted. An intercrestic accessory fossette occurs at the head of the valley in the M^1 . On all of the upper molars there occurs an accessory fossette at the anterior end of the posterior fossette just inside the mesostyle. The Quartz Basin species is apparently smaller than the Red Basin material. In size and comparable characteristics the Quartz Basin species is similar to *M. nevadensis*.

?*MERYCODUS* sp.

An ectoloph fragment of a *Merycodus*-like upper molar present in the collection from UOloc 2465, Quartz Basin, represents a much larger species than *M. nevadensis*. Converging styles on a high crowned tooth suggest a species of merycodont.

Figure 33. **A** *Merycodus* sp. Red Basin, right P^3 - M^3 lateral view x 1, **B** occlusal view, **C** *Merycodus* cf. *nevadensis* Quartz Basin, left P^3 - M^3 UO19757 occlusal view, **D** right M^1 - 2 UO19757 lateral view x 2, **E** ventral view x 2, **F** horn core UO 19744 x 1.



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TABLE 19

ANTERIOR POSTERIOR LENGTHS OF TEETH
OF *Merycodus*

	UOloc 2497 UO22215	UOloc 2465 UO19757
P ²	4.8
P ³	6.4	5.1
P ⁴	5.7	4.5
M ¹	7.2	6.2
M ²	8.6	7.5
M ³	9.7	7.8
P ³ -M ³	39.5	31.4
	UO22150	
M ₁	7.8	
M ₂	13.4	

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