FOSSIL *SIGMODON* FROM SOUTHEASTERN ARIZONA

by

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Professor of Zoology

August 10, 1967
Date

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ABSTRACT

Between 1922 and 1942, five species of fossil *Sigmodon* were named and described from Blancan and post-Blancan deposits in Kansas and Arizona.

These species (*S. medius* Gidley, *S. minor* Gidley, *S. curtisi* Gidley, *S. intermedius* Hibbard, and *S. hilli* Hibbard) were named as a result of differences observed in enamel pattern and overall length of the cheek-tooth series.

A detailed analysis was made of sample populations of 100 modern *Sigmodon hispidus*, 20 modern *Sigmodon ochrognathus* and 20 modern *Sigmodon minimus* from Arizona and 395 individual specimens of fossil *Sigmodon* from lower and middle Pleistocene deposits in southeastern Arizona. This study indicates that most of the features previously considered diagnostic of a fossil species occur within single populations and even on different teeth of the same individual. These features are either due to changes occurring in the enamel pattern as a result of wear or are simply intraspecific variations and should not, therefore, be considered valid as diagnostic of a single species.

INTRODUCTION

Gidley (1922) named and described three new fossil species of *Sigmodon* from the San Pedro Valley in southeastern Arizona. These species were described as having molars decidedly less hypsodont and with "wider, more open re-entrant valleys." The fossil teeth also have more compressed lophs or ridges than in any known modern species.

Sigmodon medius is distinguished as a Blancan species (Gidley, 1922, p. 126) by three criteria: (1) the length of its cheek-tooth series; (2) the presence of a distinct notch on the lingual wall of lower M-3 opposite the lingual re-entrant valley; and (3) the lingual anterior re-entrant valley on lower M-1 is longer than the opposing outer one.

Gidley (1922, p. 126) also considered *S. minor* to be a post-Blancan species distinct from *S. medius* because of its smaller size, and relatively narrower lower M-1. He noted too, that the lower M-1 has a relatively smaller anterior lobe and the anterior re-entrant valleys are nearly equal in length. *Sigmodon curtisi* was found in the same locality but its relatively larger size and the form and proportion of its lower third molar presumably sets it apart from S. minor.

Gazin (1942, p. 491) describes the most significant characters in the lower molars of S. medius as the depth of the posterior re-entrant valley on the lingual surface of the second cheek tooth, and a distinct notch present on the posterior lingual surface of the third tooth. The posterior portion of the lingual wall of the third cheek tooth makes a sharp right angle (wall/valley angle) with the posterior wall of the lingual re-entrant valley. The wall/valley angle is more rounded on S. hispidus cheek teeth.

Gazin (1942, p. 510) describes S. minor as considerably smaller than S. curtisi being closer in size to S. medius.

Sigmodon curtisi is considered (Gazin, 1942, p. 509) to be distinctly larger than the other two fossil forms and compares favorably with the modern cotton rat, S. hispidus. The upper dentition appears noticably more hypsodont than that of S. medius. These upper teeth are much more similar to those of modern species, but they have broader re-entrant valleys.

Hibbard (1938, p. 247) named and described a new species of fossil cotton rat (S. intermedius) from the Ogallaha Formation, Rexroad fauna, Meade County, Kansas.

He considered this species to be intermediate in size between *S. medius* and *S. curtisi*. He further distinguished *S. intermedius*, from both modern and fossil forms, by the presence of a lingual enamel islet on lower M-2. In young specimens the islet is represented by a well developed re-entrant fold. He considered *S. intermedius* to have the most primitive dentition found among the cotton rats.

In 1941 Hibbard named and described another new species (*S. hilli*) from the Borchers fauna, Meade County, Kansas. The principal diagnostic feature of *S. hilli* concerns the relative transverse diameter of the molars. In *S. hilli* the molars are relatively broader than in any other fossil or modern species.

Hibbard (1941, p. 213) further pointed out that the lower M-1 anterior re-entrant valleys of *S. hilli* are nearly equal in length and there is no distinct notch present on the lingual wall of lower M-3.

The functional significance of these dental characteristics is not clear and therefore their use as diagnostic features is questionable. In spite of the fact that their functional role is not understood, these characters may be valid if they are sufficiently conservative. That is, a 1:1 relationship between the character and the species it identifies must be established. A feature, to be diagnostic of a species, must occur in all members of that species but in no other species. The present study is an attempt to identify those features which are valid as diagnostic characters and those which are simply variations within a single population.

MATERIALS AND METHODS

The recently discovered fossil *Sigmodon* described in this paper were uncovered at three separate localities in two regions of southeastern Arizona. Six lower jaws were obtained from Post Ranch (locality 47-1) and two lower jaws were obtained from Curtis Ranch (locality 25-2) in the San Pedro Valley. Three hundred and ninety-five specimens consisting of rami, maxillae, and isolated molars were obtained from a small pocket of tuff at the Tusker locality (15-24) on 111 Ranch in the San Simon Valley near Safford.

San Pedro Valley

San Pedro Valley extends approximately 170 miles in a northwesterly direction from old Mexico and terminates at the junction of the San Pedro and Gila Rivers.

The valley is bounded on both sides by steep rugged mountains and cuts through continental fluviatile and lacustrine sediments of Cenozoic age.

Gidley (1926, p. 84) discussed several fossil localities in the San Pedro Valley and pointed out that "...the stratified beds of these localities consist principally of red clays, sands and soft limestones that were laid down in salt lakes of small extent in the central part of the Pliocene basin." He further described the localities as "...relatively small patches or layers of greenish tuffaceous clay, which...interfinger on one side with arkosic gravel and conglomerate typical of deposition on alluvial slopes and on the other with the lake beds. This position seems to confirm Bryan's view that these bone-bearing patches of greenish clay represent the marginal and fresh-water springs that are characteristic of the borders of salt lakes in such basins. The localities thus probably constituted the chief watering places for the animals of the region, and here naturally occur their fossil remains."

Post Ranch is located about two miles south of Benson, on the west side of the valley at an elevation of 3810 feet. The strata involved are composed chiefly of silts, clays, fine-grained sands and limestone.

Curtis Ranch is located about 12 miles southeast of Post Ranch on the east side of the valley and at an elevation of 4025 feet. This locality yielded fossils principally from deposits of green clay.

<u>San Simon Valley - 111 Ranch</u>

San Simon Valley lies east of the San Pedro Valley, trending in a northwesterly direction.

Tusker locality on the 111 Ranch is located approximately 14 miles southeast of Safford on the west side of the valley at an elevation of about 3400 feet.

According to Seff (1960, pp. 137-138) it is composed of sediments consisting principally of sand, gravel, clay, marl, limestone, silt, tuffaceous silt, diatomite and chert. All the Sigmodon fossils were uncovered in a single deposit of tuffaceous silt (Wood, 1962).

Wood (1960, p. 142) in his discussion on the occurrence of such a large assemblage of small rodents in a restricted area, suggests that this deposition may have been due to the accumulation of fossil owl pellets. That so large an accumulation of relatively well preserved bones and teeth could have been transported long distances by stream action alone is unlikely, nor is it probable that they represent forms which migrated through the area over long periods of time. The fossilization of vertical plant stems in the same pockets indicate a rapid burial.

Specimens

Of the six lower jaws obtained from the Post Ranch locality, two have complete dentitions. Three are missing only M-3 and one specimen consists of a single, badly worn M-3 only.

The most complete specimen is U. A. #1518 which has three molars and is only slightly worn. The total length of the cheek-tooth series is 5.9 mm. Estimations of the length of the crown-tooth series of the other five, less complete, specimens falls within the range of 5.5 mm to 6.0 mm (based on comparative measurements of the individual molars).

Two of the specimens (U. A. #1517 and #1518) have M-1 anterior lingual re-entrant valleys considerably deeper than the opposing outer one. There is no notch on the lingual wall of M-3 and there is no great extension or flattening of this wall to form a 90° angle with the lingual re-entrant valley as described by Gidley (1922).

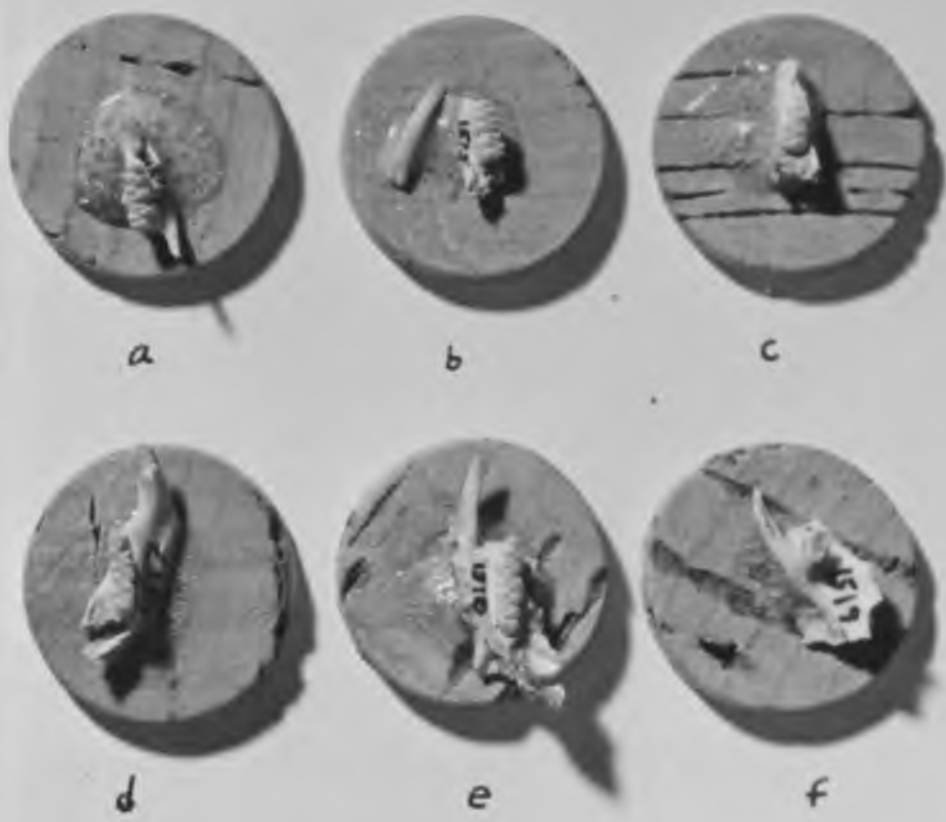
In two of the specimens with M-3 missing (U. A. #1514 and #1515) the anterior re-entrant valleys of M-1 are equal or nearly so.

There is no notch on the badly worn M-3 of #1519 and the angle where the lingual wall and re-entrant valley meet has been obliterated by wear.

The two Curtis Ranch specimens consisted of incomplete lower jaws. One jaw (U. A. #1581) has a complete molar dentition. The length of its cheek-tooth series is 5.3 mm. The second specimen (U. A. #1593) has no dentition but alveoli for all three cheek teeth are present and the mandible appears to be about equal in size to #1581. The

Figure 1. Representative fossil *Sigmodon* from Post Ranch: (a) #1514, lower right ramus; (b) #1515, lower left ramus; (c) #1516, lower right ramus; (d) #1517, lower left ramus; (e) #1518, lower right ramus; (f) #1519, lower right ramus. Representative fossil *Sigmodon* from Curtis Ranch: (a) #1581, lower left ramus; (b) #1593, lower left ramus. (All figures about twice natural size)

Fossil *Sigmodon* from Post Ranch



Fossil *Sigmodon* from Curtis Ranch

Figure 1.

M-1 anterior re-entrant valleys of #1581 are equal in length and there is a distinct notch present on the lingual side of M-3 opposite the posterior re-entrant valley.

The Tusker locality yielded 395 specimens including 38 lower jaws with complete molar dentition, 25 with only M-3 missing, 9 with only M-1 missing and 12 with only a single molar present. This collection also included one right and one left upper jaw with complete molar dentitions, 9 upper jaws with only M-3 missing, 6 with only M-1 present and 2 anterior skull portions including the rostrum and nearly complete molar dentitions.

The remainder of the Tusker collection consisted of 288 isolated molars. Those teeth with diagnostic features were used in the statistical analyses and are shown in Figure 4.

A great range of variations in size, enamel pattern and degree of wear can be seen in the Tusker assemblage and in the S. hispidus material (Table I).

Statistical analyses were made of a sample population of 100 modern S. hispidus, 20 modern S. ochrognathus, and 20 modern S. minimus. These specimens were used as a control sample against 395 fossil forms from the Tusker locality and eight from the Post and Curtis Ranches.

Measurements were taken through a Bausch and Lomb dissecting scope equipped with a micrometer.

Figure 2. Representative fossil _Sigmodon_ from the Tusker locality, 111 Ranch. (a-c-e) lower left rami; (b-d-f) lower right rami. (All figures about twice natural size)

Fossil _Sigmodon_ from Tusker Locality

Figure 2

Figure 3. Representative fossil *Sigmodon* from the Tusker locality, 111 Ranch. (a) Lateral view of right half of maxilla; (b) Occlusal view of upper left maxillary row; (c) Palatal view of maxillae and rostrum. (All figures about twice natural size)

Fossil Sigmodon from Tusker Locality

Figure 3

The term _adult_ is arbitrarily assigned, in this paper, to those specimens in which the lower M-3 has reached the line of occlusion. _Length of crown-tooth series_ refers to the anterposterior distance from the anteriormost point on the lower first molar to the posteriormost point on the cingulum of lower M-3. These points were used because the occlusal surfaces of the molars change regularly with wear.

The present study has been made without access to the fossil specimens examined by Gidley (1922), Gazin (1942) and Hibbard (1937-1941). Consequently, all interpretations of these fossils have been taken from published descriptions and illustrations.

TABLE I

COMPARISON OF DATA ON DIAGNOSTIC FEATURES TAKEN FROM SAMPLE POPULATIONS OF 100 MODERN AND 100 FOSSIL *SIGMODON*

	Modern *S. hispidus*	Tusker *Sigmodon*
Range of lengths of cheek-tooth series	6.1 - 7.2 mm	5.0 - 6.0 mm
Mean average and Standard deviation	6.4 mm .24 mm	5.5 mm .39 mm
Interior anterior re-entrant valley on lower M-1 greater than the exterior equivalent	45%	31%
Exterior anterior re-entrant valley on lower M-1 greater than the interior equivalent	38%	44%
Occurrence of a distinct notch on the lingual wall of lower M-3 opposite the lingual re-entrant valley	2%	3%
Occurrence of an indentation on the lingual wall of lower M-3 opposite the lingual re-entrant valley	14%	18%
Great extension and flattening of the lingual wall of lower M-3 forming a right or acute angle with the posterior border of the lingual re-entrant valley	21%	62%

DISCUSSION

All the fossil *Sigmodon* from southeastern Arizona which were examined, exhibited molars that were more brachydont and had wider re-entrant valleys and more constricted lophids than in any of the modern forms (Figures 4 and 4a).

Measurements of the cheek-tooth series of the Tusker fossil *Sigmodon* show that the average length (5.49 mm) is nearly one millimeter short of the modern *S. hispidus* (6.44 mm). None of the fossil specimens are large enough to fall within the range of extant species (with the exception of the modern *S. minimus*).

The increase in hypsodonty of the lower molars of modern species gives them a bulkier, more compact appearance. The teeth of modern forms are also inclined forward to a greater extent than that seen in any fossil form.

The criteria used by Gidley (1922), Gazin (1942) and Hibbard (1937; 1941) as diagnostic of all fossil species are: (1) the posterior lingual re-entrant valleys on lower M-1 and M-2 are relatively deeper than in modern forms; (2) the lingual wall of lower M-3 is extended and flattened and forms a right angle with the posterior border

Figure 4. Differences in degree of hypsodonty between modern and fossil *Sigmodon*. (a) Lateral view of isolated teeth of *Sigmodon* from the Tusker locality; (b) Lateral view of isolated teeth of *Sigmodon hispidus*; (c) Occlusal view of isolated teeth of *Sigmodon* from the Tusker locality; (d) Occlusal view of isolated teeth of *Sigmodon hispidus*; (e) Buccal view of left rami showing relative size and proportion. (All figures about twice natural size)

Differences in Degree of Hypsodonty

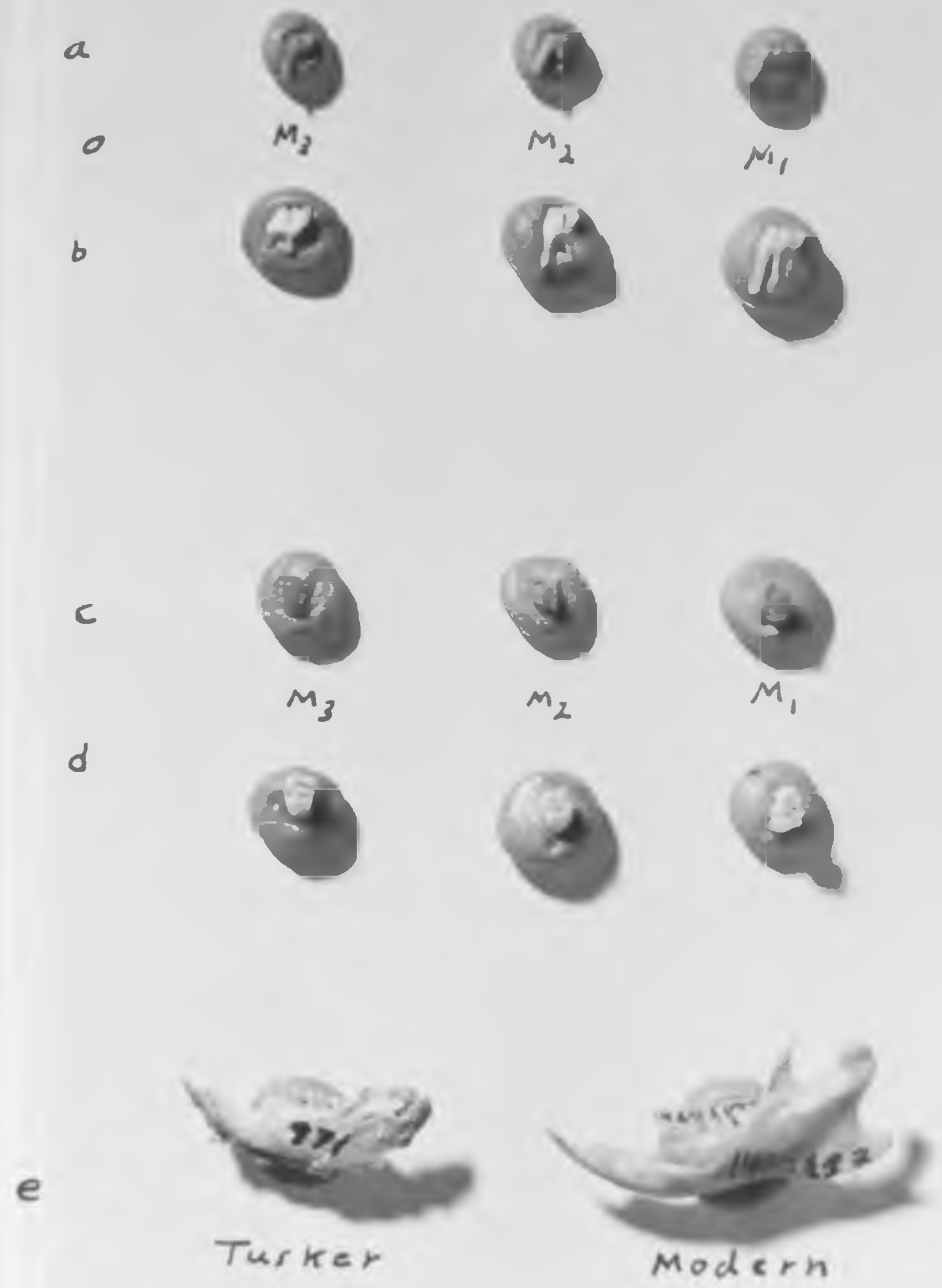


Figure 4

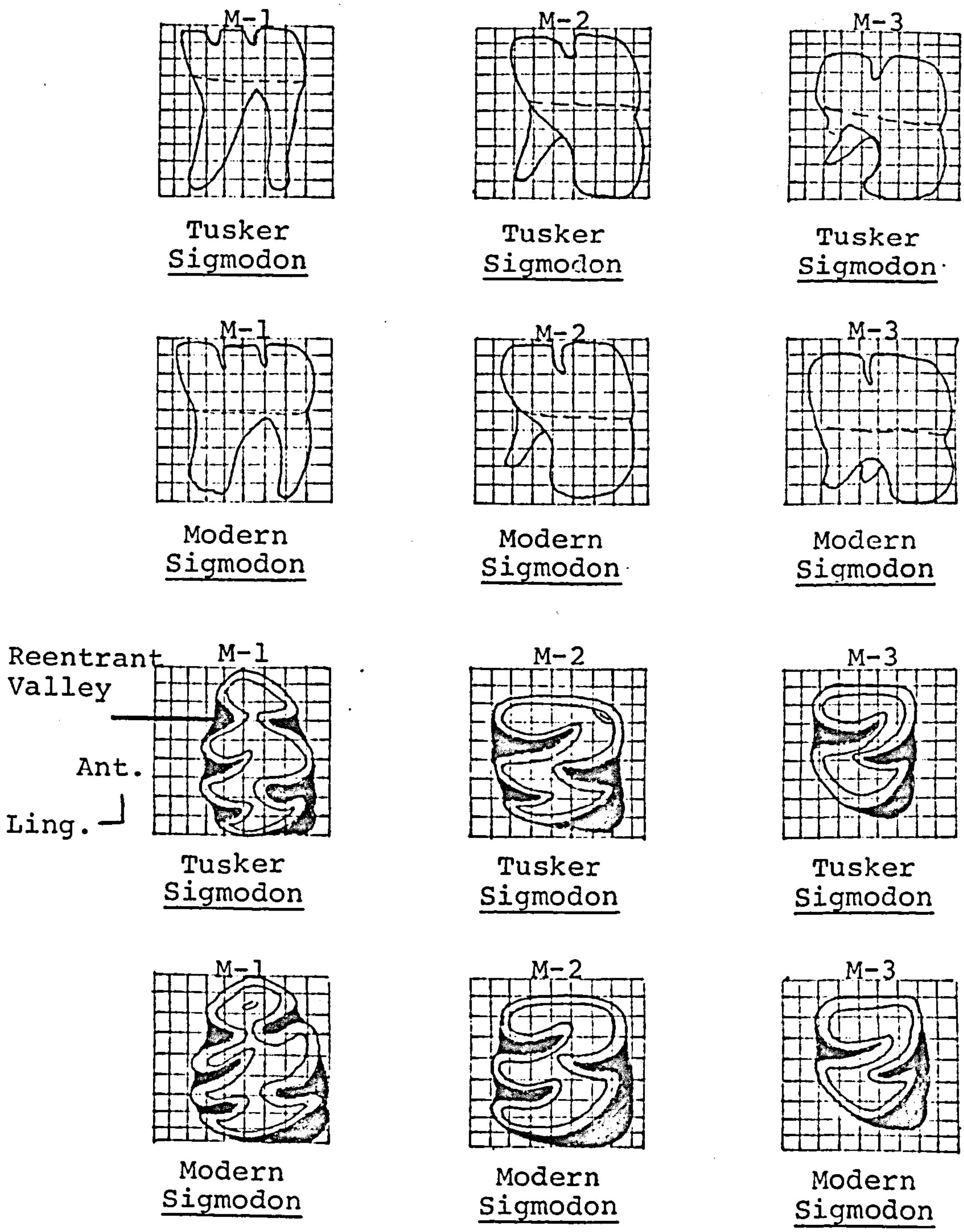


Figure 4a. Lateral and occlusal views of Sigmodon molars showing brachydont condition of fossil forms and hypsodont condition of modern forms.

of the lingual re-entrant valley (wall/valley angle). A statistical analysis of 100 modern Sigmodon hispidus and 395 fossil Sigmodon from the Tusker locality indicates that these features vary with wear.

As the occlusal surface begins to wear, the posterior re-entrant valley on lower M-2 becomes shorter and shallower as does the posterior re-entrant valley of lower M-1. Both valleys may wear down to small grooves near the lingual edge of the tooth or they may become isolated islets of enamel at their internal angles just prior to obliteration. Wear on the lower M-3 causes the angle at the junction of the lingual wall and the posterior border of the lingual re-entrant valley (wall/valley angle) to become more acute, forming an angle of 90° or less until it too eventually becomes obliterated (Figure 6). This more acute wall/ valley angle occurs in 21% of modern forms and in 62% of the fossil forms (Table I). This discrepency is probably due to the different ratios of juveniles to adults in the two populations studied.

The criteria listed in Table II, have been used as diagnostic features of the five previously named species.

The first seven features listed in Table II have been found to exist in significant percentages within the Tusker Sigmodon population. With the exception of the size of M-3 (Table II, No. 7) they have been found to also exist within a sample population of modern *Sigmodon hispidus*. It is probable that these features represent variations one should expect to find occurring within a single outbreeding population. They, therefore, cannot be considered diagnostic of fossil species distinct from the Tusker population.

Variations in the enamel patterns (Table II, Nos. 8 and 9) have been found to be due to wear. The anterior lingual re-entrant valley of lower M-1 is considerably longer than the opposing buccal valley during the juvenile stage. As the tooth wears, the lingual valley becomes shorter and shallower while the buccal valley appears to become longer and shallower. In extreme stages of wear the lingual valley may become reduced to a small groove on the lingual side of the tooth or it may become an isolated islet of enamel. The end result of wear is complete obliteration of these features. The isolated islet of enamel on the lower second molar of *S. intermedius*, described by Hibbard (1937), appears to be simply what remains of the posterior lingual re-entrant valley reduced to this state by wear. As Hibbard (1937, p. 247) pointed out, "...in young specimens this islet is represented by a well developed re-entrant fold."

The length of the cheek-tooth series of all the fossil *Sigmodon* fall within the range of the Tusker population with the exception of *S. minor* and *S. curtisi*.

TABLE II

FEATURES DEFINED AS DIAGNOSTIC OF FOSSIL SIGMODON SPECIES

S. medius	S. minor	S. curtisi	S. intermedius	S. hilli
1. Distinct notch on lingual wall of lower M-3	No notch	No notch	No notch	No notch
2. Anterior lobe of lower M-1 narrower than in modern forms	Anterior lobe smaller than in all other forms	Anterior lobe similar in size to modern forms	Unknown	Unknown
3. Unknown	Lower M-1 narrower than in other forms	Unknown	Unknown	All lower molars narrower than in other forms
4. Unknown	Unknown	Unknown	Anterior internal lophid of lower M-2 not as compressed and elongate as in other forms	Unknown
5. Unknown	Unknown	Unknown	Unknown	Anterior loph of upper M-1 smaller than in other forms

TABLE II (Cont.)

	S. medius	*S. minor*	*S. curtisi*	*S. intermedius*	*S. hilli*
6.	Exterior re-entrant valleys of upper molars arcuate	Unknown	Unknown	Unknown	Unknown
7.	Unknown	Unknown	Posterior cusp of lower M-3 broader than in other forms	Unknown	Posterior cusp of lower M-3 small tooth triangular in shape
8.	Anterior Lingual re-entrant valley longer than opposing buccal valley on lower M-1	Anterior re-entrant valleys equal in length	Anterior re-entrant valleys equal in length	Anterior re-entrant valleys equal in length	Anterior re-entrant valleys equal in length
9.	Unknown	Unknown	Unknown	Enamel groove or islet on lower M-2	Unknown
10.	Cheek-tooth series length 5.5 mm	Cheek-tooth series length 4.7 mm	Cheek-tooth series length 7.0 mm	Cheek-tooth series length 5.5 mm	Cheek-tooth series length 5.25 mm

Figure 5. Mandibles of modern *Sigmodon hispidus* showing various stages of wear and its effect on the enamel pattern of the crowns. (All figures about twice natural size)

Modern Sigmodon hispidus showing various stages of wear

Figure 5

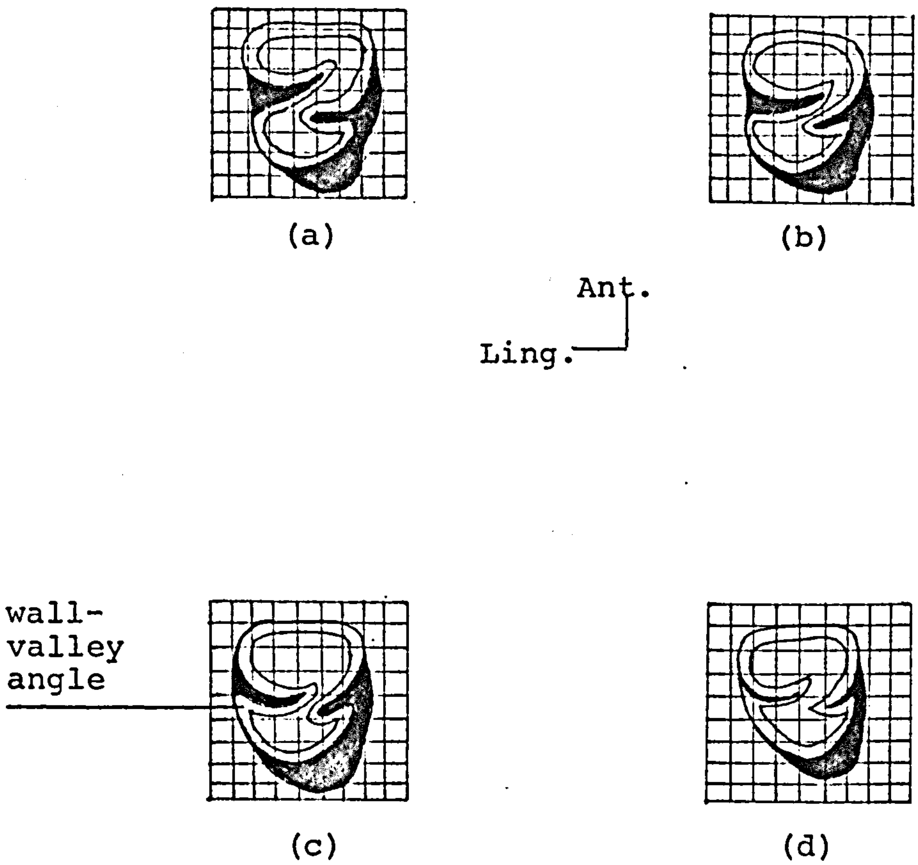
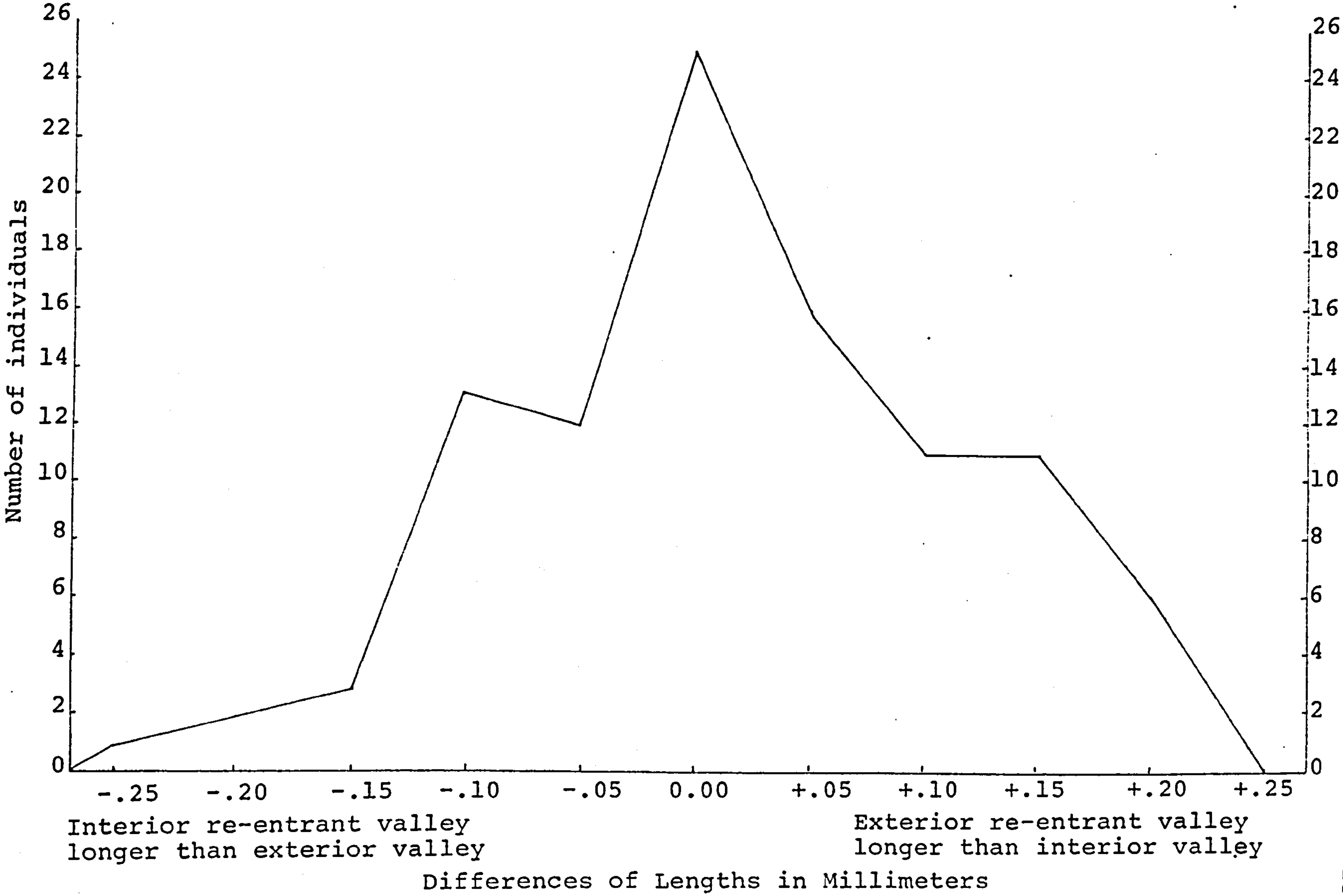


Figure 6. Occlusal views of the lower third molar showing the effect of wear on the "wall/valley angle". (a) youngest, (d) oldest

The difference between S. minor and the Tusker specimens in cheek-tooth length (Table I and II) may be due to errors in measurement or in sampling. Only 34 lower jaws from the Tusker locality were complete enough to be used for length of cheek-tooth series measurements. It is possible that through sampling error the specimens referred to as S. minor represent smaller members which were not seen in the Tusker specimens. As Gazin (1942, p. 510) pointed out:

> "There is an appreciable variation in size of the jaws and teeth, and although size of teeth is not in every case correlated with size of jaw, one heavy jawed specimen ...has slightly larger teeth than the smallest of the Benson lot:..."

Sigmodon curtisi probably represents a species distinct from the other fossil forms. The length of the cheek-tooth series and the relatively larger size of the teeth and jaws are well within the range of modern species. Since actual specimens of S. curtisi were not available, its relationship to modern forms is not postulated.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4
6
8
10
12
14
16
18
20
22
24
26
-.25
-.20
-.15
-.10
-.05
0.00
+.05
+.10
+.15
+.20
+.25
Interior re-entrant valley longer than exterior valley
Exterior re-entrant valley longer than interior valley
Differences of Lengths in Millimeters

Figure 7

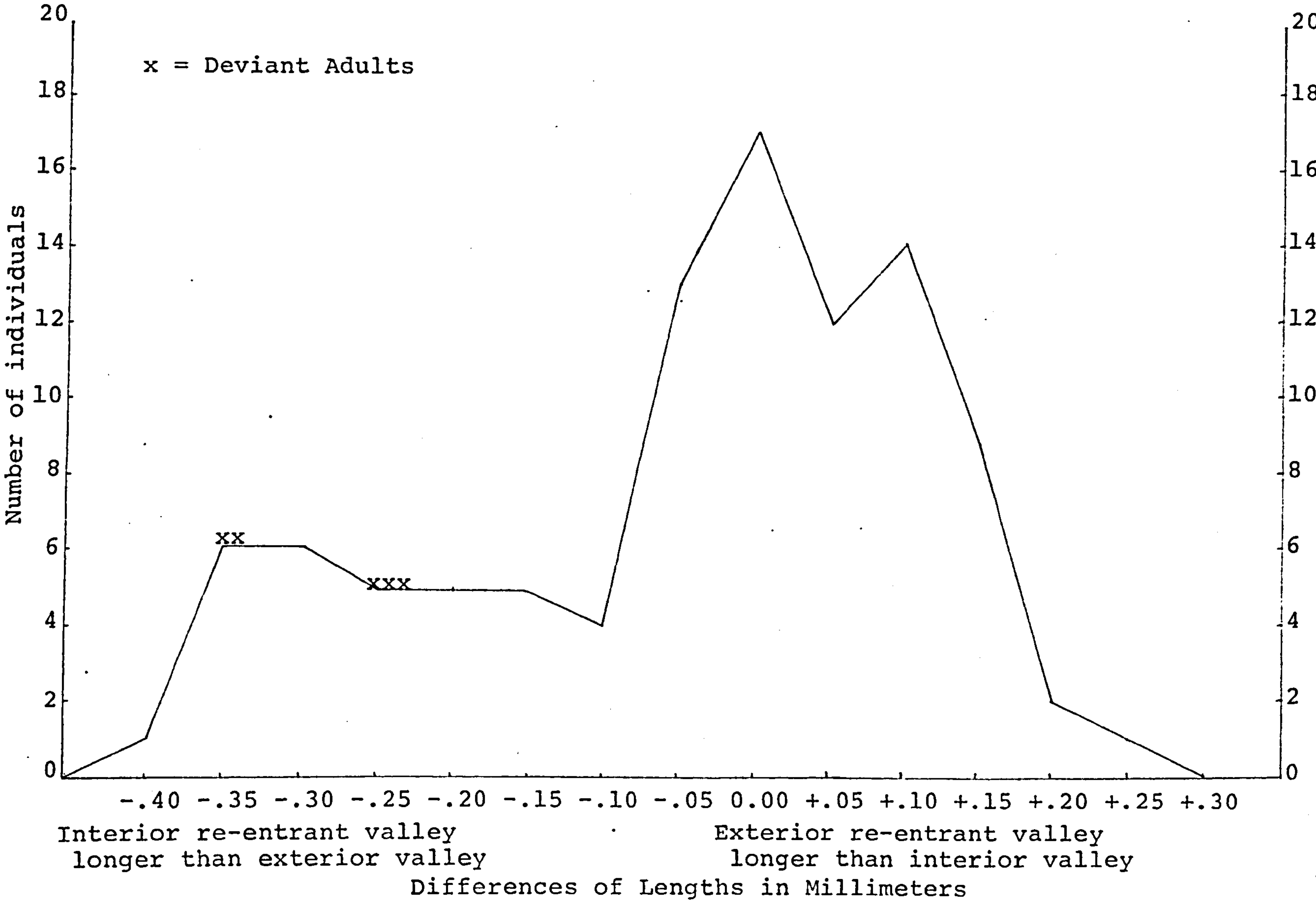
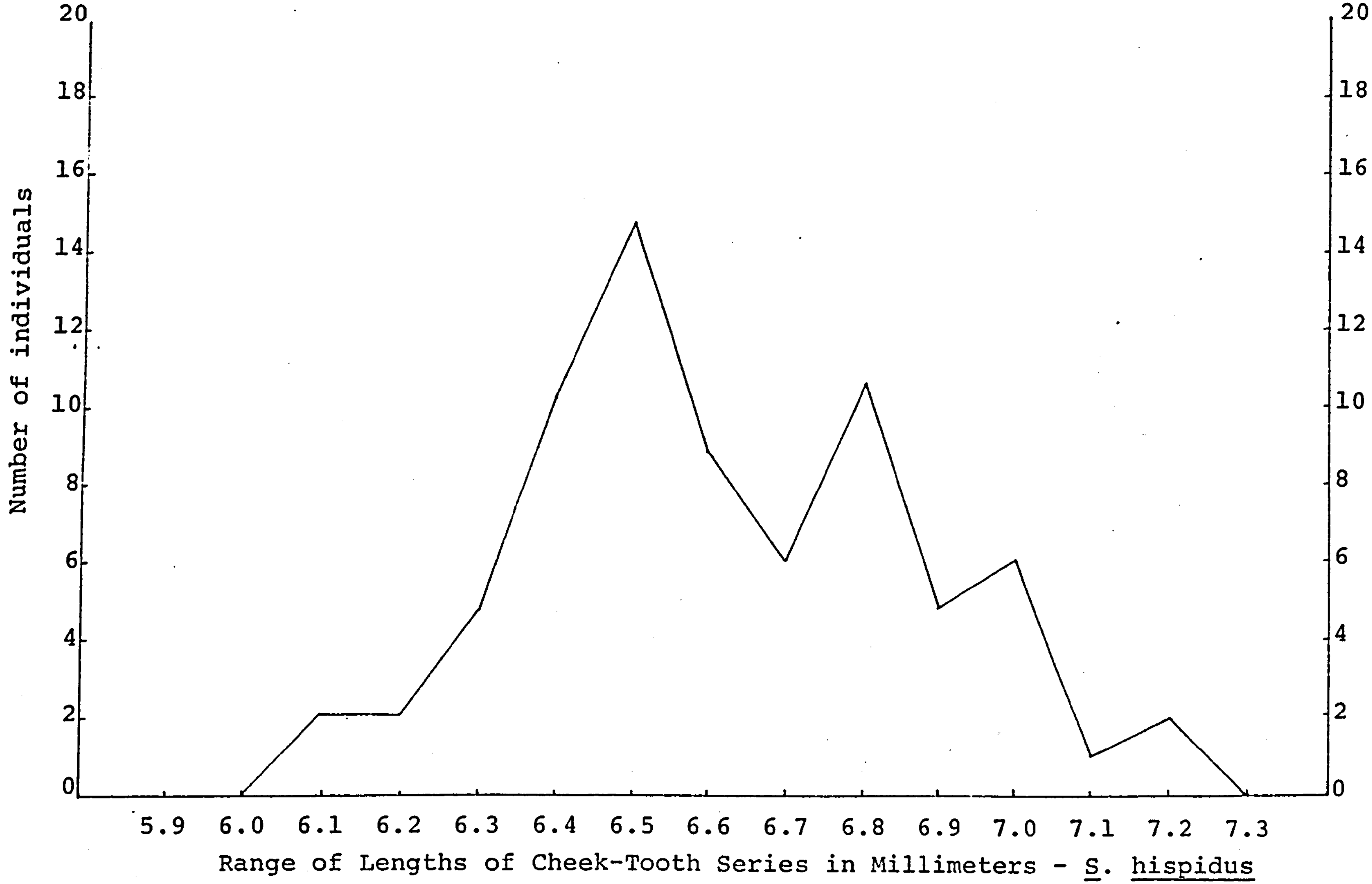
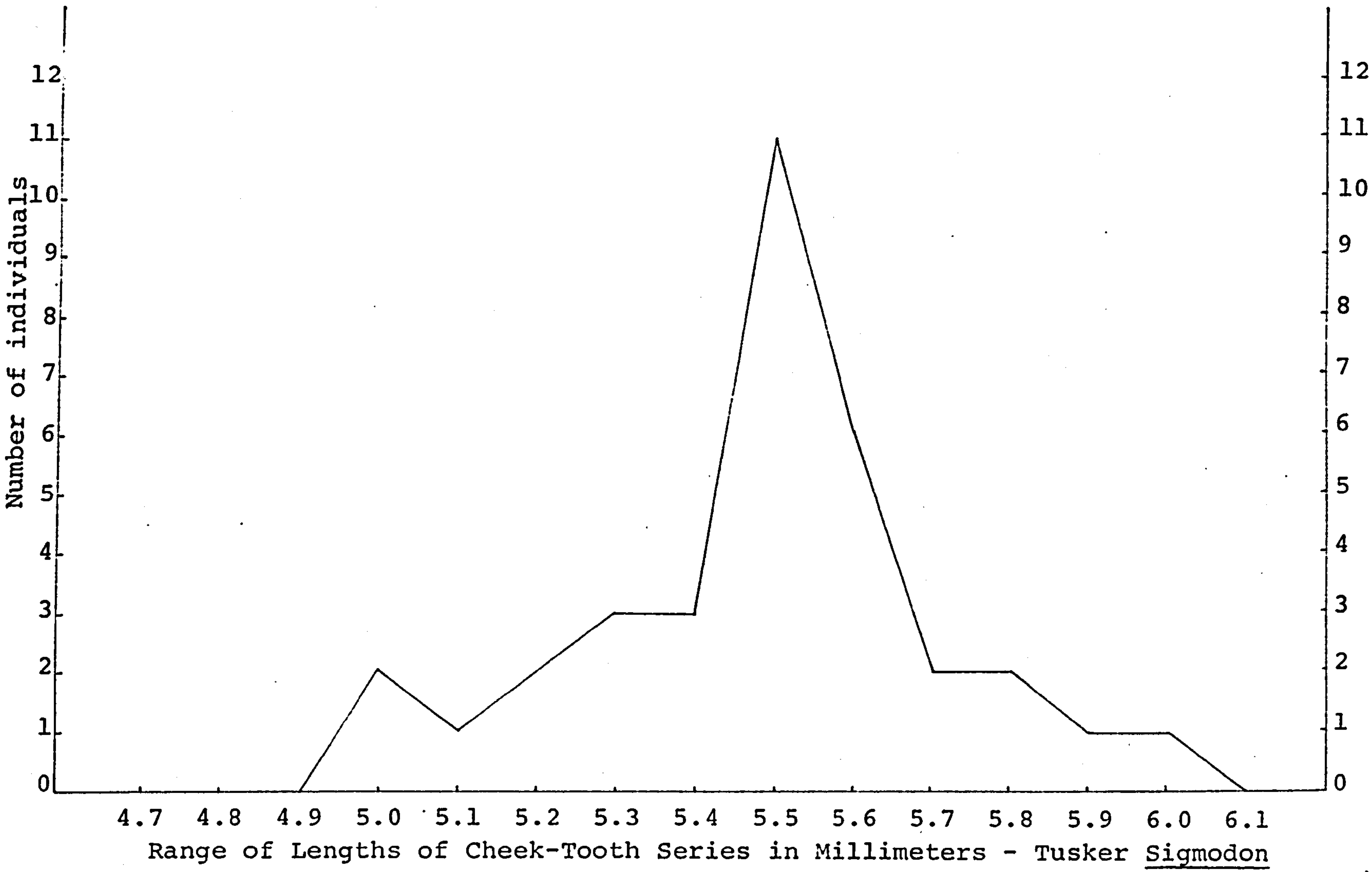

x = Deviant Adults
Number of individuals
20
18
16
14
12
10
8
6
4
2
0
xx
xxx
-.40 -.35 -.30 -.25 -.20 -.15 -.10 -.05 0.00 +.05 +.10 +.15 +.20 +.25 +.30
Interior re-entrant valley longer than exterior valley
Exterior re-entrant valley longer than interior valley
Differences of Lengths in Millimeters

Figure 8



20
18
16
14
12
10
8
6
4
2
0
Number of individuals
5.9
6.0
6.1
6.2
6.3
6.4
6.5
6.6
6.7
6.8
6.9
7.0
7.1
7.2
7.3
Range of Lengths of Cheek-Tooth Series in Millimeters - S. hispidus

Figure 9


Number of individuals
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1
2
3
4
5
6
7
8
9
10
11
12
4.7
4.8
4.9
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6.0
6.1
Range of Lengths of Cheek-Tooth Series in Millimeters - Tusker Sigmodon

Figure 10

CONCLUSION

The present collection of fossil specimens from southeastern Arizona represents a species of *Sigmodon* distinct from any known modern species. This assumption is based primarily on the degree of brachydonty and smaller size of the molars.

Sigmodon medius Gidley and the fossils from Post Ranch in the U. of A. collection represent earlier forms of a single, wide ranging Blancan species of which the Rexroad *Sigmodon* from Kansas is a northern representative.

Specimens from Curtis Ranch, Tusker Locality and possibly those previously referred to as *Sigmodon minor* represent a continuation of this species into post-Blancan times with the Borchers *Sigmodon* from Kansas as a northern representative.

Sigmodon curtisi, because of its large size, is probably an abberrant species distinct from its contemporaries and either confined in time to the Irvingtonian or an early representative of modern species.

APPENDICES

APPENDIX A

LIST OF MEASUREMENTS TAKEN FROM A SAMPLE OF 100 SIGMODON FOSSILS FROM 111 RANCH

U. of A. Number	Length of Ext. Re-entrant	Length of Int. Re-entrant	Differences
#905	.25 mm	.50 mm	-.25 mm
#977	.40	.60	-.20
#2511-24	.35	.55	-.20
#922	.55	.70	-.15
#972	.30	.45	-.15
#2511-31	.40	.55	-.15
#1024	.40	.50	-.10
#938	.45	.55	-.10
#924	.40	.50	-.10
#930	.40	.50	-.10
#1042	.40	.50	-.10
#2511-14	.45	.55	-.10
#2511-19	.45	.55	-.10
#2511-26	.40	.50	-.10
#2511-29	.35	.45	-.10
#2511-32	.40	.50	-.10
#2511-33	.40	.50	-.10
#2511-34	.40	.50	-.10
#2511-37	.40	.50	-.10

APPENDIX A (Continued)

U. of A. Number	Length of Ext. Re-entrant	Length of Int. Re-entrant	Differences
#973	.45 mm	.50 mm	-.05 mm
#977	.45	.50	-.05
#939	.45	.50	-.05
#971	.45	.50	-.05
#913	.50	.55	-.05
#1075	.45	.50	-.05
#931	.40	.45	-.05
#2511-5	.40	.45	-.05
#2511-13	.35	.40	-.05
#2511-41	.45	.50	-.05
#2511-42	.45	.50	-.05
#2511-16	.35	.40	-.05
#1039	.45	.45	.00
#1068	.35	.35	.00
#940	.50	.50	.00
#946	.45	.45	.00
#916	.40	.40	.00
#928	.45	.45	.00
#968	.50	.50	.00
#981	.50	.50	.00
#934	.50	.50	.00
#2495	.50	.50	.00

APPENDIX A (Continued)

U. of A. Number	Length of Ext. Re-entrant	Length of Int. Re-entrant	Differences
#2511-23	.40 mm	.40 mm	.00 mm
#2511-25	.45	.45	.00
#2511-27	.35	.35	.00
#2511-36	.40	.40	.00
#2511-39	.45	.45	.00
#2511-23	.45	.45	.00
#2511-35	.45	.45	.00
#2511-60	.50	.50	.00
#2511-90	.50	.50	.00
#2511-10	.40	.40	.00
#2511-11	.40	.40	.00
#2511-12	.50	.50	.00
#2511-15	.45	.45	.00
#2511-44	.40	.40	.00
#2511-45	.50	.50	.00
#2848	.45	.40	+.05
#2500-35	.50	.45	+.05
#1023-7	.50	.45	+.05
#9821-[illegible]	.50	.45	+.05
#970[illegible]-17	.55	.50	+.05
#1040	.50	.45	+.05
#983	.50	.45	+.05

APPENDIX A (Continued)

U. of A. Number	Length of Ext. Re-entrant	Length of Int. Re-entrant	Differences
#2511-1	.45 mm	.40 mm	+.05 mm
#2511-4	.45	.40	+.05
#2511-18	.45	.40	+.05
#2511-20	.45	.40	+.05
#2511-21	.45	.40	+.05
#2511-22	.50	.45	+.05
#2511-43	.45	.40	+.05
#2511-38	.55	.50	+.05
#2511-40	.50	.45	+.05
#2501	.45	.35	+.10
#966	.50	.40	+.10
#1104	.50	.40	+.10
#985	.45	.35	+.10
#967	.50	.40	+.10
#935	.55	.45	+.10
#1062	.50	.40	+.10
#2511-35	.50	.40	+.10
#2511-7	.55	.45	+.10
#2511-8	.55	.45	+.10
#2511-17	.55	.45	+.10
#947	.45	.30	+.15
#1063	.55	.40	+.15

APPENDIX A (Continued)

U. of A. Number	Length of Ext. Re-entrant	Length of Int. Re-entrant	Differences
#1077	.50 mm	.35 mm	+.15 mm
#976	.50	.30	+.15
#914	.55	.40	+.15
#932	.55	.40	+.15
#974	.45	.30	+.15
#1087	.55	.40	+.15
#1060	.60	.45	+.15
#2511-28	.55	.40	+.15
#2511-30	.55	.40	+.15
#2496	.50	.30	+.20
#922	.65	.45	+.20
#2499	.50	.30	+.20
#941	.50	.30	+.20
#975	.55	.35	+.20

Mean Average of the Difference -.0175

Standard Deviation .11

APPENDIX B

MEASUREMENTS OF THE ANTERIOR RE-ENTRANT VALLEYS OF THE MODERN <u>SIGMODON HISPIDUS</u> ON M_1

U. of A. Number		Length of Ext. Re-entrant	Length of Int. Re-entrant	Difference
#8726	J	.30 mm	.70 mm	-.40 mm
#8730	J	.35	.70	-.35
#740	J	.30	.65	-.35
#8022	J	.30	.65	-.35
#9190	J	.30	.65	-.35
#8728	A	.35	.70	-.35
#8334	A	.40	.75	-.35
#2968	J	.35	.65	-.30
#9191	J	.30	.60	-.30
#8367	J	.35	.65	-.30
#8725	J	.40	.70	-.30
#741	J	.35	.65	-.30
#12442	J	.35	.65	-.30
#5234	J	.40	.65	-.25
#4730	J	.40	.65	-.25
#9792	A	.40	.65	-.25
#12428	A	.50	.75	-.25
#4727	A	.50	.75	-.25
#12417	J	.40	.60	-.20

APPENDIX B (Continued)

U. of A. Number		Length of Ext. Re-entrant	Length of Int. Re-entrant	Difference
#8021	J	.40 mm	.60 mm	-.20 mm
#8331	J	.45	.65	-.20
#5177	J	.40	.60	-.20
#1244	J	.40	.60	-.20
#2831	A	.50	.65	-.15
#12427	A	.45	.60	-.15
#2845	A	.55	.70	-.15
#8013	A	.55	.70	-.15
#12455	A	.50	.65	-.15
#12439	A	.40	.50	-.10
#6226	A	.55	.65	-.10
#10864	A	.55	.65	-.10
#10863	A	.55	.65	-.10
#12441	A	.50	.55	-.10
#3490	A	.60	.65	-.05
#9787	A	.55	.60	-.05
#8026	A	.60	.65	-.05
#625	A	.60	.65	-.05
#174	A	.60	.65	-.05
#9785	A	.60	.65	-.05
#9786	A	.60	.65	-.05
#11937	A	.60	.65	-.05

APPENDIX B (Continued)

U. of A. Number		Length of Ext. Re-entrant	Length of Int. Re-entrant	Difference
#9791	A	.60 mm	.65 mm	-.05 mm
#12454	A	.60	.65	-.05
#6827	A	.60	.65	-.06
#14655	A	.65	.70	-.05
#9792	A	.60	.60	.00
#9795	A	.60	.60	.00
#6829	A	.55	.55	.00
#1246	A	.55	.55	.00
#772	A	.50	.50	.00
#6049	A	.60	.60	.00
#6830	A	.75	.75	.00
#9789	A	.65	.65	.00
#1066	A	.65	.65	.00
#9790	A	.65	.65	.00
#14256	A	.65	.65	.00
#2835	A	.65	.65	.00
#9788	A	.65	.65	.00
#9782	A	.70	.70	.00
#14438	A	.65	.65	.00
#10859	A	.60	.60	.00
#9797	A	.65	.65	.00
#6825	A	.60	.65	+.05

APPENDIX B (Continued)

U. of A. Number		Length of Ext. Re-entrant	Length of Int. Re-entrant	Difference
#1202	A	.70 mm	.65 mm	+.05 mm
#5474	A	.65	.60	+.05
#14262	A	.70	.65	+.05
#6828	A	.65	.60	+.05
#14259	A	.65	.60	+.05
#15285	A	.60	.55	+.05
#14323	A	.60	.55	+.05
#14837	A	.70	.65	+.05
#14321	A	.65	.60	+.05
#9781	A	.70	.65	+.05
#10861	A	.60	.55	+.05
#6824	A	.65	.55	+.10
#117	A	.75	.65	+.10
#9784	A	.65	.55	+.10
#10860	A	.65	.55	+.10
#14838	A	.75	.65	+.10
#661	A	.80	.70	+.10
#113	A	.70	.60	+.10
#14322	A	.65	.55	+.10
#9783	A	.65	.55	+.10
#5715	A	.75	.65	+.10
#14835	A	.75	.65	+.10

APPENDIX B (Continued)

U. of A. Number		Length of Ext. Re-entrant	Length of Int. Re-entrant	Difference
#6394	A	.70 mm	.60 mm	+.10 mm
#14257	A	.70	.60	+.10
#14324	A	.70	.55	+.15
#14260	A	.70	.55	+.15
#10862	A	.75	.60	+.15
#14836	A	.70	.55	+.15
#527	A	.75	.60	+.15
#124	A	.75	.60	+.15
#9794	A	.75	.60*	+.15
#14261	A	.75	.60*	+.15
#13967	A	.70	.55*	+.15
#118	A	.75	.55*	+.15
#9798	A	.70	.50*	+.20
#660	A	.70	.45*	+.25
#5702	A	.70*	gone	These were not included in the sample
#921	A	.75*	gone	
#8727	A	gone	gone	

*reduced to small groove or island

Mean Average of the Difference -.0435

Standard Deviation .13

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