THE MAMMALS OF THE WOLF RANCH LOCAL FAUNA
ST. DAVID FORMATION, COCHISE COUNTY, ARIZONA

by

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ABSTRACT

The Wolf Ranch local fauna is collected from the St. David Formation of the San Pedro Valley of Arizona. The Oro Verde arroyo, site of the fauna, is cut through a series of coarse to medium grained sandstones with some minor clay and marl units. The two fossiliferous units, IV and V, are a fine grained yellowish siltstone and a slightly silty, gray green clay.

The mammals of the fauna consist of one chiropteran, two leporids, eleven rodents, one gomphothere, two equids, and one camel. The rodents are the most abundant as well as the most diverse elements in the fauna.

The age of the fauna is Late Blancan Land Mammal Age. It is intermediate between the Benson fauna (Early Blancan) and the Curtis Ranch fauna (Irvingtonian).

INTRODUCTION

The Wolf Ranch local fauna is one of several Late Cenozoic faunas from the San Pedro Valley of Arizona. These faunas range in age from Hemphillian through Rancholabrean (Table 1), an interval of some 4.6 million years (Damon, 1969). Both the Pliocene-Pleistocene and the Matuyama-Gauss paleomagnetic boundaries are recorded in the St. David Formation of the San Pedro Valley. A thorough study of the fossil localities in the San Pedro Valley in regard to paleobiology, stratigraphy, and paleomagnetism would be of significant value in the reconstruction of the environment and ecology of this area throughout the last four to five million years.

Several of the Late Cenozoic faunas in southeastern Arizona have already been studied. Gidley (1922a) described the Benson and Curtis Ranch faunas. Gazin revised Gidley's work in 1942. The 111 Ranch fauna was described by Wood in 1962. The Wolf Ranch fauna has never been described, although certain taxa of the fauna were known from collections made as early as 1965.

This thesis is concerned primarily with the mammals of the Wolf Ranch local fauna. Twenty-three mammalian taxa are included in the Wolf Ranch local fauna. No attempt is made herein to identify the non-mammalian fossil material. In addition to the systematics, the paleoecologic and temporal aspects of the fauna are discussed and the Wolf Ranch fauna is compared to neighboring Late Cenozoic faunas.

Table 1. Selected Fossil Vertebrate Localities in Southern Arizona

Site	Locality	Age
Lehner Ranch	UA 14	Rancholabrean
Murray Springs Arroyo	UA 7101	Rancholabrean
Curtis Ranch	UA 25	Irvingtonian
111 Ranch	UA 15	Blancan
California Wash	UA 47-10	Blancan
Wolf Ranch	UA 64	Blancan
Post Ranch	UA 47	Blancan
Mendivil Ranch	UA 12	Blancan
Small House	UA 29	Hemphillian
Camel Canyon	UA 19	Hemphillian

PREVIOUS WORK AND METHODS

The location of the Wolf Ranch local fauna has been known since the early 1960's. Some of the earliest collecting was done by Robert Gray in preparation for his dissertation. George Lammers, Diane Wright, and various members of the University of Arizona Laboratory of Paleontology have also collected there. All the vertebrate specimens of the Wolf Ranch local fauna are curated in the Laboratory of Paleontology of the University of Arizona.

Fossil remains of the larger genera in the Wolf Ranch fauna are sparse and scattered. About ninety-five percent of the collection consists of the teeth of small mammals. These were collected by washing approximately 300 lbs of matrix from the fossiliferous units through fine (24 mesh) and coarse (16 mesh) screens. After drying, the resulting concentrate was examined for fossils. The arroyo and the fossil localities were mapped on a fifty foot grid that extends from Arizona Highway 90 to the north side of the arroyo (Fig.5). The terminal quarter of the arroyo is not included on the map.

List of Symbols

$\overline{X}$	mean
N	number
O.R.	observed range
*	broken
UA	University of Arizona Laboratory of Paleontology
UK	University of Kansas Museum of Paleontology
USNM	United States National Museum
UM	University of Michigan Museum of Paleontology
LACM-CIT	Los Angeles County Museum- California Institute of Technology
mm	All measurements are given in millimeters.

LOCATION AND DESCRIPTION OF THE STUDY AREA

The Wolf Ranch local fauna is located in the Oro Verde arroyo in the southwestern quarter of Cochise County, Arizona (Fig.1) in the approximate center of section 6, T22S, R22E, on the U.S.G.S. Tombstone 15 minute Quadrangle (1952). The arroyo trends roughly east-west, parallel to Arizona Highway 90 and terminates approximately one quarter of a mile west of the San Pedro River (Figs.2,3, and 4). The fauna was collected from the St. David Formation, established by Gray in 1965.

The sediments exposed along the walls of the arroyo represent a more or less continuous depositional sequence. Eight stratigraphic units can be recognized within the arroyo, of which only two, Units IV and V, are fossiliferous (Fig.6). Unit IV, a fine grained, yellowish siltstone, is slightly richer in fossil content. Unit V is a light olive gray, silty clay.

Matrix was taken from a total of nine sites along the arroyo. The metapodial of a camel, in addition to a few other elements of large mammals, was recovered from Unit V where the unit is exposed in the roadcut along Arizona Highway 90. Sites 64-8, 64-7, 64-4, 64-273, and 64-274 were the most productive. The Wolf Ranch fossil sites are listed in Figure 6. Their exact positions are indicated on the map in Figure 5.

Figure 1. Geographic Location of Wolf Ranch

Figure 2. Aerial Photo I
Oro Verde Arroyo

Figure 3. Aerial Photo II
Oro Verde Arroyo

Figure 4. Aerial Photo III
Oro Verde Arroyo

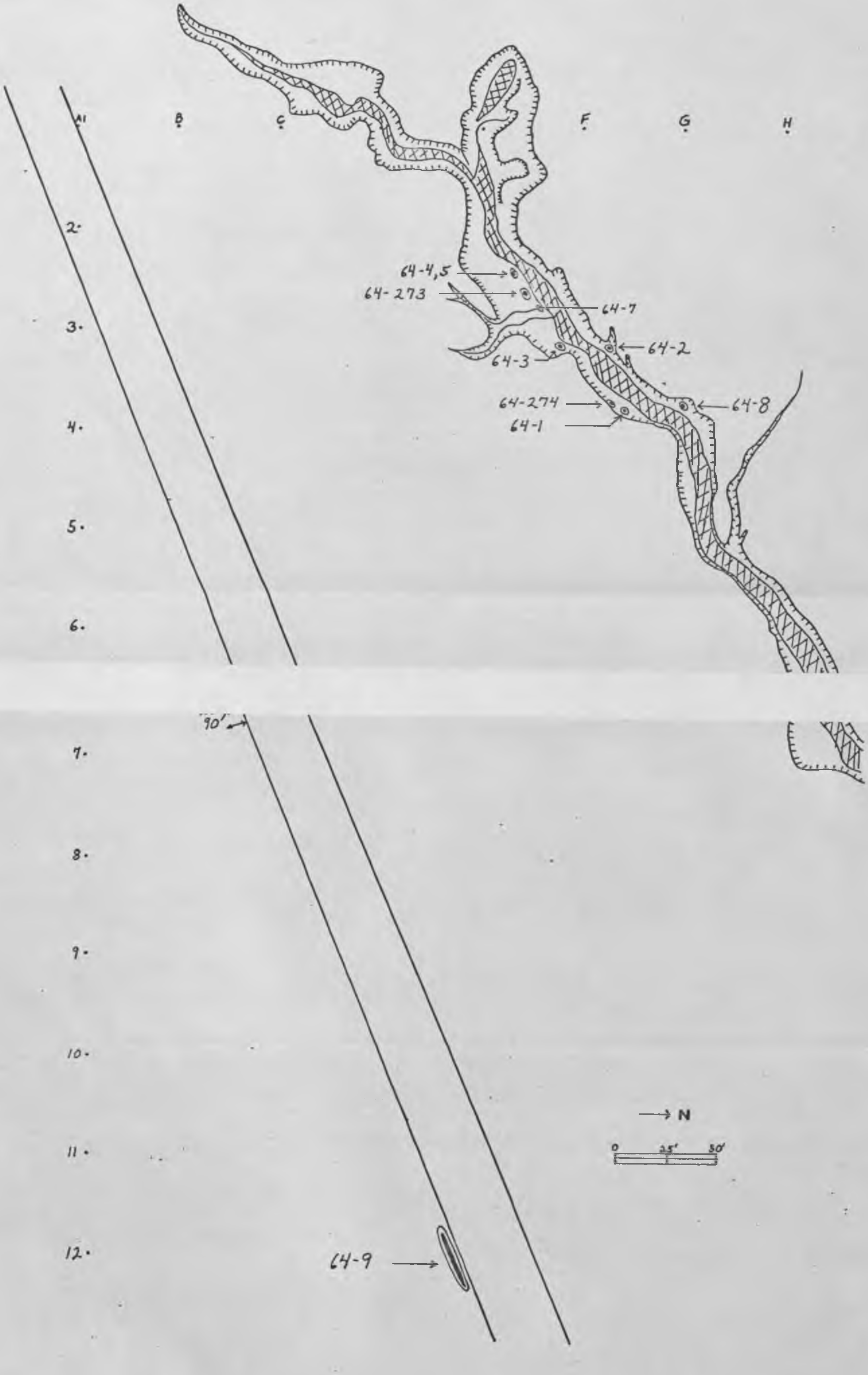


Figure 5. Oro Verde Arroyo and Fossil Localities

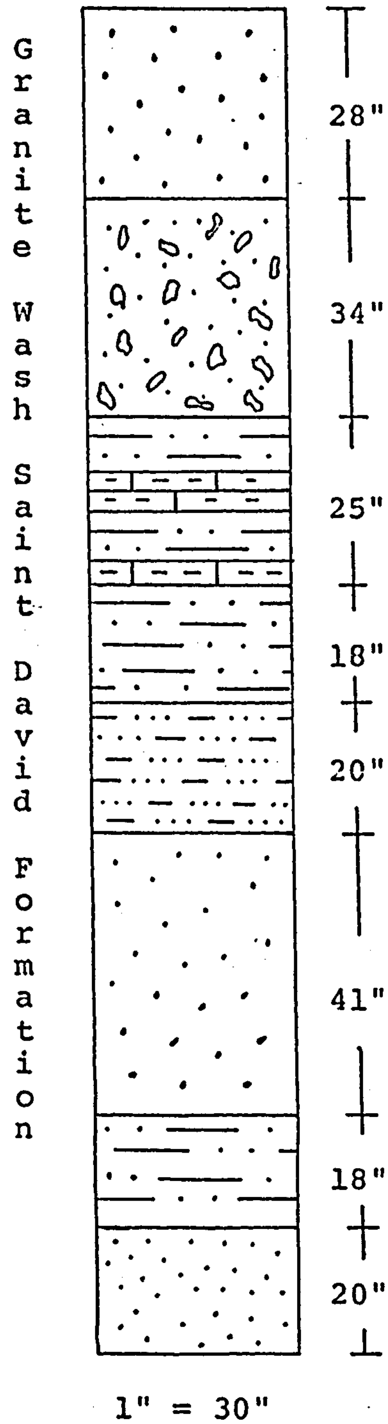
STRATIGRAPHY OF THE ORO VERDE ARROYO

The Wolf Ranch fauna was collected from the St. David Formation established by Gray in 1965. He interpreted these San Pedro Valley deposits as a continuous succession of fluvial and lacustrine sediments in which silts, clays, fine sands, and fresh water limestones predominate. The St. David Fm. also includes some minor pyroclastic units.

The sediments exposed in the walls of the Oro Verde arroyo consist primarily of sandstones with some minor clay and marl units. The attitude of the beds is approximately horizontal. The stratigraphic section illustrated in Figure 6 is a composite of two sections of the arroyo. West of Row 1 (Fig.5), Units I through V are not exposed above the present floor of the arroyo. East of Row 5, Units V through VIII have been removed by erosion. Consequently, in order to obtain a complete stratigraphic section of the arroyo, it was necessary to describe the upper half of the section from the vicinity of Row 1 and the lower half from the vicinity of Row 4. The column does not include all of the sediments exposed along the terminal portion of the arroyo. Unit I constitutes the present floor of the arroyo at point G5 on the map and Unit VII is the uppermost layer at the extreme head of the arroyo.

Units I through VI are included in the St. David Formation. These units are 11' 10" thick. Units I and III are fairly coarse sandstones. The degree of cementation varies considerably throughout these units. Units IV and V, a siltstone and a clay, are fossiliferous. Unit II, also a clay, is barren. Units VII and VIII are included in the Granite Wash of Gray (1965). These two units, 5' 2" thick, are coarse sandstones with a high gravel content.

Thickness of most of the units is fairly consistent. A notable exception to this is Unit VI. This marl reaches a maximum thickness of 2' 1" in the area of Rows 1 and 2. It becomes progressively thinner towards the arroyo terminus until at Row 4, it is less than 4" thick. The amount of clay with which it is interbedded also decreases.



Unit VIII. Sandstone. Pale grayish brown; coarse grained; unconsolidated; friable; poorly sorted; 10% gravel with maximum size of 1 1/4".

Unit VII. Sandstone. Conglomeritic; pale grayish brown; medium grained; unconsolidated; slighter harder than Unit VIII; poorly sorted; 50% gravel with maximum size of 3 1/2".

Unit VI. Marl. White; partially indurated;interbedded with a silty, brownish gray, poorly consolidated clay.

Unit V. Clay. Light olive gray; slightly silty; fossiliferous; fossil sites: 64-1, -2, -5, -9, -273, -274.

Unit IV. Siltstone. Yellowish gray; contains abundant oxidized "ghosts" of plant material; fossiliferous; fossil sites: 64-3, -4, -7, -8.

Unit III. Sandstone. Brownish gray; medium to coarse grained; cementation varies throughout the unit; upper 35% is better cemented than middle portion; lower 25% well cemented and forms a relatively continuous resistant ledge.

Unit II. Clay. Pale grayish brown; sandy.

Unit I. Sandstone. Pale grayish brown; grain size varies from medium in upper half to coarse in lower half; 70% gravel in bottom third which is very hard and forms step in arroyo floor.

Figure 6. Stratigraphy of the Oro Verde Arroyo

FAUNAL LIST

Class: Mammalia

Infraclass: Eutheria

Order: Chiroptera

Family: Vespertilionidae

Simonycteris stocki

Order: Lagomorphora

Family: Leporidae

Notolagus cf. *lepusculus*

Nekrolagus progressus

Order: Rodentia

Family: Sciuridae

Spermophilus bensoni

Family: Geomyidae

Geomys (*Nertergeomys*)? *persimilus*

Family: Heteromyidae

Perognathus gidleyi

Perognathus rexroadensis

Prodipodomys idahoensis

Prodipodomys kansensis

Family: Cricetidae

Peromyscus sp.

Baiomys brachygnathus

Family: Cricetidae (continued)

Baiomys minimus

Onychomys bensoni

Sigmodon bi-medius-minor

Sigmodon curtisi

Neotoma (Hodomys) olseni

Family: Erethizontidae

Coendou stirtoni

Order: Proboscidea

Family: Gomphotheriidae

?*Stegomastodon*

Order: Perissodactyla

Family: Equidae

Nannippus phlegon

Equus (Plesippus) sp.

Order: Artiodactyla

Family: Camelidae

cf. *Camelops*

SYSTEMATIC DESCRIPTION OF THE FAUNA

Class: Mammalia

Order: Chiroptera

Family: Vespertilionidae

Simonycteris stocki Stirton, 1931

Simonycteris stocki. Stirton, R.A. 1931. Univ. Calif. Dept. Geol. Pub. V.20, p.27.

Type. LACM-CIT 394, partial palate and rostrum bearing P^{4}, M^{1-2}, and alveoli of I^{2-3}, C, and M^{3}. LACM-CIT locality 110 (UA 25-1), Curtis Ranch fauna, St. David Formation, Cochise County, Arizona.

Material. UA 4928 M^{2}.

Diagnosis. "Dental formula I^{2} C^{1} P^{1} M^{3}; well developed incisors, I^{2} being larger than I^{3}; canine well developed; posterior inner heel of the P^{4} rounded; tri-tubercular and dilambdodont; M^{3} reduced (Stirton, 1931)."

Description of Wolf Ranch material. M^{2} W-shaped pattern on ectoloph is distinct; cingulum extends lingually from the anterior end of the ectoloph around the protocone to the posterior end of the ectoloph; cingulum most pronounced on the posterior lingual corner of the tooth; no indication of a cingulum at the base of the ectoloph; metastyle broken; metacone larger and higher than paracone; small, hooked parastyle on the anterior end of ectoloph; hypocone incipient; internal basin deep.

Discussion. The only specimen is a left M^2. A left M_1, UA 3232, has been reported from UA locality 52, McRae Wash (Lammers, 1970). The Wolf Ranch specimen was compared to all of the chiropterans of comparable size in the University of Arizona Mammalogy Collection. It compares closely with *Eptesicus* but more closely with *Lasiurus*. The similarity is even greater between the Wolf Ranch specimen and illustrations of the type of *Simonycteris stocki*.

The dimensions of the Wolf Ranch specimen are slightly greater than that of the type of *S. stocki*. Measurements were extrapolated from a scale drawing of *S. stocki* (length 1.3, width 2.3). Stirton (1931) indicates a close relationship between *Simonycteris* and the recent genus *Eptesicus*. He does not include *Lasiurus* in his comparisons with recent genera.

Table 2. Measurements of *Simonycteris stocki*

UA 4928 M^2	
Length at base of paracone and metacone	1.6
Width from mesostyle to base of protocone	2.55

Order: Lagomorpha

Family: Leporidae

Notolagus cf. lepusculus (Hibbard, 1939a)

Dicea lepuscula Hibbard, C.W. 1939a Am. Mid. Naturalist V. 21, No.2, p.509.

Notolagus lepusculus Hibbard, C.W. and E.S.Riggs. 1949. Geol. Soc. Am. Bull. V.60, p.841.

Type. UK 4583, fragment of right dentary bearing complete dentition. Locality 3, Rexroad fauna, Meade County, Kansas.

Material. UA 4913 M^{2}, UA 4914 P_{4}-M_{2}.

Diagnosis. "A small rabbit about the size of Hypo lagus ?apachensis Gazin. The external reentrant angles of the P_{4}-M_{2} extend completely across the crowns of the teeth and are filled with cement. The enamel borders are not crenulated (Hibbard, 1939a)."

Description of Wolf Ranch Material. P_{4} M_{1} M_{2}. The premolar is molariform; all teeth high crowned; anterior and posterior columns offset about one fifth of the width of the crown; narrow external reentrant angle; unstepped posterior border on the external reentrant angle; pronounced angular bend in the anterior border on the external reentrant angle; relatively quadrate occlusal outline.

Discussion. The Wolf Ranch leporid resembles to some degree Hypolagus arizonensis (Downey, 1962) in size, lack of crenulation, and angularity of the anterior border of the lower reentrant angle. H. arizonensis differs, however, in the greater width of the reentrant angle, greater length, and a less quadrate occlusal outline. Notolagus velox and the larger species of Hypolagus such as H. regalis and H. vetus are much larger than N. lepusculus. Aluralagus (Downey, 1968) differs in the presence of crenulation on the hypostria of the lower cheek teeth. N. lepusculus is smaller than Nekrolagus progressus.

Almost all fossil leporids have been described on the basis of characters exhibited by the $P_{\overline{3}}$ and/or the $P^{\underline{2}}$. Unfortunately, none of the essential premolars were collected from Wolf Ranch, and without these teeth, identification is rather tenuous.

All of the specimens of Notolagus cf. lepusculus were collected from Unit IV, the yellowish gray siltstone.

Table 3. Measurements of Notolagus cf. lepusculus

UA 4914	Length	Width
$P_{\overline{4}}$	1.9	2.2
$M_{\overline{1}}$	1.9	2.1
$M_{\overline{2}}$	1.85	1.95

Nekrolagus progressus (Hibbard, 1939a)

Pediolagus progressus Hibbard, C.W. 1939a. Am. Mid.Naturalist V.21, No. 2, p. 512

Nekrolagus progressus Hibbard, C.W. 1939a Am. Mid Naturalist V. 21, No. 3.

Type. UK 4570, incomplete right dentary with broken incisor, $P_{\overline{3}}$-$M_{\overline{1}}$. Locality 3, Rexroad fauna, Meade County, Kansas.

Material. 1 $P_{\overline{3}}$, 3 $P^{\underline{4}}$, 4 $M^{\underline{1}}$, 2 $M^{\underline{2}}$, 1 $M_{\overline{3}}$. See Appendix A.

Diagnosis. "The anterior external reentrant angle of the fourth lower premolar is wide, enamel slightly wavy. The posterior external reentrant angle is narrow and extends slightly over halfway across the tooth. Between the reentrant angle and the lingual side of the tooth is a well developed enamel island filled with cement. The enamel of the anterior border of the island is heavier than that of the posterior border (Hibbard, 1939a)."

Description of Wolf Ranch material. $P_{\overline{3}}$. The posterior external reentrant angle extends halfway across the surface of the tooth; enamel borders are wavy, but not markedly crenulated; an extremely narrow isthmus separates the posterior external reentrant angle from a well developed enamel island; anterior border of the island crenulated, posterior border smooth; enamel of anterior borders of both the island and the posterior external reentrant angle heavier than that of the posterior borders; incipient reentrant angle on the anterior face $P_{\overline{3}}$; anterior reentrant continues to the base of the tooth and becomes more pronounced with wear.

The enamel of the hypostria of the $M^{\underline{1}}$ and $M^{\underline{2}}$ is crenulated; $M_{\overline{3}}$ consists of two subequal columns, the posterior column about 2/3 the width of the anterior; no enamel connection between the columns of the $M_{\overline{3}}$.

Discussion. The anterior reentrant angle is in most instances well developed as stated by Hibbard in his original description. However, Hibbard (1963) later stated that the angle is completely absent in some specimens that he referred to this species. He did not figure or clearly mention specimens with the angle reduced as in the Wolf Ranch specimen. Hibbard (1939a) also described the posterior border of the posterior external reentrant angle as "decidely crenulated." Subsequent fossil evidence has illustrated the considerable variation in degree of crenulation in this and other areas of the tooth (Hibbard, 1944).

The incipient anterior reentrant on the $P_{\overline{3}}$ and the lack of complexity in the enamel borders may be interpreted as primitive characters warranting the erection of a new species. The species would be based, however, on only one $P_{\overline{3}}$ and consequently, should await the recovery of additional material, particularly $P_{\overline{3}}$'s.

Dawson (1958) places Nekrolagus progressus within the genus Pratilepus on the basis of the well developed enamel island. *N. progressus* has several features in common with *Pratilepus kansensis* and with *Aluralagus* (Downey, 1968) such as the anterior external reentrant angle and the development of an enamel island from an internal reentrant angle. In the absence of more consistent differences, the occurrence of an anterior reentrant angle on the $P_{\overline{3}}$ is the most valid criterion for the separation of *Nekrolagus* and *Pratilepus*. *Nekrolagus progressus* is equally represented in Units IV and V.

Table 4. Measurements of *Nekrolagus progressus*

	Length			Width		
	N	O.R.	$\overline{X}$	N	O.R.	$\overline{X}$
$P_{\overline{3}}$	1	3.1		1	2.9	
$P^{\underline{4}}$	3	2.2 - 2.3	2.23	3	3.6 - 4.0	3.38
$M^{\underline{1}}$	4	1.8 - 2.0	1.92	4	3.2 - 3.6	3.47
$M^{\underline{2}}$	3	1.2 - 1.8	1.43	3	3.0 - 3.3	3.18
$M_{\overline{3}}$	1	1.9		1	1.8	

Order: Rodentia

Family: Sciuridae

Spermophilus bensoni (Gidley, 1922a)

Citellus bensoni Gidley, J.W. 1922a. U.S.G.S. Prof. Paper 131-E, p.122.

Type. USNM 10531, first or second right upper molar and last left upper molar. Benson locality, St. David Formation, Cochise County, Arizona.

Material. UA 4805 $M^{\underline{1}}$, UA 4800 $M^{\underline{1}}$, UA 4807 $M_{\overline{1}}$, UA 4802 $M_{\overline{2}}$, UA 4803 $M_{\overline{3}}$.

Diagnosis. Cheek tooth series 10.3 mm; three transverse lophs about equal in length; posterior loph broken up into two distinct but slightly joined cuspules inner cuspule rounded cone disconnected from protocone; close to *S. beecheyi* (Gidley, 1922a).

Description of Wolf Ranch material. $M^{\underline{1}}$. Protoloph is connected to protocone; metaconule distinct and separated from protocone; anterior cingulum depressed and connects with protocone more lingually than posterior lophs; distinct posterior cingulum; small parastyle; deep central valley.

$M_{\overline{1}}$. Smaller than $M_{\overline{2}}$; metaconid large and stands higher than protoconid; talonid basin moderately deep; incipient mesostylid; small entoconid; trigonid basin deep.

$M_{\overline{2}}$. Metaconid is more prominent, posterior cingulum more curved than on $M_{\overline{1}}$; talonid basin slightly deeper and protoconid-hypoconid groove deeper than on $M_{\overline{1}}$; mesostylid large.

$M_{\overline{3}}$. Longer than $M_{\overline{1,2}}$; posterior cingulum extremely curved; mesostylid and entoconid subequal; talonid basin shallow; metaconid very high.

Discussion. The generic name, Citellus, in use when many of the species of fossil squirrels were described, has been divided into two genera, Spermophilus and Ammospermophilus. All of the species within the genus Citellus, with the exception of the antelope ground squirrel, Ammospermophilus, were transferred to Spermophilus. Gidley's species bensoni is included in Spermophilus in this paper.

Spermophilus bensoni is about the size of the recent species S. beecheyi. It is distinguished from S. cochisei of the Curtis Ranch fauna by its slightly smaller size and the lack of connection between metaloph and protocone. S. bensoni is equally abundant in Units IV and V.

Table 5. Measurements of Spermophilus bensoni

	Length	Width
UA 4805 M^1	2.1	*
UA 4807 M_1	2.0	2.1
UA 4800 M_1	1.8	1.9
UA 4802 M_2	2.0	2.4
UA 4803 M_3	2.4	2.3

Family: Geomyidae

Geomys (Nerterogeomys) persimilus

Geomys paridens Gidley, J.W. 1927a U.S.G.S. Prof. paper 131-E, p.172.

Geomys persimilus Hay, O.P. 1927. Carnegie Inst. Wash. Pub. 322B, p.136.

Nertergeomys persimilus Gazin, C.L. 1942. Proc. U.S. Nat. Mus. V. 92, No. 3155, p.507.

Type. USNM 10493, incomplete skull bearing all teeth except right P^{4} and M^{3}. Curtis Ranch fauna, St. David Formation, Cochise County, Arizona.

Material. 1 I^{1}, 1 P^{4}, 1 P_{4}, 5 M^{x}, 6 M_{x}. See Appendix A.

Diagnosis. P^{4} has enamel across the posterior wall. Anterior columns of P^{4}_{4} are narrow. Upper incisors are bisulcate. Enamel is restricted to the posterior wall in the lower molars (Gazin, 1942).

Description of Wolf Ranch material. I^{1}. Incisor is bisulcate; medial sulcus very shallow and close to the internal border of the tooth; lateral sulcus deeper and bisects the tooth; both sulci extend the entire length of the tooth.

P^{4}. Anterior and posterior lophs are appressed with broad medial union; posterior loph elongated transversely; enamel present on posterior wall; anterior side of protoloph broken; lateral dentine tracts present on metaloph not converging at apex.

M^{1-2}. M^{3} is identifiable on basis of size and curvature and none were present in the sample; upper molars convex anteroposteriorly; enamel present on anterior and posterior walls; lateral dentine tracts present.

$P_{\overline{4}}$. Posterior loph is equal in width to that of the $P\frac{4}{-}$; enamel present on posterior wall; anterior loph broken, but apparently rounded; lateral dentine tracts present.

$M_{\overline{1-2}}$. $M_{\overline{3}}$ is identifiable on basis of size and curvature and none were present in the sample; lower molars concave labially; enamel absent on anterior wall.

<u>Discussion</u>. <u>Nertergeomys</u> was erected by Gazin in 1942. White and Downs (1961) and Hibbard (1956) feel that, due to the variability of such characters as the presence or absence of enamel on the posterior wall of the $P\frac{4}{-}$ and the position of the mental foramen, <u>Nertergeomys</u> should be reduced to subgeneric level.

<u>Geomys</u> (<u>N</u>.) <u>persimilus</u> differs from <u>Geomys</u> (<u>N</u>.) <u>minor</u> of the Benson fauna in having a smaller and more nearly circular anterior loph on the $P_{\overline{4}}$. Neither Gidley (1922a) nor Gazin (1942) provide adequate measurements of the teeth. Material from the Benson and Curtis Ranch faunas was not available for comparison. However, measurements of the Wolf Ranch $P\frac{4}{4}$ compare favorably with measurements of material from Curtis Ranch assigned by Lammers (1970) to <u>Geomys</u> (<u>N</u>.) <u>persimilus</u>. <u>G</u>. <u>persimilus</u> is represented in both Unit IV and Unit V.

Table 6. Measurements of Geomys (N.) persimilus

	Width
UA 4169 P^4	1.9
UA 4168 P_4	1.9

Family: Heteromyidae

Perognathus rexroadensis Hibbard, 1950

Perognathus rexroadensis Hibbard, C.W. 1950. Contr. Univ. Mich. Mus. Paleo. V.8, No. 6, p.132.

Type. UM 24793, nearly complete left ramus with all cheek teeth. Rexroad fauna, Meade County, Kansas.

Material. UA 4901 P^4, UA 4902 P^4, UA 4899 M_1, UA 4905 M_1, UA 4906 M_1, UA 4903 M_2, UA 4904 M_2.

Diagnosis. A pocket mouse which is larger than P. gidleyi or P. mclaughlini. Only a trace of anterior groove on P_4; lingual groove on P_4 deeper than labial groove (Hibbard, 1950).

Description of Wolf Ranch Material. P^4. Metacone, hypocone, and hypostyle are subequal; labial reentrant valley deeper than lingual valley.

M_1. H-pattern is present; anterior cingulum flexed and strongly united with protostylid; hypostylid distinct and slightly smaller than protostylid.

M_2. Protostylid is reduced; hypostylid much reduced; anterior cingulum rudimentary; occlusal surface wears to H-pattern.

Discussion: *Perognathus rexroadensis* is closer to *P. mclaughlini* than to *P. gidleyi*. In *P. mclaughlini* the labial groove on the $P_{\overline{4}}$ is very shallow and does not separate the lophs, whereas in *P. gidleyi* the lateral grooves on the $P_{\overline{4}}$ are equal in depth. *P. rexroadensis* is much more abundant in Unit V, the clay layer, than in Unit IV.

Table 7. Measurements of *Perognathus rexroadensis*

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
$P^{\underline{4}}$	2	1.1		2	1.2 - 1.3	1.25
$M_{\overline{1}}$	3	1.1		3	1.2 - 1.35	1.28
$M_{\overline{2}}$	2	.8 - .9	.85	2	1.0	

Perognathus gidleyi Hibbard, 1941a

Perognathus gidleyi Hibbard, C.W. 1941a. Am. Mid. Naturalist V.26, No.2, p.350.

Type. UK 4775, partial left ramus bearing all cheek teeth. Locality 3, Rexroad fauna, Meade County, Kansas.

Material. UA 4900 $P^{\underline{4}}$, UA 4907 $P_{\overline{4}}$.

Diagnosis. *Perognathus gidleyi* is a pocket mouse the size of *P. formosus*; $P_{\overline{4}}$ is high crowned with an X-pattern; median molar valleys are deep with a distinctive H-pattern (Hibbard, 1941a).

Description of Wolf Ranch Material. P^{4}. Three roots are distinct; hypostyle slightly anterior to hypocone; protocone vertical; reentrant valleys shallow.

P_{4}. Two roots are distinct; anterior root is concave lingually; protoconid smaller and less robust than protostylid; reentrant valleys equal in depth.

Discussion. *Perognathus gidleyi* is much smaller than *P. rexroadensis*. The metacone on the P^{4} is not so large as in *P. rexroadensis*. The lower molars are shorter lingually in *P. gidleyi*. All of the Wolf Ranch specimens of *P. gidleyi* were collected from Unit V.

Table 8. Measurements of *Perognathus gidleyi*

	Length	Width
UA 4900 P^{4}	.8	.9
UA 4907 P_{4}	.8	.7

Prodipodomys idahoensis Hibbard, 1962

Prodipodomys idahoensis Hibbard, C. W. 1962. Jour. Mammalogy V. 43, No. 4, p. 482.

Type. USNM 22754, portion of the left dentary bearing P_{4}, M_{1}, and alveoli of the $M_{2,3}$. U.S.G.S. Cenozoic locality 20475, Hagerman Formation, Elmore County, Idaho.

Material. 8 P^{4}, 9 P_{4}, 5 M^{1}, 7 M_{1}, 10 M^{2}, 8 M_{2}, 3 M^{3} 4 M_{3}. See Appendix A.

<u>Diagnosis</u>. "A kangaroo rat with rooted premolars and molars which lack dentine tracts along the sides of the teeth. The lower jaw is larger than that of <u>P. kansensis</u> Hibbard. It is the size of <u>P. rexroadensis</u>, but the teeth are more hypsodont and the roots of the teeth are not as well developed (Hibbard, 1962)." Zakrzewski (1969) emended Hibbard's diagnosis to include the presence of dentine tracts along the sides of the teeth.

<u>Description of Wolf Ranch Material</u>. P^4. Lingual groove is deeper than labial groove and continues to the base of the crown; labial groove reduced with moderate wear; roots distinct; dentine tracts present; length at base of crown much greater than at top due to slope of protocone; P^4 and M^1 subequal.

M^1. Protoloph and metaloph unite lingually in early wear to form a U-shaped occlusal surface; protoloph slightly wider than metaloph; dentine tracts present; roots broken, but apparently more fused than in P^4.

M^2. Shorter and narrower than M^1; lophs unite lingually in early wear; protoloph wider than metaloph; dentine tracts present; roots almost completely fused.

M^3. Shorter and narrower than M^2; metaloph very much reduced; dentine tracts present; roots broken.

P_4. X-pattern is present; lingual reentrant groove deeper than labial groove and extends to base of crown; labial groove shallow and extends 3/4 of distance to base of crown; roots distinct; dentine tracts present; metalophid straight and slightly wider than protolophid; prostylid larger than protoconid; small cuspule present on protolophid midway between protoconid and protostylid.

$M_{\overline{1}}$. Wider than $P_{\overline{4}}$; protostylid and metaconid subequal; anterior cingulum flexed posteriorly; metalophid wider than hypolophid; lophs connect medially; dentine tracts present; roots fused more than in $P_{\overline{4}}$.

$M_{\overline{2}}$. Shorter and narrower than $M_{\overline{1}}$; hypostylid smaller and anterior cingulum not as flexed as in $M_{\overline{1}}$;dentine tracts present; roots more fused than in $M_{\overline{1}}$.

$M_{\overline{3}}$. Shorter and narrower than $M_{\overline{2}}$; hypolophid reduced to a single small cusp barely separated from the posterior side of metalophid; dentine tracts present; roots broken.

Discussion. The sample consists of thirty-six isolated cheek teeth. Relatively few of the specimens retained undamaged roots. The development of dentine tracts is variable, but in most specimens they are distinct. *Prodipodomys idahoensis* is larger and more hypsodont than *P. kansensis*. *P. idahoensis* is well represented in both Unit IV and Unit V.

Table 9. Measurements of Prodipodomys idahoensis

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
P^4	6	1.4 - 1.6	1.49	6	1.7 - 1.8	1.76
P_4	9	1.4 - 1.6	1.47	9	1.4 - 1.6	1.5
M^1	5	1.0 - 1.2	1.1	5	1.7 - 1.8	1.75
M_1	6	1.1 - 1.25	1.18	6	1.7 - 1.8	1.75
M^2	10	.9 - 1.1	.98	10	1.55 -1.7	1.59
M_2	8	.9 - 1.5	.93	8	1.5 - 1.6	1.55
M^3	3	.7 - .8	.77	3	.9 - 1.0	.97
M_3	4	.8		4	1.2 - 1.3	1.25

Prodipodomys kansensis (Hibbard, 1939b)

Dipodomys kansensis Hibbard, C.W. 1937. Am. Mid. Naturalist V. 18, No. 3, p. 462.

Prodipodomys kansensis Hibbard, C.W. 1939b. Trans Kans. Acad. Sci. V. 42, p.458.

Type. UK 3945, incomplete left dentary bearing I_1, P_4, and alveoli of M_{1-3}. Edson Quarry fauna, Ogalala Formation, Sherman County, Kansas.

Material. 5 P^4, 4 P_4, 2 M_1, 4 M^2, 1 M_2. See Appendix A.

Diagnosis. P_4 high crowned with two roots and X-pattern; smaller than M_1, and as large as M_2 or larger; M_1 and M_2 subequal; M_3 greatly reduced; M_1 with two well developed roots; $M_{2,3}$ single rooted (Hibbard, 1939b).

<u>Description of Wolf Ranch Material</u>. P^{4}. Lingual groove is deeper than labial groove and extends almost to base of crown; hypocone larger than protocone; protocone closely appressed to metaloph; posterior cingulum curves anteriorly; dentine tracts present; roots broken.

M^{2}. Lophs unite lingually in early wear to form U-pattern; protoloph is slightly wider and more curved than metaloph; dentine tracts present; roots broken, but apparently fusing.

P_{4}. Metalophid is slightly curved and wider than protolophid; protolophid bilobate; no evidence of a third cusp between protoconid and protostylid; metaconid and hypoconid subequal; dentine tracts present; roots broken.

M_{1}. Wider than P_{4}; hypostylid and entoconid subequal; anterior cingulum flexed posteriorly; lophs connect medially; dentine tracts present.

M_{2}. Shorter and narrower than M_{1}; hypostylid smaller than in M_{1}; dentine tracts present.

<u>Discussion</u>. The sample consists of sixteen isolated cheek teeth. The number and condition of the roots of $P\frac{4}{4}$, M_{1}, and M_{2} are uncertain because none of the specimens retained sufficient vestiges. The anterior-posterior dimension of the fourth premolar is much less than in other species, especially <u>P. idahoensis</u>, due to the slight slope of the anterior lophs. The dimensions

of the teeth indicate a size about equal to that of D. merriami. Dentine tracts are present along the sides of the teeth. Hibbard (1937, 1939b) does not recognize dentine tracts in the type specimen.

Prodipodomys kansensis differs from P. minor (Gidley) in being less hypsodont and from P. mascallensis Downs in the lack of a posterior groove on the $P_{\overline{4}}$. Prodipodomys kansensis is not so large and high crowned as P. idahoensis. Prodipodomys kansensis is represented at Wolf Ranch in both Units IV and V.

Table 10. Measurements of Prodipodomys kansensis

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
$P^{\underline{4}}$	4	1.1 - 1.4	1.25	4	1.5 - 1.6	1.57
$M^{\underline{2}}$	4	.8 - .9	.86	4	1.4 - 1.5	1.44
$P_{\overline{4}}$	4	1.1 - 1.3	1.2	4	1.3 - 1.4	1.32
$M_{\overline{1}}$	2	1.1		2	1.6	
$M_{\overline{2}}$	1	.9		1	1.4	

Family: Cricetidae

Peromyscus sp.

The sample consists of two left $M_{\overline{1}}$'s. The teeth are extremely corroded on all surfaces, probably as a result of having passed through the digestive tract of a predator. Both have well developed roots and appear relatively low crowned. Accurate measurements are not possible. The teeth are, however, larger than either Bensonomys or

Onychomys from the Wolf Ranch fauna, but smaller than *Sigmodon*.

Baiomys brachygnathus (Gidley, 1922a)

Peromyscus brachygnathus Gidley, J. W. 1922a. U.S.G.S. Prof. Paper 131-E, p.124

Baiomys brachygnathus Hibbard, C. W. 1941. Am. Mid. Naturalist V. 26, No. 2, p. 352.

Type. USNM 10501, greater proportion of the right dentary bearing complete dentition. Curtis Ranch fauna, St. David formation, Cochise County, Arizona.

Material. 5 M^1, 16 M_1, 3 M_2. See Appendix A.

Diagnosis. Length of cheek-tooth series 2.8 mm; about the size of *B. taylori*; jaw relatively short anterior to cheek teeth; last molar very much reduced (Gidley, 1922a).

Description of Wolf Ranch Material. M^1. Tooth narrows anteriorly; anterocone bilobed in 30% of sample; metacone and hypocone subequal; labial reentrant valleys more open than lingual reentrant valleys.

M^2. Shorter and slightly narrower than M^1; protocone smaller than paracone; metacone and hypocone subequal.

M_1. Shorter and narrower than M^1; shallow groove in anteroconid in 29% of sample; anteroconid narrow; posterior cingulum extends to lingual edge of crown.

M_2. About equal in size to the M^2; shorter than the M_1 but about the same width; anterior cingulum extends to labial edge of crown; metaconid transversely elongated.

Discussion. Excluding size, Gidley (1922a) lists as the primary difference between B. brachygnathus and B. minimus the presence of a groove in the anterocone (-id). The absence of this groove in the type of B. brachygnathus may easily be due to wear. Gidley (1922a) states "The teeth are too much worn to determine their normal height in unworn condition." The groove is reduced in B. brachygnathus, but not completely absent.

Table 11. Measurements of Baiomys brachygnathus

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
M^1	3	1.4 - 1.45	1.42	4	.85 - .95	.9
M^2	1	1.05		1	.8	
M_1	15	1.25 - 1.45	1.33	15	.80 - .90	.85
M_2	2	1.05		2	.85 - .90	.87

Baiomys minimus (Gidley, 1922a)

Peromyscus minimus Gidley, J. W. 1922a. U.S.G.S. Prof. Paper 131-E, p. 124.

Baiomys minimus Hibbard, C. W. 1941. Am. Mid. Naturalist V. 26, No. 2, p. 352.

Type. USNM 10500, portion of the left dentary bearing complete dentition. Benson Locality, St. David Formation, Cochise County, Arizona.

Material. UA 4353 M_{1-2}.

Diagnosis. Very small size; length of the cheek tooth series 2.6mm; cusps depressed with well marked cingula at the entrance of the external reentrant valleys; anterior lobe of first cheek tooth relatively narrow and bilobate; posterior lobe of last cheek tooth much reduced (Gidley, 1922a).

Description of Wolf Ranch Material. $M_{\overline{1}}$. Anteroconid bilobate; well developed posterior cingulum; width equal to $M_{\overline{2}}$, but length greater; anteroconid groove shallow and lost with moderate wear.

$M_{\overline{2}}$. Anterior cingulum extends almost to labial edge of crown; protoconid and hypoconid subequal.

Discussion. The only specimen is a fragment of the left dentary with the first two molars in place. *Baiomys minimus* is distinguished from *B. brachygnathus* primarily on the basis of size, being smaller than either *B. brachygnathus* or the extant species *B. taylori*. It is distinguished from *Reithrodontomys* by its extremely small size and bilobed anterocone (-id).

Table 12. Measurements of *Baiomys minimus*

UA 4353	Length	Width
$M_{\overline{1}}$	1.1	.7
$M_{\overline{2}}$	.9	.7
Length of tooth row 2.0		

Onychomys bensoni Gidley, 1922a

Onychomys bensoni Gidley, J. W. 1922a. U.S.G.S. Prof. Paper 131-E, p. 125.

Type. USNM 10509, right dentary bearing complete dentition. Benson Locality, St. David Formation, Cochise County, Arizona.

Material. UA 4501 $M_{\overline{1}}$, UA 4502 $M_{\overline{1}}$, UA 4503 $M_{\overline{1}}$, UA 4358 $M_{\overline{1}}$, UA 4359 $M_{\overline{1}}$, UA 4360 $M_{\overline{1}}$, UA 4362 $M^{\underline{2}}$, UA 4361 $M_{\overline{2}}$.

Diagnosis. "About the size of *O. torridus* but with a less reduced last molar. The hinder lobe of the last molar is less reduced even than in *O. Leu. ruidose*. *O. bensoni* differs from all the living species of the genus in having more widely open valleys and less conspicuous lophs in the molar teeth, a more depressed heel on the last lower molar, and apparently a relatively larger and higher coronoid process." (Gidley, 1922a).

Description of the Wolf Ranch Material. $M^{\underline{1}}$. Anterocone is labial to the long axis, giving the lingual border of the tooth a humped appearance; occlusal surfaces of cusps very steep; strong lingual cingular shelf between protocone and hypocone.

$M^{\underline{2}}$. Process of anterior cingulum extends almost to the labial border of the tooth; strong labial and lingual cingular shelves.

$M_{\overline{1}}$. Posterior cingulum is broad; transverse lophs narrow; wide metaconid-entoconid and protoconid-hypoconid reentrant valleys.

$M_{\overline{2}}$. Anterior cingulum is small; shorter than $M_{\overline{1}}$ but equal in width; broad posterior cingulum.

Discussion. *Onychomys bensoni* was originally described by Gidley in 1922 from the Benson Locality in southeastern Arizona. *Onychomys bensoni* is smaller than *O. pedroensis* described by Gidley from the Curtis Ranch fauna. The length of the lower cheek tooth series given for *O. pedroensis* is 4.5 mm compared to 3.9 mm for *O. bensoni*. The cheek teeth of *O. bensoni* are lower crowned and less laterally compressed than those of *O. pedroensis*. The angles formed by the occlusal surface with the unworn sides of the cusps are more acute in *O. bensoni*.

Table 13. Measurements of *Onychomys bensoni*

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
M^{1}	1	1.95		1	1.2	
M^{2}	1	1.45			*	
M_{1}	5	1.7 - 1.9	1.83	5	1.1 - 1.2	1.17
M_{2}	1	1.40		1	1.2	

Bensonomys arizonae (Gidley, 1922a)

Eligmodontia arizonae Gidley, J. W. 1922a. U.S.G.S. Prof. Paper 131-E, p. 124.

Bensonomys arizonae Gazin, C. L. 1942. Proc. U. S. Nat. Mus. V. 92, No. 3155, p. 489.

Type. USNM 10503, portion of left dentary bearing M_{1-3}. Benson Locality, St. David Formation, Cochise County, Arizona.

Material. 6 $M^{\underline{1}}$, 1 $M^{\underline{2}}$, 6 $M_{\overline{1}}$, 4 $M_{\overline{2}}$, 1 $M_{\overline{3}}$. See Appendix A.

Diagnosis. Knoblike process at anterior extremity of masseteric crest on lower jaw, last lower cheek tooth reduced, and sulcus between capsular and coronoid processes. Molars more brachydont than *Eligmodontia*, notch on anteroconid better developed, and lower incisor more procumbent (Gazin, 1942).

Description of Wolf Ranch Material. $M^{\underline{1}}$. Bilobate anterocone, sulcus disappearing only in more advanced stage of wear; lingual border of crown smoothly curved; anterocone bisected by long axis of tooth.

$M^{\underline{2}}$. Shorter than $M^{\underline{1}}$; width equal to $M^{\underline{1}}$; paracone large; hypocone and metacone subequal; anterior cingulum rudimentary.

$M_{\overline{1}}$. Anteroconid bilobate and narrow; broad anterior cingulum extends almost to protoconid; lingual cusps higher than labial cusps; longer and narrower than $M^{\underline{1}}$.

$M_{\overline{2}}$. Shorter than $M_{\overline{1}}$; small anterior cingulum; broad posterior cingulum; width of tooth equals and occasionally exceeds that of the $M_{\overline{1}}$.

$M_{\overline{3}}$. Smaller than $M_{\overline{2}}$; metaconid and protoconid subequal; occlusal surface originally S-shaped, but with wear the metaconid may unite with the entoconid to form a small enamel lake.

Discussion. Gazin (1942) distinguished *Bensonomys* from *Peromyscus* on the basis of "the anterior extension of the masseteric crest into a prominent, knoblike process antero-external to the anterior root of the first cheek tooth, the dorsal position of the mental foramen, the reduction of the last molar, and the depth of the sulcus between the capsular and coronoid processes."

In addition to the above characters, *Peromyscus* is slightly higher crowned and has a wider anteroconid. The ratio of length to width is greater in the teeth of *Peromyscus*. The lingual border of the M^1 of *Bensonomys* is a smoother curve due to the central placement to the anterocone, as opposed to the more labial placement in *Peromyscus*.

Bensonomys arizonae was described from the lower dentition only. Unfortunately, no complete skull or associated upper and lower dentition has since been discovered. Six isolated M^1's and one M^2 are herein assigned to *Bensonomys* on the basis of size, bilobate anterocone, crown height, and the absence from the fauna of another genus of comparable size and abundance.

The specimens of *B. arizonae* collected from Unit IV, the yellowish gray siltstone, are slightly greater in certain dimensions than the specimens from Unit V, the gray green clay, The width of the M^1 illustrates this particularly well. The difference in width may warrant a new species when additional fossil material is available.

Table 14. Measurements of *Bensonomys arizonae*

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
$M^{\underline{1}}$	6	1.55 - 1.65	1.6	6	1.0 - 1.15	1.09
$M^{\underline{2}}$	1	1.2		1	1.0	
$M_{\overline{1}}$	6	1.60 - 1.70	1.66	6	1.0 - 1.15	1.05
$M_{\overline{2}}$	4	1.20 - 1.30	1.22	4	.9 - 1.1	1.02
$M_{\overline{3}}$	1	1.0		1	.9	

Table 15. Measurements of *Bensonomys arizonae* $M^{\underline{1}}$'s

Width			
Unit IV		Unit V	
UA 4522	1.15	UA 4332	1.05
UA 4523	1.15	UA 4333	1.10
UA 4524	1.10	UA 4339	1.0

Sigmodon bi-medius-minor

Type. UA 4328, R$M_{\overline{1}}$. Wolf Ranch fauna (64-273), St. David Formation, Cochise County, Arizona.

Material. 59 $M^{\underline{1}}$, 45 $M_{\overline{1}}$, 57 $M^{\underline{2}}$, 48 $M_{\overline{2}}$, 5 $M^{\underline{3}}$, 31 $M_{\overline{3}}$. See Appendix A.

Diagnosis. A cotton rat intermediate between *S. medius* Gidley and *S. minor* Gidley. The mean length and width of the $M_{\overline{1}}$ is used to differentiate between the species.

Description of the Wolf Ranch Material. $M^{\underline{1}}$. Anterocone is broad and situated labial to long axis of tooth; anterocone occasionally bilobate in early wear.

M^{2}. Occlusal surface is quadrate; process of anterior cingulum extends to labial edge of crown; metalophule flexed anteriorly; major root lingual.

M^{3}. Anterior loph is not connected to posterior loph; paracone and metacone subequal.

M_{1}. Tooth narrows anteriorly; anteroconid moderately broad; broad posterior cingulum extends to lingual edge of crown.

M_{2}. Occlusal surface is quadrate; small anterior cingulum; elongated hypoconid; entoconid and metaconid subequal; major root posterior.

M_{3}. Occlusal surface is S-shaped; anterior border flat.

Discussion. In 1922 Gidley described *Sigmodon medius* from the Early Blancan Benson fauna and *S. minor* from the Irvingtonian Curtis Ranch fauna. The two species have never been identified in association. *Sigmodon medius* is believed to be ancestral to *S. minor*. Statistical analysis indicates that the Wolf Ranch sample, two hundred forty-five teeth, represents a single population. The characters exhibited by the specimens are intermediate between those given by Gidley (1922a) for *S. medius* and *S. minor*. *Sigmodon bi-medius-minor* is distinguished by the mean length and width of the M_{1} in a large sample. In the Wolf Ranch *Sigmodon bi-medius-minor* the mean length of the M_{1} is 2.0 mm

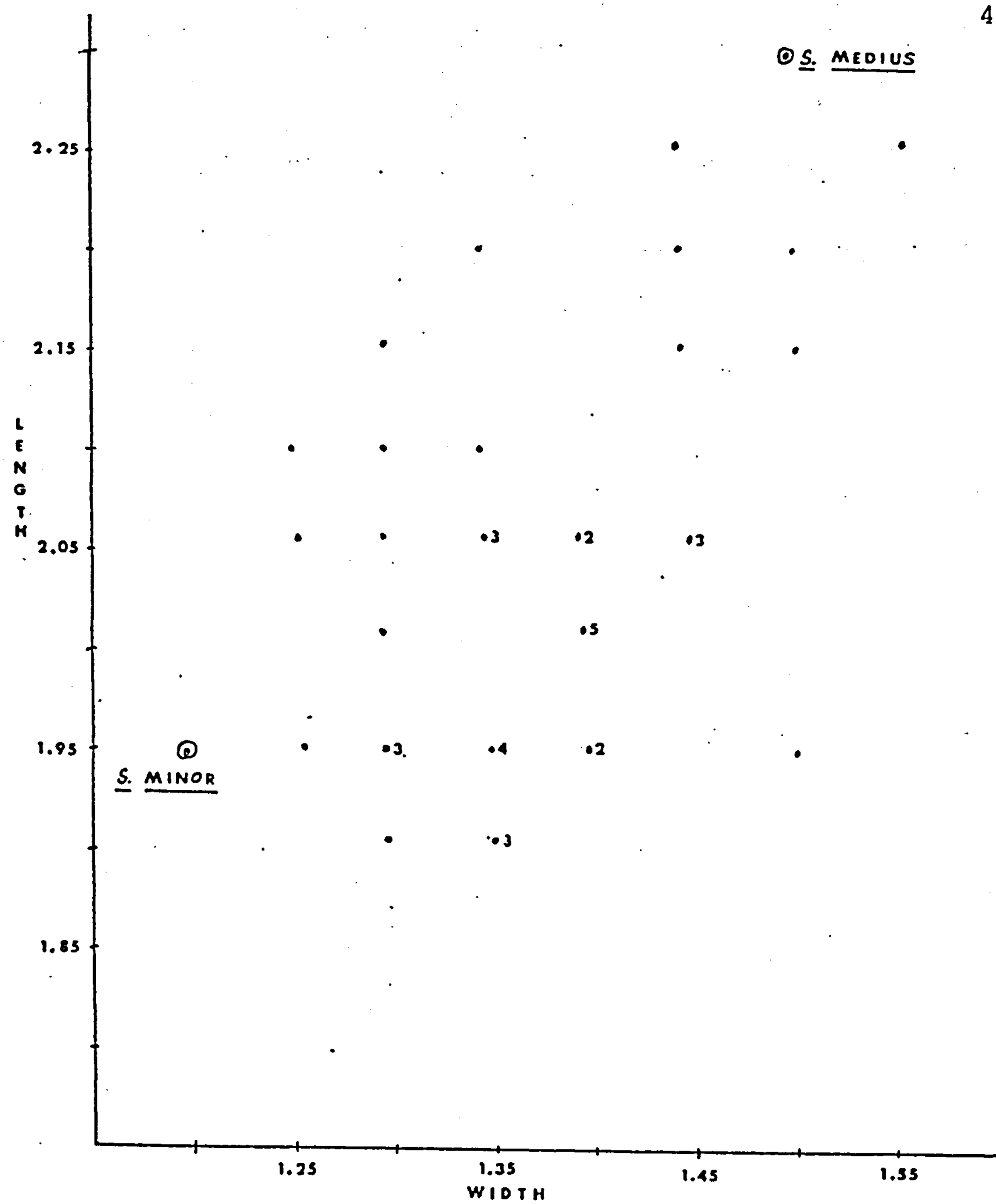


Figure 7. Sigmodon $M_{\overline{I}}$'s

and the mean width is 1.4 mm. The measurements of the $M_{\overline{1}}$'s are plotted in a scatter diagram (Fig. 7). The dimensions of the $M_{\overline{1}}$ in the type of S. medius (USNM 10519) and the type of S. minor (USNM 10512) were taken from casts of the types and are included in Figure 7. I believe that a chronoclinal relationship exists between S. medius and S. minor with the Wolf Ranch species intermediate between the two.

In 1970 Crusafont-Pairó and Reguant proposed an open system of nomenclature for intermediate forms. The intermediate species is named by placing the prefix "bi-" before the names of the two species between which it lies. The two species are placed in temporal order. The Wolf Ranch Sigmodon is named in this manner.

Table 16. Measurements of Sigmodon bi-medius-minor

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
$M^{\underline{1}}$	54	1.7 - 2.1	1.96	51	1.45 - 1.85	1.54
$M^{\underline{2}}$	53	1.25 - 1.55	1.47	54	1.2 - 1.7	1.43
$M^{\underline{3}}$	5	1.3 - 1.45	1.38	5	1.15 - 1.3	1.24
$M_{\overline{1}}$	39	1.9 - 2.25	2.0	39	1.25 - 1.55	1.4
$M_{\overline{2}}$	41	1.3 - 1.7	1.59	41	1.35 - 1.65	1.32
$M_{\overline{3}}$	33	1.5 - 1.9	1.64	31	1.25 - 1.65	1.32

Sigmodon curtisi Gidley, 1922a

Sigmodon curtisi Gidley, J. W. 1922a. U.S.G.S. Prof. Paper 131-E, p. 125.

Type. USNM 10511, large portion of the lower mandibles bearing complete dentition. Curtis Ranch fauna, St. David Formation, Cochise County, Arizona.

Material. UA 4537 M^{3}.

Diagnosis. Large cotton rat; length of lower cheek tooth series 7.0 mm; less hypsodont, reentrant valleys more open, and lophs more compressed than in recent species; M_3 relatively larger with broader hind cusp than in recent species; lingual wall of posterior lobe of M_3 extended and flattened to form a sharp right angle with the posterior wall of the reentrant angle (Gidley, 1922a).

Description of Wolf Ranch Material. M^{3}. Anterior loph is not connected to posterior loph; three well developed roots; high crowned; thick enamel.

Discussion. The sample consists of a single left M^{3} collected from Unit IV. *S. curtisi* is the largest species of fossil *Sigmodon*. It is distinguished from *S. medius* and *S. minor* primarily on the basis of size and robosity; and is as abundantly represented as the smaller species. Its phylogenetic history is undecided. It may be an early off-shoot of *S. medius* or it may represent an emigrant from outside the local area.

Table 17. Measurements of *Sigmodon curtisi*

	Length	Width
UA 4537 M^{3}	2.0	1.7

Neotoma (Hodomys) olseni

Neotoma *(Hodomys)* *olseni* *Nomen nudem*. Lammers, G. 1970 Dissertation, Univ. Ariz. p.99.

Type. UA 3234, right dentary bearing all cheek teeth. Curtis Ranch fauna, St. David Formation, Cochise County, Arizona.

Material. 6 M^1, 7 M_1, 2 M^2, 5 M_2, 3 M^3, 3 M_3. See Appendix A.

Emended diagnosis. S-shaped M_3 with a shallow third reentrant angle on the anterior external lobe; smallest species of the subgenus *Hodomys*.

Description of Wolf Ranch Material. M^1. Anterior lingual valley separates anterocone from protocone and continues to base of crown; labial reentrant valleys deeper than lingual valleys; in advanced stages of wear, the posterior labial and lingual valleys almost directly opposite one another.

M^2. Protocone may connect with paracone in advanced wear to form enamel lake and S-shaped occlusal surface.

M^3. Shallow posterior valley separating metacone and hypocone is lost in early wear; protocone most prominent cusp.

M_1. Anterior labial and posterior lingual reentrant valleys are relatively shallow and disappear in extreme wear to form S-shaped occlusal surface; anterior lingual and posterior labial reentrant valleys deeper and wear to enamel islands.

$M_{\overline{2}}$. Paraconid is much reduced; hypoconid most prominent cusp; anterior labial and posterior lingual reentrant valleys as in $M_{\overline{1}}$.

$M_{\overline{3}}$. Occlusal surface is S-shaped; shallow reentrant valley on anterior labial lobe.

Discussion. Lammers states in his 1970 diagnosis of *Neotoma* (*Hodomys*) *olseni* that the reentrant valleys of the upper molars are oblique to the long axis of the occlusal surface on the labial side and perpendicular to the long axis on the lingual side. The reentrant valleys of the lower molars are oriented opposite to the upper molars.

The above arrangement of the reentrant valleys of the upper molars is found in all species of the subgenus *Hodomys*. It is not exclusively diagnostic of *N. olseni*. The arrangement of the reentrant valleys of the lower molars is also found in all species of *Hodomys*. In addition, it only occurs in relatively unworn teeth. With moderate wear, the lingual reentrant valleys gradually assume a position perpendicular to the long axis. The S-shaped $M_{\overline{3}}$ is also found in all species of *Hodomys*. A third reentrant valley is not present on the $M_{\overline{3}}$ of *N. olseni* from Curtis Ranch. The absence is probably due to wear. One $M_{\overline{3}}$ (UA 4538) from Wolf Ranch does exhibit a trace of an anteroexternal reentrant valley. The presence of this character validates the referral of the species to Hodomys rather than to Parahodomys.

P. A. Wood, in his 1963 description of the Blancan 111 Ranch fauna, places a large number of Neotoma specimens within the recent species N. alleni. This identification is incorrect and in need of revision. The 111 Ranch Neotoma is larger than N. olseni, but not nearly so large and robust as N. alleni. The cusps, even in fairly unworn teeth, are not prismatic. The 111 Ranch Neotoma is sufficiently distinct to warrant the erection of a new species of N. (Hodomys).

Neotoma (H.) olseni was never published as a new species by Lammers and remains a Nomen nudem. The Wolf Ranch Neotoma is assigned to N. olseni pending publication. Neotoma olseni is much smaller than N. alleni or the 111 Ranch Neotoma. It is well represented in both Units IV and V at Wolf Ranch.

Table 18. Measurements of *Neotoma* (*Hodomys*) *olseni*

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
M^1	5	3.40 - 3.65	3.50	5	2.25 - 2.40	2.32
M_1	6	3.15 - 3.30	3.22	6	1.90 - 2.00	1.97
M^2	2	2.65 - 2.75	2.70	2	2.15 - 2.25	2.20
M_2	5	2.80 - 2.95	2.86	5	2.10 - 2.20	2.13
M^3	3	1.95 - 2.20	1.96	3	1.60 - 1.75	1.66
M_3	3	2.15 - 2.25	2.18	3	1.55 - 1.70	1.61

Family: Erethizontidae

Coendou stirtoni White, 1968.

Coendou stirtoni. White, J.A. 1968. Contr. Los Angeles County Mus. No. 136, p.2.

Type. LACM 17633, fragmentary palate with P^4–M^2. LACM 1428, Arroyo Tapiado, San Diego County, California.

Material. UA 4911 I^1, UA 4912 M^1.

Diagnosis. "Large in size, with P^4 as large as M^1, crowns of teeth larger than in any species except *C. brachygnathus* (Wilson), but with mandibles markedly smaller and less massive than in the latter species (White, 1968)."

Description of Wolf Ranch Material. I^1. Anteroposterior diameter is greater than transverse diameter; enamel restricted to the anterior face of the tooth.

M^1. Very small enamel island in labial end of most posterior loph; lingual reentrant valley extends 1/3 of the way across the crown; labial end of second anterior loph flexed posteriorly; median basin deepest.

Discussion. White (1968) states that in Coendou the P^4 is as wide as the M^1, but that in Erethizon the P^4 is markedly larger than the M^1. Coendou stirtoni is larger than C. cascoensis White or C. cumberlandicus White. The M^1 (UA 4912) is incomplete, and the length given in the table is, therefore, not the maximum.

Table 19. Measurements of Coendou stirtoni

	Length	Width
UA 4911 I^1	5.6	5.0
UA 4912 M^1	> 6.9	7.9

Order: Proboscidea

Family: Gomphotheriidae

?Stegomastodon Pohlig

Material. UA 2441a tusk fragment, UA 24416 M^3.

Diagnosis. "Brevirostrine, bunolophodont, trilophodont mastodont. Less bunodont or choerodont than any but the most primitive Old World anancines, but more so than Haplomastodon or Cuvieronius. Alternation or obliquity of main cones present, moderate. Tusks simply curved, nearly straight, without enamel. Skull short and high, elephantoid (Simpson and Paula Couro, 1957)."

<u>Description of Wolf Ranch Material</u>. The sample consists of an isolated left $M^{\underline{3}}$ and a small tusk fragment. The tusk fragment, in very poor condition, exhibits no trace of enamel. The $M^{\underline{3}}$ is quite worn and in rather poor condition. The two anterior roots are well developed. The principle cusps exhibit little alternation.

<u>Discussion</u>. The presence of spiral enamel bands around the tusks is characteristic of the genus *Cuvieronius*. However, the absence of enamel on the Wolf Ranch tusk fragment may be due to spalling or simply to the original position of the fragment within the body of the tusk. There are at present no conclusive dental characters with the exception of the enamel bands, for the separation of *Stegomastodon* and *Cuvieronius*.

Table 20. Measurements of *Stegomastodon*.

UA 2441b $M^{\underline{3}}$	
Length at base of crown	184
Width at base of crown	76
Length of major posterior root	99
UA 2441a tusk fragment	
Radius	69

Order: Perissodactyla

Family: Equidae

Nannippus phlegon (Hay, 1899)

Equus phlegon Hay, O.P. 1899. Amer. Geol. V. 24, p. 345.

Hipparion (Nannippus) phlegon Matthew, W.D. 1926. Quart. Rev. Biol. V. 1, p. 165.

Nannippus phlegon Gazin, C.L. 1942. Proc. U.S.Nat. Mus. V. 92, No. 3155, p.494.

Material. UA 4929 $M_{\overline{3}}$, UA 4930 metatarsal, UA 4931 distal end femur, UA 4932 $I_{\overline{3}}$, $P_{\overline{2}}$, UA 4933 $P_{\overline{3-4}}$, UA 2434a $P_{\overline{3}}$-$M_{\overline{3}}$.

Diagnosis. Very high crowned teeth; smooth oval protocone; extremely slender limbs and feet; no trace of fifth digit and trapezium; side toes complete (Matthew, 1926).

Description of Wolf Ranch Material. External reentrant valley deep almost in contact with the metaconid-metastylid groove; enamel smooth and uncrenulated; metaconid and metastylid oval to round; incipient parastylid; labial borders of protoconid and hypoconid curved.

$P_{\overline{x}}$'s are molariform; entoflexid and metaflexid larger than in molars.

$M_{\overline{x}}$'s are not so wide as premolars; external reentrant valley slightly shallower.

Discussion. This species is known from several Blancan localities in the San Pedro Valley, but little material has been published. It is well represented in the Benson, 111 Ranch, and Curtis Ranch faunas. The Wolf Ranch sample consists of a few mandible fragments with teeth and some incomplete limb bones.

Table 21. Measurements of <u>Nannippus phlegon</u>

	Length			Width		
	N	O.R.	$\bar{X}$	N	O.R.	$\bar{X}$
$P_{\bar{3}}$	1	14		1	10	
$P_{\bar{4}}$	2	15		2	10-11	10.5
$M_{\bar{1}}$	1	14.5		1	9	
$M_{\bar{2}}$	1	14		1	8.5	
$M_{\bar{3}}$	2	20 - 21	20.5	2	9 - 10	9.5

<u>Equus</u> (<u>Plesippus</u>) sp.

<u>Material</u>. UA 4934 $P_{\bar{3}}$-$M_{\bar{3}}$, UA 2434g $P_{\bar{3}}$.

<u>Description of Wolf Ranch Material</u>. Lower cheek teeth. High crowned; very slightly convex lingually; little antero-posterior curvature; smooth enamel borders; labial borders of protoconid and hypoconid flat; metastylid angular; metaconid round to oval; entoconid squared; internal reentrant valley between metastylid and metaconid V-shaped and penetrates almost to the isthmus between the two cusps; parastylid absent possibly due to wear.

$P_{\bar{x}}$. Pli caballinid present, but not pronounced; median external reentrant valley rounded and does not penetrate the isthmus between the entoflexid and metaflexid; hypoconulid less prominent than in molars; entoflexid large and elongated with the anterior end flexed lingually; metaflexid large but smaller than entoflexid; width greater than molars;

length greater than first and second molar.

$M_{\overline{X}}$. Pli caballinid more prominent than in premolars; median external reentrant valley rounded and extends lingually between the entoflexid and metaflexid; hypoconulid pronounced; entoflexid smaller than in premolars with the anterior end slightly flexed only in the last molar; metaflexid equal in size to entoflexid.

Discussion. The dental characters used to separate the subgenera of *Equus* are gradational. Many of the supposedly distinctive features are within the variation of a single group (Savage, 1951). It is difficult to assign isolated specimens to a definite species due to this diagnostic overlap. Ideally, a large sample of specimens should be studied before a definite identification is made in order to determine the amount of variation within the population.

Plesippus was felt to be morphologically intermediate between *Equus* and *Pliohippus* by Schultz in 1936. Subsequently, *Plesippus* has been more commonly treated as a subgenus of *Equus*. The character most often employed to separate *E*. (*Equus*) and *E*. (*Plesippus*) is the shape of the metaconid-metastylid groove. This groove is held to be V-shaped in *Plesippus* and U-shaped in *Equus*. McGrew (1944), after a study of recent equids, felt that the shape of the groove was a diagnostic character. On the basis of this groove, the Wolf Ranch specimens are referred to the subgenus *E.* (*Plesippus*).

Table 22. Measurements of *Equus* (*Plesippus*) sp.

	Length	Width
$P_{\overline{3}}$	31	20
$P_{\overline{4}}$	30	21
$M_{\overline{1}}$	28	16
$M_{\overline{2}}$	30	14
$M_{\overline{3}}$	37	11
Length of the tooth row $P_{\overline{3}} - M_{\overline{3}}$		15.6

Order: Artiodactyla

Family: Camelidae

cf. *Camelops*

The sample consists of a small fragment of a cheek tooth and the shaft of a right metatarsal. The tooth fragment is the labial selene of the anteroexternal cusp (paracone) of a left $M^{\underline{3}}$. The metatarsal is badly fragmented and retains neither the proximal nor the distal articular surface. The dimensions of both specimens indicate a large camel in the size range of *Camelops* (Webb, 1965).

Table 23. Measurements of cf. *Camelops*

UA 4927 metatarsal shaft	
Length	348
Width	52
UA 2434c tooth fragment	
Length	64
Width	35

PALEOECOLOGY OF THE WOLF RANCH LOCAL FAUNA

The Wolf Ranch collection is dominated by small mammals. The Rodentia are by far the most abundant order in the sample. In Unit V, the large mammals are very poorly represented, and in Unit IV they are not represented at all. Although the smaller mammals are commonly the most abundant elements in an extant community, the larger mammals are always present to some extent. Therefore, I must assume that for some reason the abundance of the larger mammals is not accurately represented in the fossil record of Wolf Ranch. This inaccuracy could be due to the distance of the habitat of the larger mammals from the site of deposition (Shotwell, 1955, 1958) or to the inability of the depositional agency to accomadate large, heavy bones, or to something as simple as herd migration. Regardless of the cause, there is a built in bias for the preservation of small life forms. The small mammal teeth constitute a more representative sampling of the mammal population than do the large mammal remains. The fossil remains of the large forms are, therefore, excluded from the following analysis.

Shotwell's (1955, 1958) method of quantitative analysis is modified here to apply to a sample consisting solely of small mammal teeth. The minimum number is used to determine relative abundance. The corrected number of specimens per individual is used to determine the degree of preservation. The minimum number is merely the minimum number of individuals necessary to account for all the specimens assigned to a given genus. The corrected number of specimens is calculated by the following formula:

$$\frac{\text{number of specimens x 100}}{\text{estimated number of elements}}$$

The estimated number of elements is the number of cheek teeth present in each genus. This number will vary from one genus to another. In order to eliminate this variation, the number of specimens is multiplied by the arbitrary figure, 100. The corrected number of specimens per individual is obtained by dividing the corrected number of specimens by the minimum number.

The values of the above variables are recorded in a faunal analysis diagram (Figs. 8, 9, 10). The minimum number determines the number of degrees within the circle that are alloted to each of the genera. The resulting pie sections are shaded to indicate the degree of preservation. These diagrams provide a concise, graphic representation of the relative abundance and the degree of preservation for each small mammal genus in the Wolf Ranch local fauna.

Faunal analysis diagrams have been prepared for Unit IV, the yellowish siltstone, Unit V, the gray green clay, and for the total sample. The most obvious feature is the predominance of Sigmodon, ranging from 38% to 44.7% of each sample. Eleven genera of small mammals are represented in Unit IV. The total increases to fourteen in Unit V. The faunas of both units are compared in Table 24. The abundance of Sigmodon, Geomys, Prodipodomys, Nekrolagus, Spermophilus and Bensonomys remains fairly constant from Unit IV to Unit V. Notolagus, Peromyscus, and Coendou are known only from Unit IV. Perognathus, Neotoma, and Onychomys increase slightly in abundance from Unit IV to Unit V. Simonycteris is known only from Unit V. It is interesting to note that Baiomys increases sharply in abundance from Unit IV to Unit V, but that the degree of preservation decreases. Prodipodomys is equally abundant in Units IV and V, but is not so well preserved in Unit IV as in Unit V.

Shotwell maintains that the completeness of preservation is directly proportional to the distance of the respective habitats from the site of deposition. I do not think that the proximal and distal communities derived through the application of this theory are reliable. There are too many variables (depositional environment, post-mortem transportation, etc.) involved that could skew the basic relationship of distance to abundance.

The grain size and cross bedding of some of the coarse sandstones below Unit IV are indicative of stream channel deposits. Unit IV, more fine grained, suggests a near stream or possibly a point or bar deposit. Unit V, very fine grained, may represent an overbank deposit.

Unit V includes both abundant small mammal material and a few elements of larger mammals. If Unit V is postulated as an overbank deposit, it is necessary to reconcile the simultaneous occurance of small, light fossils with large, heavy fossils. It is possible that the larger carcasses remained afloat for a longer period of time and were concentrated, while the smaller bodies were macerated more rapidly and settled out with the finer particles. If so, there should be some evidence of graded (according to size) sinking. The data, however, are inconclusive. The fossils are scattered evenly throughout Unit V, and there is no evidence of layering.

In order to determine the environment of Wolf Ranch, it is necessary to assume that the fossil species of extant genera had approximately the same ecological requirements as the living forms, and that the ecological requirements of fossil genera may be similar to those of the most closely related extant genus.

The elements of the fauna suggest a variety of habitats loosely centered about a semi-permanent to permanent source of water. Equus, Camelops, Nannippus, and Spermophilus suggest an open grassland habitat. Coendou, *Neotoma*, and *Stegomastodon* suggest a brushy or wooded area. *Perognathus* and *Prodipodomys* suggest a habitat intermediate between grassland and brush. *Sigmodon* and *Baiomys* favor moist, weedy, grassy areas.

It is interesting to note that the most abundant genus, *Sigmodon*, does not occur far from water. It is equally abundant in Units IV and V. The degree of preservation remains fairly constant. *Dipodomys*, direct ancestor of *Prodipodomys*, the second most abundant genus, has very little need of water. Therefore, it is probable that more than one community is represented.

The elements of the fossil faunas and their distribution in the San Pedro Valley indicate that the climate was somewhat moister, but not greatly different, from that of today. The relatively greater abundance of water could have been due to greater annual precipitation or a higher level in the fossil water table.

Table 24. Comparison of Units IV and V

numeral = minimum number

	Unit IV	Unit V
Simonycteris	0	1
Notolagus	1	0
Nekrolagus	2	2
Spermophilus	1	1
Geomys	2	2
Perognathus	1	3
Prodipodomys	5	5
Peromyscus	2	0
Baiomys	3	8
Onychomys	2	3
Bensonomys	2	2
Sigmodon	19	19
Neotoma	3	4
Coendou	1	0
Stegomastodon	0	1
Nannippus	0	1
Equus	0	2
Camelops	0	1

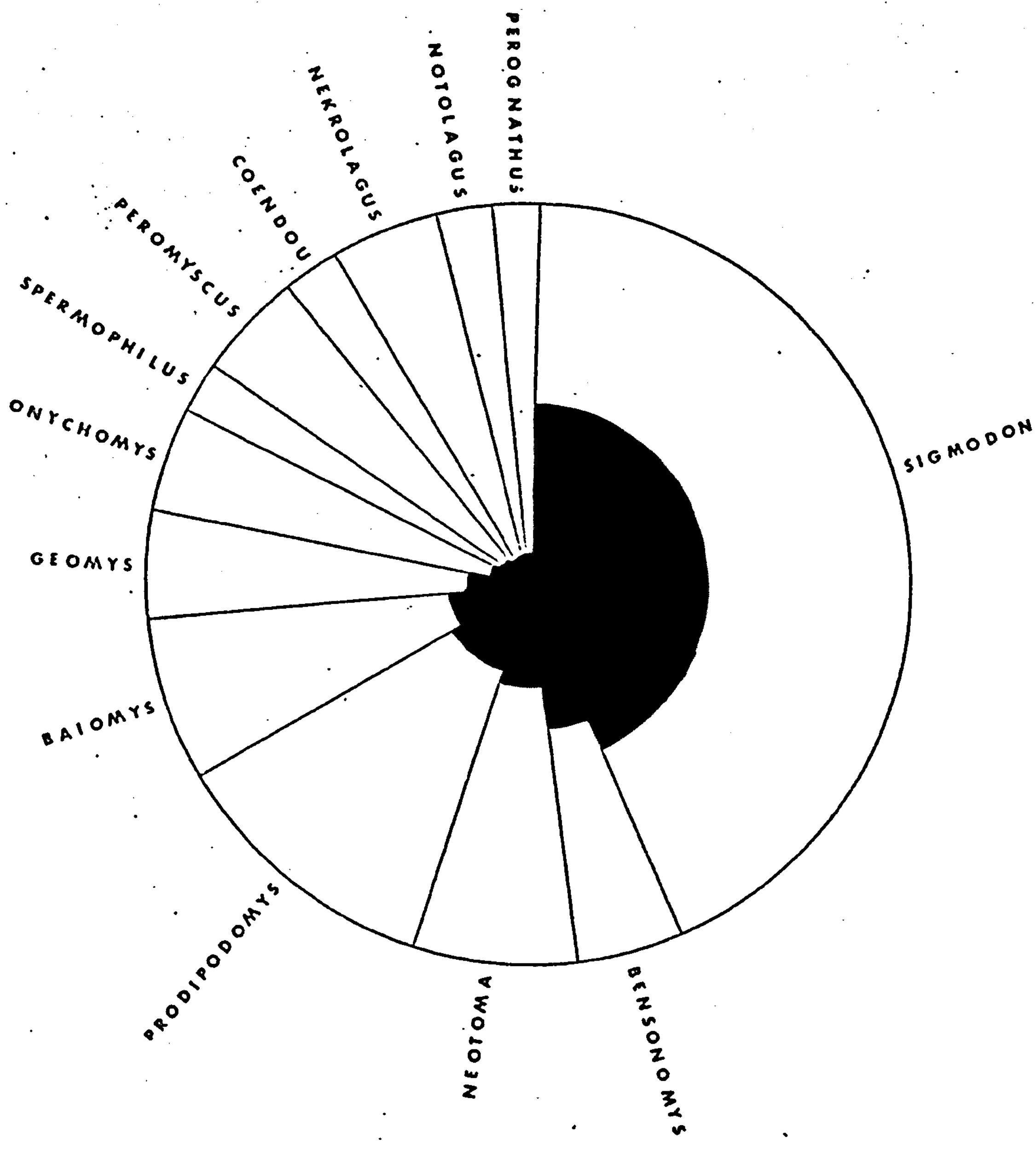


Figure 8. Faunal Analysis Diagram: Unit IV

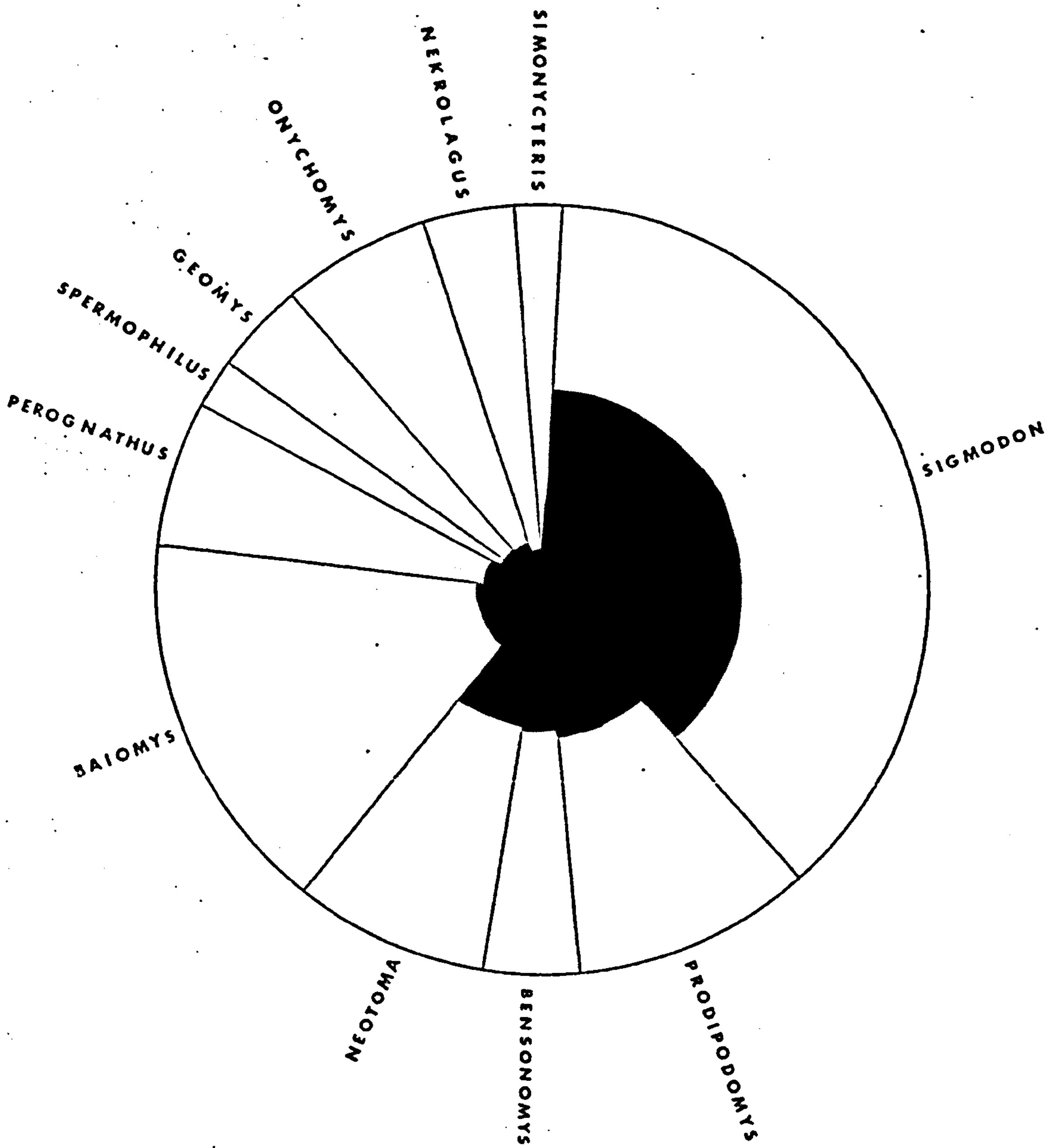


Figure 9. Faunal Analysis Diagram: Unit V

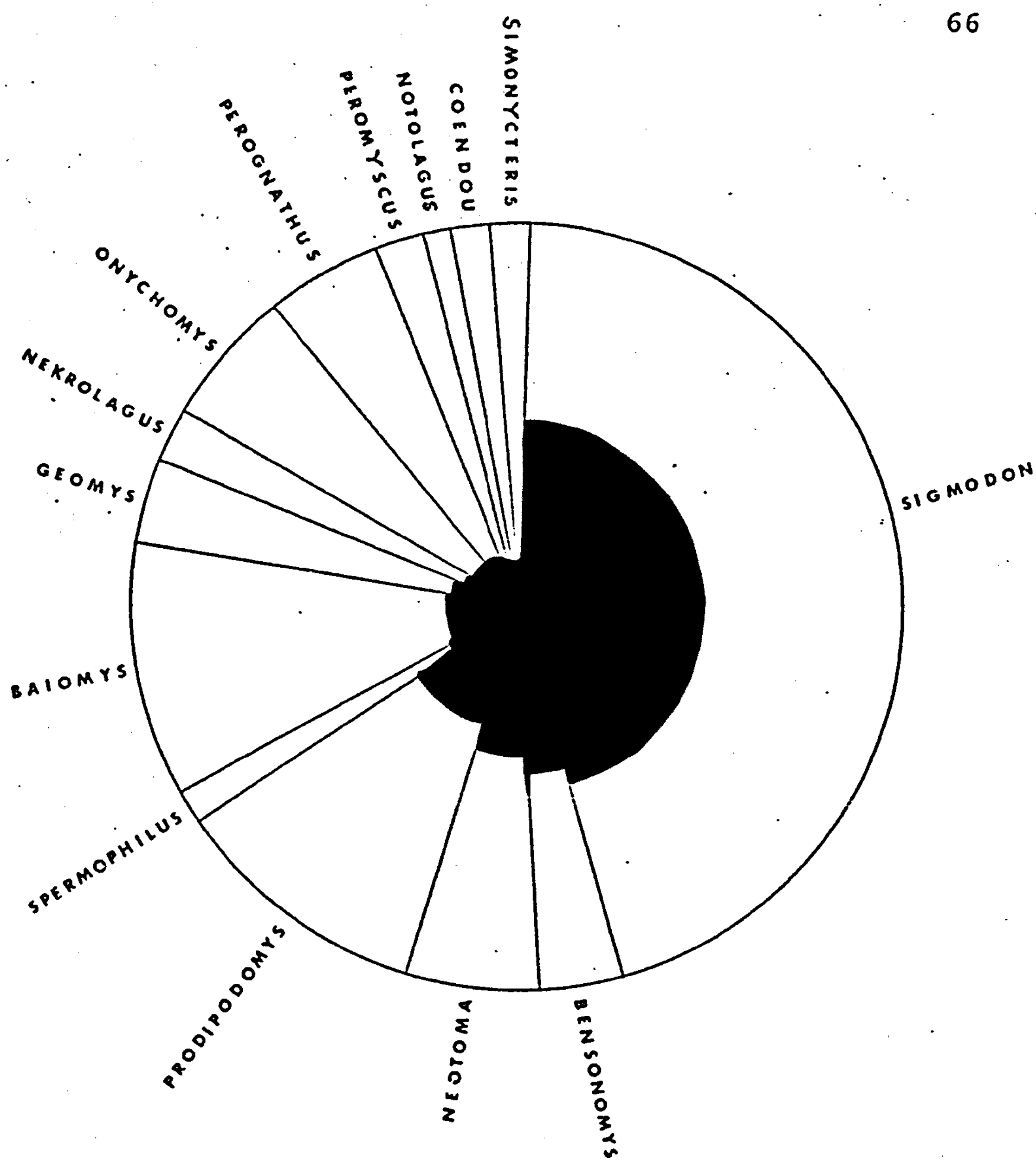


Figure 10. Faunal Analysis Diagram: Total Sample

AGE OF THE WOLF RANCH LOCAL FAUNA

The temporal and geographic ranges of the Wolf Ranch genera are listed in Table 25. The temporal and geographic ranges of the Wolf Ranch species are listed in Table 26. Data in Table 26 show that the Wolf Ranch fauna is intermediate between the Benson fauna and the Curtis Ranch fauna in that six species are common with both faunas.

The Benson fauna is generally held to be Early Blancan, more or less equivalent to the Rexroad fauna of Kansas with two species in common between those faunas. Only one species (*Perognathus rexroadensis*) is common between Benson, Rexroad, and Wolf Ranch. The Curtis Ranch fauna is considered to be Early Irvingtonian, based on the presence of two advanced species of *Sigmodon* (*S. minor* and *S. curtisi*), *Hydrochoerus*, and *Lepus* and the absence of *Nannippus*.

The age of the Wolf Ranch fauna is best placed in Late Blancan because of the stage of evolution of *Sigmodon* (intermediate between *S. medius* and *S. minor*) and the presence of *Nannippus*, an equid that is not known from Irvingtonian deposits.

Table 25. Temporal and Geographic Ranges of the Wolf Ranch Genera

Simonycteris	Blancan - Irvingtonian, N.A.
Notolagus	Hemphillian - Blancan, N. A.
Nekrolagus	Hemphillian - Blancan, N. A.
Spermophilus	Clarendonian - Recent, N. A. Pleistocene - Recent, Eur. and Asia
Geomys	Hemphillian - Recent, N. A.
Perognathus	Barstovian - Recent, N. A.
Prodipodomys	Hemphillian - Blancan, N. A.
Baiomys	Blancan - Recent, N. A.
Onychomys	Blancan - Recent, N. A.
Bensonomys	Blancan - Irvingtonian, N. A.
Sigmodon	Blancan - Recent, N. A. Recent, S. A.
Neotoma	Blancan - Recent, N. A.
Coendou	Blancan - Irvingtonian, N. A. Recent, S. A.
Stegomastodon	Blancan - Irvingtonian, N. A. Pleistocene, S. A.
Nannippus	Clarendonian - Blancan, N. A.
Equus	Blancan - Rancholabrean, N. A. Pleistocene, S. A. Upper Pliocene - Recent, Eur., Af., and Asia
Camelops	Blancan - Rancholabrean, N. A.

Table 26. Temporal and Geographic Ranges of Wolf Ranch Species

Species of Wolf Ranch Fauna	Early Blancan: Benson	Early Blancan: Rexroad	Early Blancan: Hagerman	Irvingtonian: Curtis R.	Irvingtonian: Borchers
Simonycteris stocki				X	
Notolagus lepusculus		X			
Nekrolagus progressus		X			
Spermophilus bensoni	X				
Geomys (*N.*) *persimilus*				X	
Perognathus gidleyi		X			X
Perognathus rexroadensis	X	X			
Prodipodomys idahoensis			X		
Prodipodomys kansensis		X			
Baiomys brachygnathus				X	
Baiomys minimus	X				
Onychomys bensoni	X				
Bensonomys arizonae	X			X	
Sigmodon bi-medius-minor					
Sigmodon curtisi				X	
Neotoma (*H.*) *olseni*				X	
Coendou stirtoni					
Nannippus phlegon	X				

APPENDIX A

FOSSIL MATERIAL: UA CATALOG NUMBERS

Nekrolagus progressus

UA	4916	P^4
	4917	"
	4918	"
	4920	M^1
	4923	"
	4921	"
	4922	"
	4924	M^2
	4925	"
	4915	M_3
	4919	P_3

Geomys (*Nertergeomys*) *?persimilus*

UA	4972	I^1
	4169	P^4
	4168	"
	4898	M^x
	4892	"
	4884	"
	4885	"
	4893	"
	4894	M_x
	4897	"
	4895	"
	4896	"
	4886	"
	4887	"

Prodipodomys idahoensis

UA	4812	P^4
	4914	"
	4915	"
	4916	"
	4849	"
	4850	"
	4851	"
	4856	"
	4823	P_4
	4822	"
	4824	"
	4825	"
	4819	"
	4820	"
	4855	"
	4908	"
	4858	M^1
	4827	"
	4826	"
	4857	"
	4859	"
	4864	M_1
	4829	"
	4828	"
	4831	"
	4861	"
	4863	"
	4830	"
	4868	M^2
	4834	"
	4867	"
	4870	"
	4869	"
	4833	"
	4832	"
	4836	"
	4838	"
	4835	"
	4874	M_2
	4840	"
	4841	"
	4872	"
	4873	"
	4842	"
	4839	"
	4843	"
	4875	M^3

<u>P. idahoensis</u> cont'd.

	4876	M^{3}
	4845	"
	4846	M_{3}
	4847	"
	4877	"
	4878	"

<u>Prodipodomys kansensis</u>

UA	4811	P^{4}
	4813	"
	4817	"
	4848	"
	4852	"
	4854	P_{4}
	4853	"
	4818	"
	4821	"
	4860	M_{1}
	4862	"
	4871	M^{2}
	4866	"
	4865	"
	4837	"
	4844	M_{2}

<u>Baiomys brachygnathus</u>

UA	4340	M^{1}
	4507	"
	4508	"
	4509	"
	4510	"
	4511	M_{1}
	4512	"
	4513	"
	4514	"
	4341	"
	4342	"
	4343	"
	4344	"
	4345	"
	4346	"
	4347	"
	4349	"
UA	4350	"
	4351	"
	4352	"
	4543	"

UA	4516	M_{2}
	4517	"
	4356	"

<u>Bensonomys arizonae</u>

UA	4332	M^{1}
	4333	"
	4339	"
	4522	"
	4523	"
	4524	"
	4529	M_{1}
	4530	"
	4531	"
	4542	"
	4348	"
	4532	$M_{1,2,3}$
	4515	M_{2}
	4354	"
	4355	"
	4357	M^{2}

<u>Sigmodon bi-medius-minor</u>

UA	4400	M^{1}
	4401	"
	4402	"
	4403	"
	4404	"
	4405	"
	4406	"
	4407	"
	4408	"
	4409	"
	4410	"
	4411	"
	4412	"
	4413	"
	4414	"
	4415	"
	4416	"
	4417	"
	4418	"
	4419	"
	4420	"
	4421	"
	4422	"
	4423	"
	4424	"
	4425	"

Sigmodon bi-medius-minor cont'd.

UA	4426	M^1
	4429	"
	4337	"
	4210	"
	4211	"
	4213	"
	4214	"
	4215	"
	4216	"
	4217	"
	4218	"
	4219	"
	4220	"
	4221	"
	4222	"
	4223	"
	4224	"
	4225	"
	4226	"
	4227	"
	4228	"
	4229	"
	4230	"
	4231	"
	4232	"
	4233	"
	4234	"
	4235	"
	4236	"
	4334	"
	4335	"
	4336	"
	4207	M_1
	4208	"
	4209	"
	4307	"
	4308	"
	4309	"
	4310	"
	4311	"
	4312	"
	4313	"
	4314	"
	4315	"
	4316	"
	4317	"
	4318	"
	4319	"
	4320	"
	4321	M_1
	4322	"
	4323	"
	4324	"
	4325	"
	4326	"
	4327	"
	4328	"
	4329	"
	4330	"
	4331	"
	4533	"
	4521	"
	4504	"
	4504	"
	4427	"
	4428	"
	4430	"
	4534	"
	4431	"
	4432	"
	4433	"
	4434	"
	4506	"
	4519	"
	4520	"
	4535	"
	4536	"
	4437	M^2
	4438	"
	4439	"
	4440	"
	4436	"
	4441	"
	4442	"
	4443	"
	4444	"
	4445	"
	4446	"
	4447	"
	4448	"
	4449	"
	4450	"
	4451	"
	4452	"
	4453	"
	4454	"
	4455	"
	4456	"

<u>Sigmodon</u> cont'd.

4457	$M_{\overline{2}}$
4458	"
4459	"
4460	"
4461	"
4462	"
4463	"
4435	"
4237	"
4238	"
4239	"
4240	"
4241	"
4242	"
4243	"
4244	"
4245	"
4246	"
4247	"
4248	"
4249	"
4250	"
4251	"
4252	"
4253	"
4254	"
4255	"
4256	"
4257	"
4258	"
4259	"
4260	"
4261	"
4262	"
4263	"
4281	"
4492	$M_{\overline{2}}$
4434	"
4463	"
4464	"
4465	"
4466	"
4467	"
4468	"
4469	"
4471	"
4472	"
4473	"
4474	$M_{\overline{2}}$
4475	"
4476	"
4477	"
4478	"
4479	"
4480	"
4481	"
4482	"
4483	"
4484	"
4485	"
4525	"
4264	"
4265	"
4266	"
4267	"
4268	"
4269	"
4270	"
4271	"
4272	"
4273	"
4275	"
4276	"
4277	"
4278	"
4279	"
4280	"
4282	"
4283	"
4284	"
4285	"
4286	"
4287	"
4288	"
4304	$M^{\underline{3}}$
4305	"
4306	"
4338	"
4486	"
4487	$M_{\overline{3}}$
4488	"
4489	"
4490	"
4491	"
4492	"
4493	"

Sigmodon cont'd.

4494 M_3
4495 "
4496 "
4497 "
4498 "
4499 "
4500 "
4470 "
4274 "
4289 "
4290 "
4291 "
4292 "
4293 "
4294 "
4295 "
4296 "
4297 "
4298 "
4299 "
4300 "
4301 "
4302 "
4303 "

Neotoma (Hodomys) olseni

4363 M^1
4364 "
4380 "
4381 "
4382 "
4383 "
4365 M_1
4366 "
4367 "
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SELECTED BIBLIOGRAPHY

Cantwell, Robert J. 1969. Fossil Sigmodon from the Tusker Locality, 111 Ranch, Arizona. Journal of Mammalogy. Vol. 50, No. 2, pp. 375-378.

Crusafont-Pairó, M. and S. Reguant. 1970. The Nomenclature of Intermediate Forms. Systematic Zoology. Vol. 19, No. 3, pp.254-257.

Damon, Paul E. 1969. Correlation and Chronology of Ore Deposits and Volcanic Rocks. Annual Progress Report No. COO-689-120 to Research Division, United States Atomic Energy Commission.

Dawson, Mary R. 1958. Later Tertiary Leporidae of North America. University of Kansas. Vertebrata. No. 6.

Dice, L.R. 1917. Systematic position of several American Tertiary lagomorphs. University of California Department of Geology Bulletin. Vol. 10, No. 12, pp. 179-183.

______. 1929. The phylogeny of the Leporidae, with description of a new genus. University of California Department of Geology Bulletin. Vol. 10, No. 4, pp. 340-344.

______. 1931. Alilepus, a new name to replace Allolagus Dice, preoccupied, and notes on several species of fossil hares. University of California Department of Geology Bulletin. Vol. 12, No. 2, pp.159-160.

Downey, Joseph S. 1962. Leporidae of the Tusker local fauna from southeastern Arizona. Journal of Paleontology. Vol. 36, No. 5, pp. 1112-1115.

______. 1968. Late Pliocene Lagomorphs of the San Pedro Valley, Arizona. U.S. Geological Survey Professional Paper. No. 600-D, pp. 169-173.

Framzen, D.S. 1947. The pocket gopher, Geomys quinni McGrew, in the Rexroad fauna, Blancan age, of southwestern Kansas. Transactions of the Kansas Academy of Science. Vol. 50, pp. 55-59.

Gazin, C. L. 1932. A Miocene mammalian fauna from southeastern Oregon. Contributions to Paleontology. Carnegie Institute. No. 418, pp. 37-86.

______. 1934. Fossil hares from the Late Pliocene of southern Idaho. U.S. National Museum Proceedings. Vol. 83, No. 2976, pp. 111-121.

Gazin, C. L. 1942. The Late Cenozoic vertebrate faunas from the San Pedro Valley, Arizona. U.S. National Museum Proceedings. Vol. 92, No. 3155, pp. 475-518.

Gidley, James W. 1922a. Preliminary report on fossil vertebrates of the San Pedro Valley, Arizona, with descriptions of new species of Rodentia and Lagomorpha. U. S. Geological Survey Professional Paper. No. 131-E, pp. 119-131.

______. 1922b. Field explorations in the San Pedro Valley and Sulpher Springs Valley of southern Arizona. Explorations and Field Work of the Smithsonian Institution in 1921. pp. 25-30.

Gidley, James W. and C. L. Gazin. 1933. New Mammalia in the Pleistocene fauna from Cumberland Cave. Journal of Mammalogy. Vol. 14, pp. 343-357.

______. 1938. Pleistocene vertebrate fauna from Cumberland Cave, Maryland. U. S. National Museum Bulletin. No. 171.

Gray, Robert S. 1965. Late Cenozoic sediments in the San Pedro Valley near St. David, Arizona. Ph. D. Dissertation, University of Arizona. 198 pp.

______. 1967. Petrography of the Upper Cenozoic non-marine sediments in the San Pedro Valley, Arizona. Journal of Sedimentary Petrology. Vol. 37, No. 3, pp. 774-789.

Hall, R.E. and K.R. Kelson. 1959. The Mammals of North America. Roland Press Co. Vol. I & II.

Hay, O. P. 1899. On the nomenclatures of certain American Fossil Vertebrates. American Geologist. Vol. 24, p. 345.

Hay, O.P. 1927. The Pleistocene of the western region of North America and its vertebrated animals. Carnegie Institute of Washington Publ. 322B, pp. 1-346.

Hibbard, Claude W. 1937. Additional Fauna of Edson Quarry of the Middle Pliocene of Kansas. American Midland Naturalist. Vol. 18, No. 3, pp 460-464.

_______. 1939a. Four New Rabbits from the Upper Pliocene of Kansas. The American Midland Naturalist. Vol, 21, pp. 506-514.

_______. 1939b. Notes on additional fauna of Edson Quarry of the Middle Pliocene of Kansas. Transactions of the Kansas Academy of Science. Vol. 42, pp. 457-462.

_______. 1940. A new Pleistocene fauna from Meade County Kansas. Transactions of the Kansas Academy of Science. Vol. 43, pp. 417-425.

_______. 1941a. New Mammals from the Rexroad fauna, Upper Pliocene of Kansas. American Midland Naturalist. Vol. 26, No.2, pp. 337-368.

_______. 1941b. The Borchers fauna, a new Pleistocene interglacial fauna from Meade County, Kansas. Kansas Geological Survey Bulletin. Vol. 38, No.7, pp. 197-220.

_______. 1942. Pleistocene mammals of Kansas, Kansas Geological Survey Bulletin. Vol. 41, pp.261-269.

_______. 1944. Abnormal tooth pattern in the lower dentition of the Jackrabbit, Lepus Californicus deserticola (Mearns). Journal of Mammology. Vol. 25, No. 1, pp. 64-66.

_______. 1950. Mammals of the Rexroad Formation from Fox Canyon, Kansas. Contributions of the University of Michigan Museum of Paleontology. Vol. 8, No.6, pp. 113-192.

_______. 1956. Vertebrate fossils from the Meade Formation of southwestern Kansas. Papers of the Michigan Academy of Science, Arts, and Letters. Vol. 41, pp. 145-199.

________. 1958. Summary of North American Pleistocene mammalian local faunas. Papers of the Michigan Academy of Science, Arts, and Letters. Vol.43, pp. 3-31.

________. 1960. An interpretation of Pliocene and Pleistocene climates in North America. Sixty-second Annual Report of the Michigan Academy of Science, Arts, and Letters. pp. 5-30.

________. 1962. Two new rodents from the Early Pleistocene of Idaho. Journal of Mammalogy. Vol. 43, No. 4, pp. 482-485.

________. 1963. The origin of the P_3 pattern of *Sylvilagus*, *Caprolagus*, *Oryctolagus* and *Lepus*. Journal of Mammalogy. Vo. 44, No. 1, pp. 1-15.

________. 1967. New rodents from the Late Cenozoic of Kansas. Papers of the Michigan Academy of Science, Arts, and Letters. Vol. 52, pp. 115-132.

________. 1969. The rabbits (*Hypolagus* and *Pratilepus*) from the Upper Pliocene Hagerman local fauna of Idaho. Papers of the Michigan Academy of Science, Arts, and Letters. Vol. 1, No. 1, pp.81-97.

________. 1970. Pleistocene mammalian local faunas from the Great Plains and Central Lowland provinces of the United States. University of Kansas Department of Geology Special Publication. No. 3, pp.395-493.

Hibbard, C.W., C.E. Ray, D.E. Savage, D.W. Taylor, and J.E. Guilday. 1965. Quaternary mammals of North America. The Quaternary of the United States Princeton University Press. pp. 509-525.

Hibbard, C.W. and E.S. Riggs. 1949. Upper Pliocene vertebrates from Keefe Canyon, Meade County, Kansas. Geological Society of America Bulletin. Vol. 60, pp. 829-880.

Hibbard, C.W. and C.B. Schultz. 1948. A new Sciurid of Blancan age from Kansas and Nebraska. University of Nebraska Museum Bulletin. Vol. 3, pp. 19-29.

Hooper, E.T. 1952. A systematic review of the harvest mice (genus *Reithrodontomys*) of Latin America. University of Michigan Museum of Zoology Miscellaneous Publications. Vol. 77, pp. 1-255.

Lammers, George E. 1970. The Late Cenozoic Benson and Curtis Ranch faunas from the San Pedro Valley, Cochise County, Arizona. Ph. D. dissertation. University of Arizona.

Lance, John F. 1960. Stratigraphy and structural position of Cenozoic fossil localities in Arizona. Arizona Geological Society Digest. Vol. 3, pp. 155-159.

Martin, R. A. 1970. Line and grade in the extinct medius species group of Sigmodon. Science. Vol. 167, pp. 1504-1506.

Matthew, W. D. 1926. The evolution of the horse. Quarterly Review of Biology. Vol. 1, pp. 139-185.

Meade, G. E. 1945. The Blanco fauna. University of Texas Publication. Vol. 4401, pp. 509-556.

Merriam, C. Hart. 1894. A new subfamily of murine rodents the Notominae-with a description of a new genus and species and a synopsis of the known forms. Proceedings of the Philadelphia Academy of Natural Science. pp. 225-252.

McGrew, P. C. 1944. An Early Pleistocene fauna from Nebraska. Field Museum of Natural History Geological Survey. Vol. 9, No. 2, pp. 33-66.

Osgood, W. H. 1900. Revision of the pocket mice of the genus Perognathus. North American Fauna. Vol. 18, pp. 9-63.

Russel, R. J. 1968. Evolution and classification of the pocket gopher of the subfamily Geomyinae. University of Kansas Museum of Natural History Publication. Vol. 16, pp. 473-579.

Savage, D. E. 1951. Late Cenozoic vertebrates of the San Francisco Bay region. University of California Department of Geology Bulletin. Vol. 28, No. 10, pp. 215-314.

_______. 1955. A survey of various Late Cenozoic vertebrate faunas of the Panhandle of Texas. University of California Department of Geology Bulletin. Vol. 31, No. 3, pp. 51-72.

Schultz, J. R. 1936. Plesippus francescana (Frick) from the Late Pliocene, Coso Mountains, California, with a review of the genus Plesippus. Carnegie Institute Publ. Vol. 473, pp. 1-13.

Shotwell, J. Arnold. 1955. An approach to the Paleoecology of mammals. Ecology. Vol. 36, No. 2, pp.327-337.

_______. 1958. Inter-community relationships in Hemphillian (Mid-Pliocene) mammals. Ecology. Vol.39, No. 2, pp. 271-282.

_______. 1967. Late Tertiary geomyid rodents of Oregon. University of Oregon Museum of Natural History Bulletin. No. 9.

Simpson, George G. 1961a. Principals of Animal Taxonomy, Columbia University Press. 247 pp.

_______. 1961b. Horses. The American Museum of Natural History in cooperation with Doubleday and Company, Inc. 323 pp.

Simpson, George G. and Carlos De Paula Conto. 1957. The Mastodonts of Brazil. Bulletin of the American Museum of Natural History. Vol. 112, Article 2.

Starrett, A. 1956. Pleistocene mammals of the Berends fauna of Oklahoma. Journal of Paleontology. Vol. 30, No. 5, pp. 1187-1192.

Stirton, R.A. 1931. A new genus of the family Vespertilionidae from the San Pedro Pliocene of Arizona. University of California Department of Geology Publication. Vol. 20, pp. 27-30.

Strain, W. S. 1966. Blancan mammalian fauna and Pleistocene formations Hudspeth County, Texas. Texas Memorial Museum Bulletin. No. 10. 55 pp.

Tessman, Norman and Everett H. Lindsay. Arizona vertebrate fossil localities. University of Arizona Press. In manuscript.

United States Geological Survey. 1952. Topographic map of the Tombstone 15 minute quadrangle. Department of the Interior.

Webb, S.David. 1965. The osteology of Camelops. Bulletin of the Los Angeles County Museum. Science Series: No. 1.

White, John A. 1968. A new porcupine from the Middle Pleistocene of the Anza-Borrego Desert of California. Los Angeles County Museum Contribution. No. 136, pp. 1-15.

_______. 1970. Late Cenozoic porcupines (Mammalia, Erethizontidae) of North America. American Museum Novitates. No. 2421.

White, John A. and T. Downs. 1961. A new Geomys from the Vallecito Creek Pleistocene of California. Los Angeles County Museum Contribution. Vol.42, pp. 3-34.

Wilson, E.D. and R.T.Moore. 1959. Structure of the basin and range province in Arizona. 55th Annual Meeting of the Cordilleran Section of the Geological Society of America. pp. 89-105

Wilson, R.W. 1933. A new rodent fauna from Later Cenozoic beds of southwestern Idaho. Carnegie Institute. No. 440, pp. 117-135.

_______. 1937. A new genus of lagomorph from the Pliocene of Mexico. Southern California Academy of Science Bulletin. Vol. 36, pp 98-104.

Wood, Albert E. 1935. Evolution and relationships of the Heteromyid rodents with new forms from the Tertiary of North America. Annals of the Carnegie Museum. Vol. 24, pp. 73-262.

_______. 1959. Eocene radiation and phylogeny of the rodents Evolution. Vol. 13, pp. 354-361.

Wood, Paul A. 1962. Pleistocene fauna from 111 Ranch area Graham County, Arizona. Ph. D. dissertation. University of Arizona.

Zakrzewski, Richard J. 1969. The rodents from the Hagerman local fauna, Upper Pliocene of Idaho. University of Michigan Museum of Paleontology Contribution. Vol.23, No. 1, pp. 1-36.

_______. 1970. Notes on kangaroo rats from the Pliocene of southwestern Kansas, with a description of a new species. Journal of Paleontology. Vol. 44, No. 3, pp. 474-477.