FOSSIL MAMMALS OF THE COLEMAN IIA LOCAL FAUNA, SUMTER COUNTY, FLORIDA

By

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MEASUREMENTS AND ABBREVIATIONS

I. Measurements

Sciurus and Glaucomys

Innominate length - greatest length

Innominate width - greatest width with the calipers held perpendicular to the long axis of the innominate

Femur length - greatest length

Femur width (distal) - distance between the medial and lateral condyles

Tibia length - greatest length

Tibia width (proximal) - distance between the medial and lateral condyles

Humerus length - greatest length

Humerus width (proximal) - distance between the greater and lesser tuberosities

MA length - mandibular alveolar length

RA length - ramus alveolar length; distance from the greatest angle of the posterior border of the ascending ramus to the anterior border of the alveolus of the first lower molar (see Martin, 1967)

Cryptotis and Blarina

Condyloid to mental foramen - distance from the most posterior projection of the condyloid process to the center of the mental foramen

Cryptotis and Blarina - continued

Condyloid to M_1 - distance from the most posterior projection of the condyloid process to the anterior border of M_1

Sigmodon

Length M_3 - the entire visible length of the tooth in occlusal view; not merely the occlusal surface

Width M_1, M_2, M_3- the entire visible width of the teeth in occlusal view; not merely the occlusal surface

Canis

Width P^4 and M^1 - taken by first placing one edge of the calipers flush with the labial border of the paracone and metacone, then bringing the other ediege into contact with the protocone

All multiple tooth measures designated by letters (e. g., $M_1 - M_2$) are measurements taken from the anterior border of the first tooth to the posterior border of the second, inclusive; each is not measured separately.

Measurements were taken with a Helios 7-inch calipers and a Gaertner platform measuring microscope.

A cross (+) preceding the name of a taxon indicates that it is extinct.

II Abbreviations

UF - University of Florida, Florida State Museum (Walter Auffenberg, S. David Webb, Thomas Patton)

FGS - Florida Geological Survey (Stanley Olsen)

FDT - Florida Diving Tours

UT or UTMM - University of Texas, Texas Memorial Museum (Ernest Lundelius, Jr.)

UMMVP - University of Michigan Museum,Vertebrate Paleontology (Claude Hibbard)

LACM - Los Angeles County Museum (Theodore Downs, John White)

UAVP - University of Arizona, Vertebrate Paleontology (Everett Lindsay)

MUVP - Midwestern University, Vertebrate Paleontology (Walter Dalquest)

UKMVP - University of Kansas Museum, Vertebrate Paleontology (Theodore Eaton, Orville Bonner)

UK - University of Kansas Museum, Natural History (J. Knox Jones, Robert Hoffmann)

UCMVP - University of California at Berkeley Museum, Vertebrate Paleontology (Donald Savage)

UCMVZ - University of California at Berkeley, Museum of Vertebrate Zoology (William Lidicker)

AMNH - American Museum of Natural History (Richard Tedford, Malcolm McKenna, Richard Van Gelder, Sydney Anderson, Guy Musser)

USNM - United States National Museum (Clayton Ray, Nicholas Hotton, Charles Handley, Henry Setzer, Ronald Pine, John Paradiso)

INTRODUCTION

Florida has produced, and still continues to produce, some of the richest Pleistocene deposits in the world. Yet these deposits have, until very recently, defied interpretation. This is particularly true of the mammalian faunas; less so of some of the reptilian faunas. Auffenberg's (1958) study of the genus *Terrapene* is the only published attempt to correlate the numerous isolated Florida deposits both in time and in relation to major eustatic changes in sea level. However, of those Pleistocene faunas considered by Auffenberg (1958), only six--Vero (Weigel, 1962), Williston (Holman, 1959), Sabertooth Cave (Simpson, 1928), Seminole Field (Simpson, 1929), Reddick IA (Gut and Ray, 1963), and Melbourne (Ray, 1958)--had been studied in any detail with respect to their mammalian component. In addition, Brooks (1968) presented evidence that some of the ancient shorelines considered by Auffenberg (1958) to be of Pelistocene age are probably much more archaic. Nonetheless, my studies of the Florida Pleistocene mammalian faunas confirm most of Auffenberg's conclusions regarding the chronological ordering of these faunas.

The Coleman IIA local fauna represents a particularly important, previously unsampled, time period in Florida's history, and has provided the information necessary to develop a coherent picture of mammalian turnover in Florida during the Ice Ages (Pleistocene). Therefore it seems reasonable to familiarize the reader with those other Florida

Pleistocene faunas which I will constantly mention in the text. The following is a list of these faunas. Exact locations and geologic setting are given only if not previously described. All localities are mapped in Figure 1 and the numbers preceding the localities refer to their location on the latter map:

2) Ichetucknee River, Columbia County (Simpson, 1930; Auffenberg, 1963; Kurten, 1965; McCoy, 1963; Martin, 1969a)

3) Santa Fe River, Gilchrist County (Martin, 1969a)
Localities 1, 1B, 2, 4A, 8A

6) Haile, Alachua County (Brodkorb, 1953; Auffenberg, 1963; Ligon, 1965)
Localities VIIA, VIIIA, XIA, IXB, XIIIA, XIIIB, XIIIC, XIVA, XIVB, XVA

4) Arredondo, Alachua County (Bader, 1957; Brodkorb, 1959; Auffenberg, 1963)
Localities IA, IIA, IIB

7) Williston, Levy County (Holman, 1959)
Locality III

8) Devil's Den, Levy County (Arata, 1961; Kurtén, 1965)

9) Reddick, Marion County (Brodkorb, 1957; Gut and Ray, 1963)
Localities IA, IB, IIC

13) Sabertooth Cave, Citrus County (Simpson, 1928; Auffenberg, 1963)

11) Withlacoochee River, Citrus County (Martin, 1968a, 1969a)
Locality 7A

20) Eichelberger Cave, Marion County (Auffenberg, 1963)
Localities A and B

18) Bradenton Field and 51st Street, Manatee County (Simpson, 1929; Auffenberg, 1963)

14) Seminole Field, Pinellas County (Simpson, 1929; Auffenberg, 1963)

5) Payne's Prairie, Alachua County (Auffenberg, 1963; Martin, 1969a)

16) Melbourne, Brevard County (Gazin, 1950; Ray, 1958

star) Coleman, Sumter County

Locality IIA (this report)

Locality III; A, B, C, D: the west wall of Pit III is composed of a series of superimposed fresh water marls; the letters stand for four recognizable spring heads.

15) Pool Branch, Polk County

Fossils from this locality were recovered from a canal bank east of the Peace River near the Clear Spring Mine; near the town of Fort Meade.

19) Punta Gorda, Charlotte County

Fossils were recovered from the bank of Alligator Creek in the N edge SW-1/4 NE-1/4 Sec. 26, T 41 S, R 23 E of the Cleveland Quadrangle.

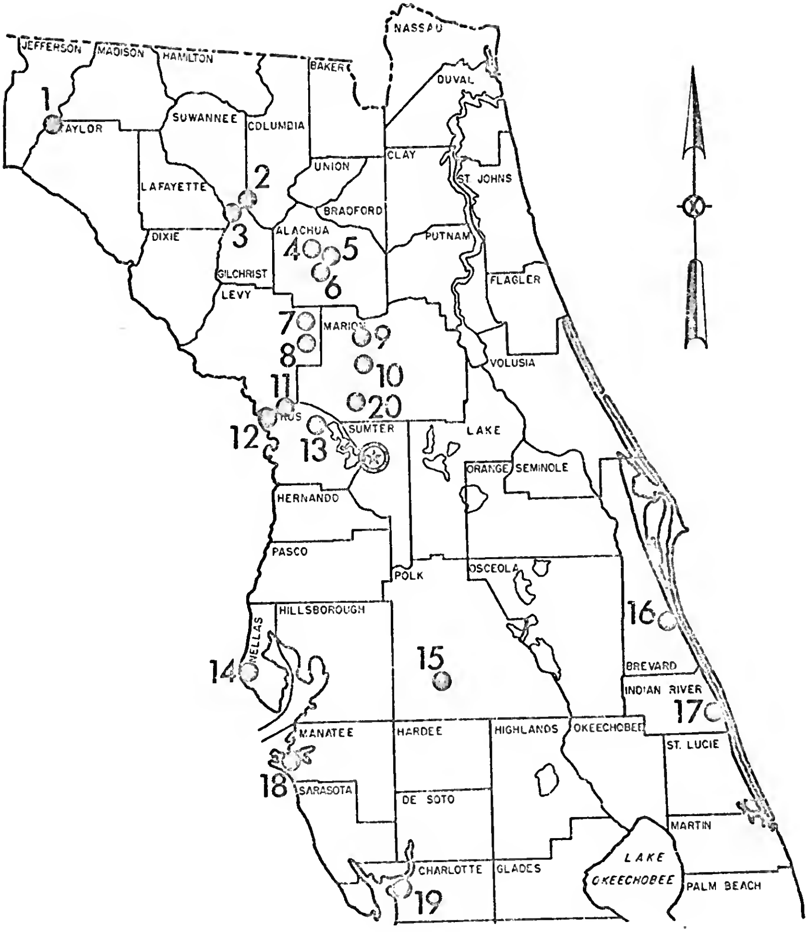
1) Aucilla River, border of Madison and Jefferson Counties

Localities from this river and their mammalian contents have not been described.

12) Inglis, Citrus County

Locality IA; The fossil material from this locality comes from a limestone sinkhole, filled with beach sands, exposed on the north bank of the Florida Barge Canal.

Figure 1 -- The major Pleistocene local faunas of Florida. The numbers on the map correspond to the same numbers preceding the names of the faunas in the list of localities.


NASSAU
JEFFERSON
MADISON
HAMILTON
BAKER
DUVAL
1
TAYLOR
SUWANNEE
COLUMBIA
UNION
CLAY
ST. JOHNS
LAFAYETTE
2
3
BRADFORD
DIXIE
ALACHUA
4
5
6
PUTNAM
GILCHRIST
LEVY
FLAGLER
7
8
MARION
9
10
VOLUSIA
11
20
12
13
SUMTER
LAKE
ORANGE
SEMINOLE
HERNANDO
PASCO
POLK
OSCEOLA
HILLSBOROUGH
PINELLAS
14
15
16
BREVARD
INDIAN RIVER
17
MANATEE
HARDEE
HIGHLANDS
OKEECHOBEE
18
SARASOTA
ST. LUCIE
DE SOTO
MARTIN
LAKE
OKEECHOBEE
CHARLOTTE
GLADES
PALM BEACH
19

Lime-mining operations provide some of the most productive fossil localities in Florida. These operations are concentrated on the Ocala Arch, an uplifted limestone ridge in the center of the state including formations of Eocene through Pleistocene age. The Coleman IIA fauna was removed from a filled sinkhole in the Ocala Eocene limestone at the Dixie Lime and Stone Corporation at Coleman, Sumter County, Florida (SE-1/4, NW-1/4, Sec. 7, T 20 S, R 23 E; 70-90 feet above present sea level; Figure 1).

The original Coleman IIA deposit no longer exists; it was completely destroyed by further mining operations. Mr. Robert Allen, one of the first collectors at the site, provided me with the following description of the locality. The sink was approximately 30 yards long and 25 yards wide. Two facies, a wet orange-brown clay and a coarse gray-white sand, were obvious in this perspective. Although the clay facies appeared homogeneous, the sand facies was filled with pebble- to boulder-sized limestone rubble. The bone removed from the clay was usually colored white or orange, with all gradations in between; the bone from the gray-white sand was characteristically black, occasionally white. Bones also transgressed these facies boundaries, and are characteristically colored half orange-brown and half black, testifying to the contemporaneity of both lithologic units. Wet bone from the sand was much harder than that from the clay upon initial removal. None of the bone appears to have been tumbled, and semi-articulated (or at least closely associated) skeletal materials were removed from both clay and sand facies. This suggests a lack of transport by water or any other agent.

An unpublished manuscript of Norm Tessman shows that the long bones of all species of the large mammals recovered from the Coleman IIA deposit suffered pre-fossilization breaks. Pre-fossilization breaks, or "green" breaks, are recognized by their rough and oblique nature and microscopic evidence of lacunae collapse along the broken surface (Tessman compared the fossil bones with some intentionally broken in the laboratory and some known to have accumulated in a Recent sinkhole for confirmation of these characteristics). Bone breakage due to post-fossilization phenomena usually can be recognized by the "clean" nature of the break. Less than 10% of bones demonstrating green breaks also manifested tooth markings indicative of large carnivore action. These data strongly suggest that the Coleman IIA deposit was a natural-trap type of sinkhole.

That the sink was quite extensive and not filled to the top with water during most of its depositional history is shown by the relatively large quantity of bat remains. Those of Myotis austroriparius are particularly common, and as this bat dwells now in limestone caves and sinks in north Florida, we may assume that it also inhabited the more inaccessible reaches of the Coleman IIA sinkhole. Owl remains have also been recovered from the sink, and it is conceivable that they also utilized the cavernous portions for roosting sites, and inadvertently stockpiled small mammal remains. One may find fossilized owl pellets at the Reddick IA site, which at least suggests that the phenomenon is not particularly unusual.

SPECIES LIST

	% Total	Minimum Number Individuals
Didelphis marsupialis	2.0	5
Cryptotis parva	2.4	6
Blarina brevicauda	0.4	1
Scalopus aquaticus	0.8	2
Pipistrellus subflavus	3.6	9
Myotis cf *austroriparius*	10.4	26
Plecotus rafinesquii	0.8	2
Bat sp.	11.2	28
+*Dasypus bellus*	0.4	1
+*Holmesina septentrionalis*	0.4	1
Lepus alleni	2.4	6
Sylvilagus sp.	3.6	9
Sciurus carolinensis	1.6	4
Glaucomys sp.	0.4	1
Geomys cf *G. pinetis*	4.8	12
Reithrodontomys humulis	2.0	5
Peromyscus floridanus	7.6	19
Peromyscus sp.	11.2	28
Ochrotomys nuttalli	1.2	3
+*Sigmodon bakeri* new sp.	4.4	11
+*Pitymys arata* new sp.	0.8	2
Neofiber alleni	0.4	1
Erethizon dorsatum	0.4	1
+*Hydrochoerus* sp.	?	?
Canis lupus	1.6	4
+*Urocyon minicephalus* new sp.	6.8	17
+*Arctodus pristinus*	0.4	1
Procyon lotor	0.4	1
Spilogale putorius	0.8	2
Mephitis mephitis	0.4	1
Conepatus sp.	0.8	2
+*Felis onca augusta*	2.8	7
Felis rufus	0.4	1
+*Mammuthus* sp.	0.4	1
+*Equus* sp.	0.8	2
+*Platygonus cumberlandensis*	4.4	11
+*Mylohyus* sp.	0.4	1
+*Tanupolama* cf *I. mirifica*	2.8	7
Odocoileus virginianus	3.2	8
		249

SPECIES ACCOUNT

Class Mammalia

Order Marsupialia

Family Didelphidae

Didelphis marsupialis Allen- opposum

Material: UF 11826-11829; 1 left dentary, 1 left maxilla, 5 right humeri, 2 left femora, 4 vertebrae.

Remarks: The fossil material is identical to that of Recent D. marsupialis.

Order Insectivora

Family Soricidae

Cryptotis parva (Say)- least shrew

Material: UF 11628-11641; 9 mandibles, 6 maxillae, 1 humerus.

Remarks: Table 1 shows that size differences separate mandibles of C. parva from those of Blarina brevicauda. There is little overlap in the measurements even though the series of Blarina measured consisted almost exclusively of B. brevicauda minima, the smallest subspecies of Blarina. In those fossil specimens in which the M_3 is present, the talonid is reduced as in Recent Cryptotis (Hibbard, 1963; Guilday, 1962).

Blarina brevicauda (Say)- shorttail shrew

Material: UF 11626; 1 right mandible.

Remarks: The M_3 is not preserved on the fossil, but the size of the mandible (Table 1) and qualitative characters (after Guilday, 1962) identify it as B. brevicauda.

Table 1

Measurements (in mm) of the lower dentition and mandible of Recent and fossil *Blarina brevicauda* and *Cryptotis parva*

$\overline{X}$ = mean; O. R. = observed range; number of specimens in parentheses

	B. brevicauda (20)		*B. brevicauda* (1) (fossil)	*C. parva* (20)		*C. parva* (fossil)	
	$\overline{X}$	O. R.		$\overline{X}$	O. R.	$\overline{X}$	O. R.
Condyloid to mental foramen	8.2	7.2-9.3	7.7	6.1	5.9-6.7	6.6	6.1-7.0(8)
Condyloid to M_1	9.2	8.1-10.6	8.5	6.9	6.7-7.4	7.1	6.8-7.6(8)
Condyloid to M_2	7.5	6.2-8.9	6.8	5.7	5.5-6.0	5.8	5.5-6.1(8)
M_1-M_2	3.5	3.1-4.0	3.4	2.6	2.4-2.7	2.7	2.5-2.9(8)
M_1-M_3	4.7	4.2-5.5	-	3.4	3.2-3.6	3.6	3.5-3.6(2)
M_2-M_3	3.0	2.6-3.5	-	2.2	2.1-2.4	2.3	2.2-2.3(2)

Family Talpidae

Scalopus aquaticus Linnaeus- eastern mole

Material: UF 11642-11645; 1 right dentary, 2 femora, 3 humeri.

Remarks: The small sample precludes statistical treatment, but the humeri and toothless dentary agree with the same elements of Recent *Scalopus aquaticus* from Florida.

Order Chiroptera

Family Vespertilionidae

Myotis cf *M. austroriparius* (Rhodes)- southeastern myotis

Material: UF 13244, 13245, 13251, 13252, 13256-13292: partial skull, partial palates and mandibles.

Remarks: Considering the western affinities of a number of the Coleman IIA mammals, the possibility that this is a small western species of *Myotis* deserves careful consideration. Yet I cannot discern any qualitative or quantitative differences between the Coleman *Myotis* and Recent *M. austroriparius* from Florida, while size differences tend to separate it from *M. keenii* and *M. grisescens* (Table 2). On the other hand, I cannot separate the Coleman II *Myotis* from *M. lucifugus*.

Pipistrellus subflavus (F. Cuvier)- eastern pipistrelle

Material: UF 13246-13250, 13253-13255; dentaries and partial palates.

Remarks: The genus *Pipistrellus* has one less premolar than either *Plecotus* or *Myotis*, and may be separated from other living Florida bats on the basis of size and dental configuration. The fossil material is identical to that of Recent *P. subflavus* from Florida.

Table 2

Distance (in mm) from anterior border of canine alveolus to posterior border of M_3 alveolus in select fossils and Recent specimens of *Myotis*

	Coleman IIA			Devil's Den		
	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.
M. austroriparius	11	5.8	5.5-5.9	6	5.5	5.3-5.9
M. grisescens				7	6.3	6.2-6.6
	Indiana, Pennsylvania					
M. keenii (Miller and Allen, 1928)	10	6.2	6.0-6.6			

Plecotus rafinesquii Lesson- Rafinesque's big-eared bat

Material: UF 13240-13243; a partial palate and mandibles.

Remarks: The use of *Plecotus* rather than *Corynorhinus* follows Dalquest (1953) and Handley (1959). The following features may distinguish dentitions of *Plecotus* from those of *Myotis*:

1) Paraconid and metaconid less separated in *Plecotus*
2) Protoconid higher and more blade-like in *Plecotus*
3) Only two upper premolars in *Plecotus*
4) Hypocone on M^1-M^2 absent in *P. rafinesquii* (well developed in all *Myotis* I have seen from Florida).

The third character is not applicable to the fossil material available, but the others clearly permit the identification of *P. rafinesquii*.

Order Edentata

Family Dasypodidae

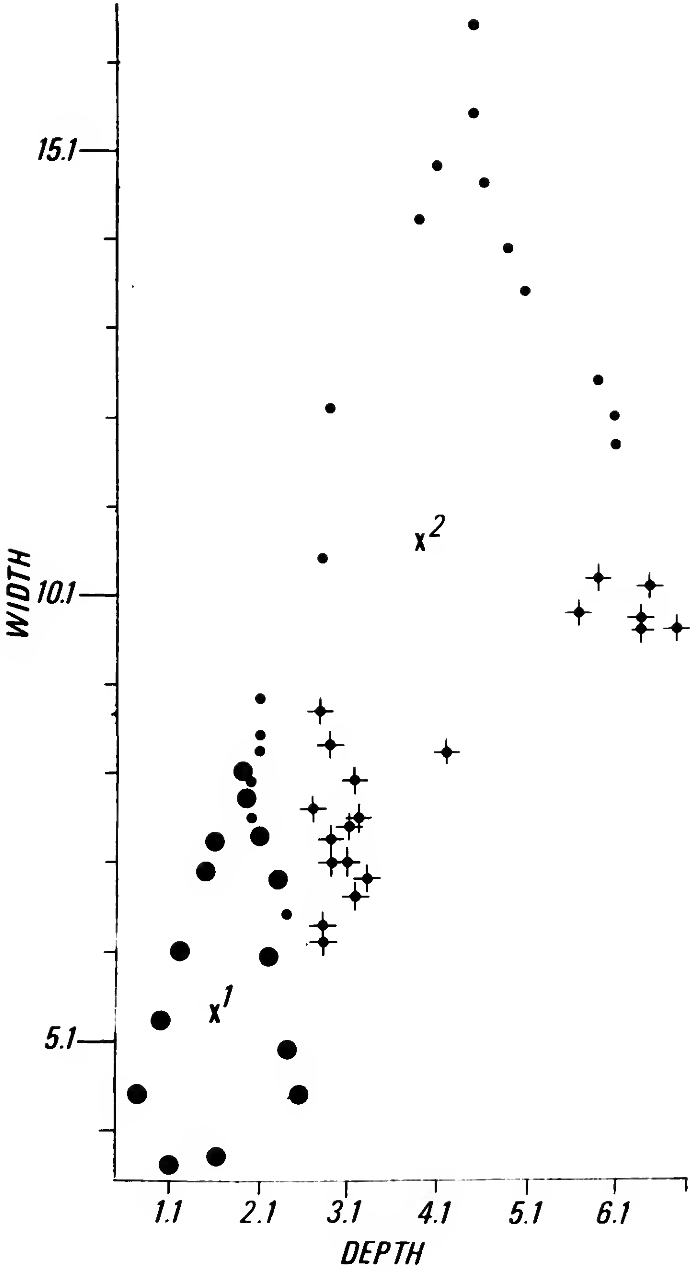
+Dasypus bellus (Simpson)- beautiful armadillo

Material: UF 13190, 13191, 13187; dermal plates and an astragulus

Remarks: The fossil Dasypus material includes dermal plates of two size classes (Figure 2). They may be from two individuals, but most likely represent samples from two body areas of a single individual. As can be seen from Figure 2 there is very little overlap in size of the dermal plates between the extinct Dasypus bellus and the living D. novemcinctus. The area of overlap includes, in the fossil armadillos, only the small animal from Coleman IIA and a few plates of animals from other deposits. Measurements of the fossil and Recent armadillo dermal plates (movable plates only) are presented below (N = number of plates measured, $\overline{X}$ = mean, O. R. = observed range of measurements):

	Thickness			Width		
	N	$\overline{X}$	O.R.	N	$\overline{X}$	O.R.
D. novemcinctus	235	1.6	0.9-2.4	235	5.4	3.5-8.1
+D. bellus						
Blancan (Haile XVA)	10	3.5	2.9-4.2	10	10.5	8.2-12.4
Irvingtonian (Coleman IIA)	21	4.0	2.7-6.8	21	8.2	6.2-10.3
Rancholabrean (Haile VIIA, Haile XIB, Reddick IA, Reddick IB, Bradenton 51st St., Arredondo II, Medford I, Kendrick I)	163	3.9	1.9-6.1	163	11.4	6.6-16.5

Figure 2 -- Scatter diagram relating *Dasypus bellus* to *Dasypus novemcinctus* when depth of the movable dermal plates is plotted against width of these plates. Large circules denote the range of measurements in *D. novemcinctus*, small circules and circles with lines denote the range of measurements of *D. bellus*. Circles with lines = dermal plates from Coleman IIA, X^1 = grand mean of 235 measured plates of D. novemcintus, X^2 = grand mean of 194 measured plates of *D. bellus*.


WIDTH
15.1
10.1
5.1
1.1
2.1
3.1
4.1
5.1
6.1
DEPTH
x1
x2

+Holmesina septentrionalis (Leidy)- armadillo

Material: UF 13186, 18188, 18189; dermal plates and metapodials.

Remarks: Considering that there are two names in the recent literature for this animal, and that there are two species (one undescribed; Haile XVA) of possibly two genera of chlamytheres in Pleistocene deposits from Florida, a general review of this subject seems worthwhile now. Much of this discussion is taken from Simpson (1930b).

The first chlamythere record in North America was published by Leidy (1889 a); the material consisted of dermal plates found in Peace Creek, Florida, and was referred to Glyptodon, new species septentrionalis. "Later Leidy (1889 b) recognized that they did not belong to a glyptodont but to a gigantic armadillo and referred them to Chlamytherium humboldtii Lund, a species described from cave deposits in Brazil (Simpson, 1930 b)." Sellards (1915) demonstrated that the Florida chlamythere was a different species than C. humboldtii, and referred the Peace Creek material, and material from Vero, Florida, to Chlamytherium septentrionalis. Simpson (pers. commun.) has pointed out to me that Sellards' use of septentrionalis was incorrect. As the species name must agree in gender with the genus to which it is referred, the proper name for referral to Chlamytherium is septentrionale. Following the taxonomic system of Castellanos (1927), with new Florida chlamythere fossils from Bradenton Field, Simpson (1930 b) referred the Florida chlamythere to a new genus, Holmesina, species septentrionalis (agreeing in general with Holmesina, which is feminine).

Some workers since that time (Bader, 1957; Weigel, 1962) have followed Simpson's conclusions, but others (James, 1957; Ray, 1958; Gut and Ray, 1963; Hibbard and Dalquest, 1966) have reinstated *Chlamytherium*.

There are presently six named genera of Plio-Pleistocene chlamytheres: *Chlamytherium* (=*Pampatherium*), *Plaina*, *Hoffstetteria*, *Kraglievichia*, *Vassalia*, and *Holmesina*. The first five were originally described from South American deposits (reviewed by Castellanos, 1927, 1937, 1957), the last solely from the United States (Simpson, 1930b). *Kraglievichia*, *Plaina*, and *Vassalia* are Pliocene forms (from Entrerian, Monte Hermosan, and Araucanian time), and South American *Chlamytherium* and *Hoffstetteria* are restricted by Castellanos to the Pleistocene (Pampean of Argentina and Brazilian and Ecuadorian deposits presumably of Pleistocene age). As Simpson (1930b) states, "If . . . [*Chlamytherium*, *Kraglievichia*, and *Vassalia*] . . . be retained in a single genus, then the Florida form belongs in that genus. If Castellanos is followed, which is probably preferable . . . , then the Florida species cannot be referred to any of his three South American genera, for it differs from them as much as they differ among themselves."

Considering that there is no recent taxonomic revision of these forms available, Simpson's statements seem to outline the most logical present course of action regarding the taxonomic status of the Florida late Pleistocene (Rancholabrean) chlamythere, recorded by Ray (1958) from Melbourne, Weigel (1962) from Vero, Bader (1957) from Hornsby Springs, Gut and Ray (1963) from Reddick IA, and by Simpson (1928, 1929, 1930b) from Sabertooth Cave, Bradenton Field, Peace Creek, Withlacoochee River, Venice, Sarasota, and Seminole Field. The same cannot necessarily be said of the chlamytheres noted by Hibbard and Dalquest (1966) from the middle Pleistocene of Texas, and by Cahn (1922) and Hay (1926) from deposits of uncertain age in Texas, as there is evidence that anthoe genus of chlamythere was also present in North America during part of the Pleistocene.

Castellanos (1927, 1957) and Simpson (1930 b) assumed that a maximum of three genera of chlamytheres existed during the entire Pleistocene in both North and South America. Further, only one species of each genus was recognized during that time (South America, Chlamytherium humboldtii and Hoffstetteria occidentale; North America, Holmesina septentrionalis). Recent collecting in Florida directed by S. David Webb has produced a new, small chlamythere of early Pleistocene (late Blancan) age. This species is now known from the Haile XIIA, Haile XVA (Robertson, Ph. D. disser., U. Fla.), and the Santa Fe River 1 (intrusive) and 1B faunas. The generic status of the Blancan form is not now known; in size and some features of the dentition the beast probably best approximates Kraglievichia.

In the Coleman IIA chlamythere the dermal plates and metapodials are comparable in size to those of Holmesina septentrionalis. This is the earliest record of this genus in Florida. The following is a list of localities in Florida, other than those noted previously, that contain remains of Holmesina septentrionalis:

Alachua County:- Arredondo, Pit I (site unknown), Pit II (just S of B); Haile, Loc. VIIA, VIIIA; and Payne's Prairie, Loc. III.

Calhoun County:- Chipola River, Loc. 2.

Charlotte County:- Charlotte Harbor.

Citrus County:- Withlacoochee River, Loc. 7A.

De Soto County:- Joshua Creek; and Prairie Creek.

Gilchrist County:- Ichetucknee River; and Santa Fe River, Locs. 2, 3, 7B, 11C, 17.

Levy County:- Waccasassa River.

Marion County:- Medford, Cave 1; Orange Springs, Loc. 1; and Reddick IIC.

Orange County:- Rock Springs.

Palm Beach County:- Jupiter Inlet.

Polk County:- Pool Branch.

Sarasota County:- Apollo Beach.

Sumter County:- Coleman III, Locs. B, C.

Suwanee County:- Branford IA.

Order Lagomorpha

Family Leporidae

Lepus alleni Mearns- antelope jackrabbit

Material: UF 13178, 13179; femora and innominates.

Remarks: The Coleman material referrable to the antelope jackrabbit consists of ten femora and two innominates. All lagomorph dental components in the fauna were assignable to *Sylvilagus*. The femora are rather large, and most closely approximate the antelope jackrabbit, *Lepus alleni* (Table 3; Figure 3). There is some overlap in measurements between *L. alleni* and *L. townsendii*, but configuration of the lesser trochanter and accompanying muscle scars (of the obturators and quadratus femoralis especially) readily separate these species (Figure 10). *Lepus alleni* is also a member of the Inglis IA Irvingtonian deposit, and its occurrence in these deposits marks the first record of this genus from Florida.

Table 3

Measurements (in mm) of fossil and living rabbit femora

	N	$\bar{X}$	O. R.
		Lepus californicus	
Gr. w shaft	9	8.6	7.2-9.5
Gr. length	9	108.2	100.5-114.8
Gr. w distal	9	16.1	15.2-16.8
Gr. w head	9	8.2	7.6-8.9
		Lepus townsendii	
Gr. w shaft	10	10.1	9.3-10.8
Gr. length	10	123.1	117.7-129.0
Gr. w distal	10	19.0	18.3-20.5
		Lepus alleni	
Gr. w shaft	6	9.3	8.4-9.8
Gr. length	6	118.9	114.4-122.6
Gr. w distal	6	18.6	18.3-19.3
Gr. w head	6	9.6	8.9-10.1
		Lepus americanus	
Gr. w shaft	5	6.6	6.0-7.5
Gr. length	5	89.9	84.7-96.7
Gr. w distal	5	12.7	11.7-13.9
Gr. w head	5	6.5	5.9-6.8

Table 3 (continued)

	N	$\bar{X}$	O. R.
		Coleman II *Lepus alleni*	
Gr. w. shaft	7	9.0	8.0-10.3
Gr. length	1	118.3	-
Gr. w distal	2	17.8	17.6-18.0
Gr. w head	3	9.5	9.2-9.7
		Coleman II *Sylvilagus*	
Gr. w shaft	3	6.2	6.0-6.5
Gr. length	1	71.4	-
Gr. w distal	3	11.2	11.0-11.6
Gr. w head	1	5.5	-

Sylvilagus sp.- marsh and/or cottontail rabbit

Material: UF 13158-13161, 13165, 13166, 13174-13177: 3 femora, 6 humeri, 2 scapulae, 4 calcanea, 11 mandibles, 2 tibia, 1 innominate, 5 ulnae, isolated teeth.

Remarks: The material is too poor to be identifiable to species, as characteristic portions of the mandibles have been shorn away. Both *Sylvilagus floridanus* and *S. palustris* are presently sympatric in Florida, found in almost every situation providing dense underbrush. Some measurements of the Coleman IIA *Sylvilagus* are presented in Table 3.

Figure 3 -- Femora of *Lepus alleni* (UF 13178; right) and *Sylvilagus* sp. (UF 13176; left) from Coleman IIA.


UF13176
UF13178

Order Rodentia

Family Sciuridae

Sciurus carolinensis Gmelin- Gray squirrel

Material: UF 11650-11658; 3 innominates, 2 right mandibles, 1 maxilla, 5 femora, 2 humeri, 2 tibia, 2 ulna, 2 incisors.

Remarks: Table 4 shows that in almost all measurements the fossils conform to Recent *Sciurus carolinensis*. *Sciurus niger* is consistently larger. The MA length of *S. niger* shown in Table 4 agrees with the dentary tooth row measurements presented by Moore (1956) for *S. niger shermani* from central Florida.

Glaucomys sp.- flying squirrel

Material: UF 11646-11649; 2 dentaries, 1 femur.

Remarks: Table 5 shows that the *Glaucomys* fossils are not identifiable to species when either the MA or RA lengths are considered separately. This is true also when the MA length is plotted against the RA length (Figure 4). The one fossil from which both measurements were obtainable lies intermediate between the two species.

Guilday, *et al*. (1964) identified both *G. volans* and *G. sabrinus* from the New Paris No. 4 Sinkhole in Pennsylvania. Although the fossil G. volans averaged 8% larger than modern samples from Pennsylvania, overlapping with modern *G. sabrinus macrotis* in MA length, they felt that *G. volans* was larger in the Pleistocene. This interpretation gains support from the fact that in the same fauna *G. sabrinus* averaged 13% larger than Recent Appalachian races of that species.

The Coleman IIA *Glaucomys* are 8% larger than the average Recent

G. volans from the southeastern U. S. However, because the MA length is so variable in *G. sabrinus* (V = 8.97) and because the theoretical range of measurements for the MA length of *G. sabrinus* at ±3s includes the entire theoretical range at ±3s for *G. volans*, the Coleman IIA *Glaucomys* must remain unidentified at present.

Table 4

Measurements (in mm) of mandibles and postcranial elements of Recent and fossil *Sciurus niger* and *s. Carolinensis*

N = number of specimens; 95% Conf. $\overline{X}$ = 95% confidence limits of the mean;
O. R. = observed range; S = standard deviation; V = coefficient of variation;
$\pm 3S$ = theoretical range of measurements at plus or minus 3 standard deviations

	N	95% Conf. $\overline{X}$	O. R.	S	V	$\pm 3S$
			Sciurus niger			
Innominate length	9	60.4± 2.92	54.2-66.8	3.80	6.29	49.0-71.8
Innominate width	9	19.1± 1.22	16.5-21.0	1.59	8.32	14.33-23.89
Femur length	10	67.4± 2.93	63.3-75.1	4.09	6.07	55.13-79.67
Femur width (distal)	10	12.4± .558	11.2-13.8	.780	6.29	10.06-14.74
Tibia length	10	75.8± 4.12	69.5-84.4	4.12	5.57	63.44-88.16
Tibia width (proximal)	10	12.7± .692	11.3-14.3	.968	7.62	9.80-15.60
Humerus length	9	51.4± 2.22	48.0-54.7	2.89	5.62	42.73-60.07

Table 4 (continued)

	N	95% Conf. $\overline{X}$	O. R.	S	V	$\pm 3S$
S. niger (cont'd)						
Humerus width (proximal)	10	9.5± .434	8.6-10.3	.606	6.38	7.68-11.32
Humerus width (distal)	9	13.6± .458	12.9-14.9	.607	4.46	11.78-15.42
M. A. length	45	14.0± .167	12.0-15.2	.862	5.90	11.52-16.48
			Sciurus carolinensis			
Innominate length	10	47.3± 2.08	43.0-51.9	3.35	7.08	37.25-57.35
Innominate width	11	15.3± .927	12.9-17.8	1.38	9.02	11.16-19.44
Femur length	10	54.8± 2.01	47.3-58.5	2.81	5.13	46.37-63.20
Femur width (distal)	12	9.8± .642	7.8-11.1	1.01	10.3	6.77-12.83
Tibia length	10	60.9± 2.12	55.4-65.1	3.41	5.59	50.67-71.13
Tibis width (proximal)	11	10.4± .508	8.3-11.4	.651	6.26	8.45-12.35

Table 4 (continued)

	N	95% Conf. $\bar{X}$	O. R.	S	V	$\pm 3S$
S. carolinensis (cont'd)						
Humerus length	9	40.8± 2.24	36.9-44.3	2.68	6.57	32.76-42.73
Humerus width (proximal)	8	7.7± .294	7.4-8.4	.351	4.56	6.65-8.75
Humerus width (distal)	11	11.2± .376	10.4-11.9	.560	5.00	9.52-12.88
M. A. length	42	11.5± .167	10.4-12.4	.537	4.67	9.79-13.21

Sciurus fossils

		Innom-inate length	Innom-inate width	Femur length	Femur width (distal)	Tibia length	Tibia width (prox-imal)	Humerus length	Humerus width (prox-imal)	Humerus width (distal)	M.A. length
cf. *carolinensis*	UF 11654	49.6	14.9	-	-	-	-	-	-	-	-
cf. *carolinensis*	UF 11654	50.9	15.7	-	-	-	-	-	-	-	-
carolinensis	UF 11655	-	-	60.0	9.8	-	-	-	-	-	-
carolinensis	UF 11655	-	-	61.0	9.8	-	-	-	-	-	-
cf. *carolinensis*	UF 11658	-	-	-	-	62.4	-	-	-	-	-
carolinensis	UF 11658	-	-	-	-	-	9.5	-	-	-	-
carolinensis	UF 11658	-	-	-	-	-	10.5	-	-	-	-

Table 4 (continued)

Sciurus fossils (cont'd)		Innom- inate length	Innom- inate width	Femur length	Femur width (distal)	Tibia length	Tibia width (prox- imal)	length	Humerus width (prox- imal)	Humerus width (distal)	M. A. length
carolinensis	UF 11658	-	-	-	-	-	10.6	-	-	-	-
carolinensis	UF 11656	-	-	-	-	-	-	44.0	7.3	10.9	-
carolinensis	UF 11656	-	-	-	-	-	-	44.3	7.5	11.0	-
carolinensis	UF 11650	-	-	-	-	-	-	-	-	-	10.8
carolinensis	UF 11651	-	-	-	-	-	-	-	-	-	10.3

Figure 4 -- Scatter diagram relating *Glaucomys sabrinus* (large circles) to *G. volans* (small circles) when RA length is plotted against MA length. Star = fossil *Glaucomys* from Coleman IIA.

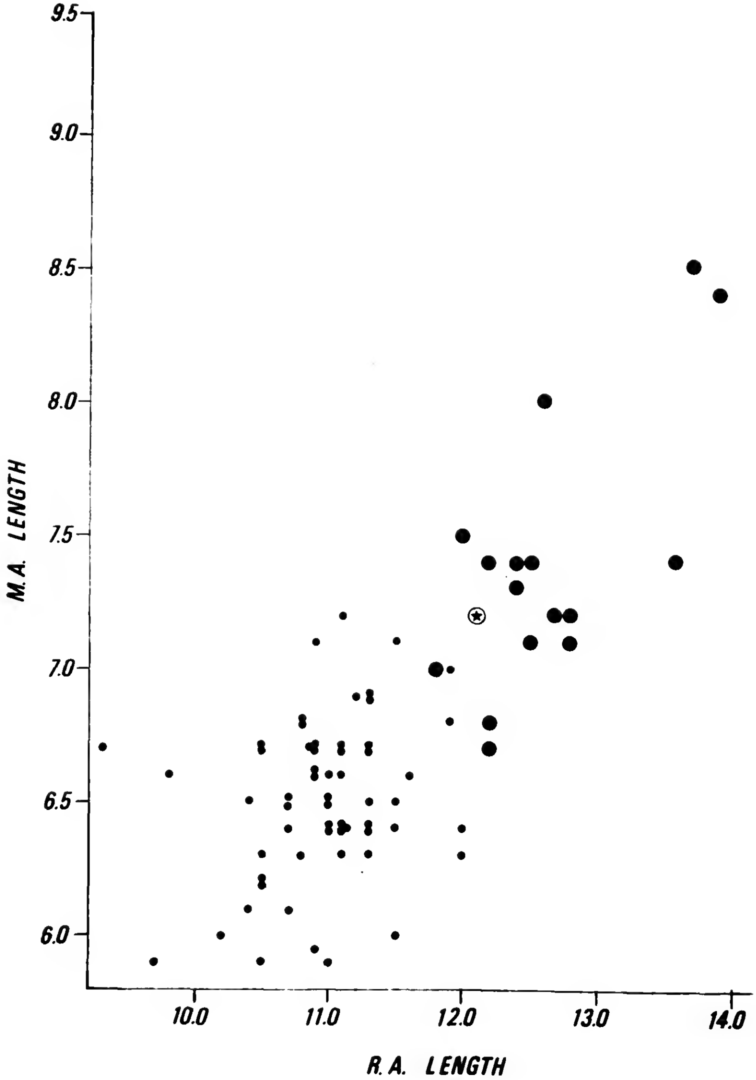

9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
M.A. LENGTH
10.0
11.0
12.0
13.0
14.0
R.A. LENGTH

Table 5

Measurements (in mm) of mandibles of Recent and fossil *Glaucomys sabrinus* and *Glaucomys volans* (Abbreviations as in Table 4)

	N	95% Conf. $\bar{X}$	O. R.	S	V	$\pm 3S$
			Glaucomys sabrinus			
R. A. length	23	12.9± .323	12.0- 14.3	.733	5.68	10.70- 15.10
M. A. length	23	7.6± .295	6.7- 9.4	.682	8.97	5.55- 9.65
			Glaucomys volans			
R. A. length	58	10.9± .143	9.3- 12.0	.544	6.73	9.27- 12.53
M. A. length	58	6.5± .080	5.9- 7.2	.305	4.69	5.59- 7.42
			Glaucomys fossils			
			R. A. length	M. A. length		
UF 11646			12.1	7.2		
UF 11647			-	7.0		

Family Geomyidae

Geomys cf G. pinetis Rafinesque- southeastern pocket gopher

Material: UF 11659-11683; 1 partial cranium, 10 right mandibles, 8 left mandibles, 5 left femora, 2 left humeri, 3 right humeri, 4 right innominates, 4 left innominates, 2 right tibia-fibulae, 12 left upper incisors, 11 right upper incisors, isolated teeth.

Remarks: The fossil specimens are identical to Recent G. pinetis from Florida. However, they are not certainly unseparable from G. bursarius and G. personatus either. These three species are obviously closely related and probably represent remnants of a common Pleistocene Gulf coast population.

Family Cricetidae

Reithrodontomys humulis (Audubon and Bachman)- eastern harvest mouse

Material: UF 11686-11695; 8 mandibles, isolated teeth.

Remarks: Reithrodontomys humulis is easily identifiable by the presence of a distinct labial cingulum, usually with associated cusplets, on the M_1 and M_2 (Hall and Kelson, 1959; Hooper, 1952). The grooved upper incisors are also diagnostic.

Peromyscus floridanus (Chapman)- gopher or Florida mouse

Material: UF 11731, 11733-11736, 11738-11743, 11746-11747, 11749-11761, 11763-11768; 31 mandibles.

Remarks: Identification of P. floridanus follows Martin (1967). This mouse is one of the largest of North American *Peromyscus*. It is identifiable from the MA length alone. The dental pattern of the fossils agrees with the description given by Bader (1959), in that the ectolophid and ectostylid are rare or absent, while on the M_1 and M_2 the mesostylid and mesolophid are poorly developed or absent.

Ochrotomys nuttalli (Harlan)- golden mouse

Material: UF 11730; 3 humeri (2 left, 1 right), 1 right mandible, 1 right maxilla, 2 isolated molars.

Remarks: *O. nuttalli* mandibles without teeth can be separated from other Recent Florida *Peromyscus* species when RA length is plotted against MA length (Martin, 1967). The position of the mental foramen will further separate *O. nuttalli* from some additional *Peromyscus* species (Martin 1968b), but identification of toothless mandibles is not possible if either *P. maniculatus* or *P. leucopus* is presumed present in the fossil fauna under study. Molars of the golden mouse are easily identified. The molar pattern is one of the most complex of the *Peromyscines* (Osgood, 1909; Hooper, 1957; Bader, 1959; Martin, 1968b).

Humeri like those of *Peromyscus*, lacking an entepicondylar foramen, may also be referred to *O. nuttalli*. The entepicondylar foramen is absent in *O. nuttalli* and is present in specimens of *Peromyscus polionotus*, *P. gossypinus*, and *P. leucopus*.

Peromyscus sp.

Material: UF 11720-11729, 11732, 11737, 11744, 11745, 11748, 11762, 11769-11784; 17 left mandibles, 7 right mandibles, 5 right humeri, 8 left humeri, 5 right femora, 10 left femora, 3 right innominates, 3 right tibia-fibulae, 3 left tibia-fibulae, numerous isolated teeth.

Remarks: This material probably represents a mixture of three or four *Peromyscus* and *Ochrotomys* species. It undoubtedly contains some small *P. floridanus*, a few specimens of *O. nuttalli* (toothless mandibles), and either one or two of the species *P. gossypinus*, *P. leucopus*, or *P. maniculatus*. The incidence of accessory cusps increases on the molars of these smaller mandibles, as they do in *P. gossypinus*, *P. leucopus*, and *P. maniculatus*. Three mandibles (UF 11720, 11723, 11724) have an MA length which falls in the range of *P. polionotus* (fossils: 3.6-3.7mm; Recent *P. polionotus*: 3.1-3.7mm), but this length also falls within the measured range of all southeastern *Peromyscus* species except *P. floridanus* (Martin, 1967). Since no mandibles or teeth were identified as *P. polionotus* it seems likely that the oldfield mouse is absent from the Coleman IIA fauna.

Western *Peromyscus* species, such as *P. pectoralis*, *P. boylii*, and *P. eremicus* now found in Texas are definitely not represented in Coleman IIA (see Martin, 1968b).

+*Sigmodon bakeri*, new species

= *Sigmodon hispidus*, Holman, 1959;
Bull. Florida State Museum, 5(1):1-24

Holotype: UF 11700, a left mandible with all teeth

Horizon and Locality: late Irvingtonian; Coleman IIA, Sumter County, Florida.

Referred specimens:

Coleman IIA, Sumter County, Florida

UF 11696-11719; 11 left mandibles, 8 right mandibles, 2 left maxillae, 3 left femora, 4 right femora, isolated teeth.

Bradenton Field, Manatee County, Florida; early Sangamon:

UF 2002; left mandible.

Williston III, Levy County, Florida; early Sangamon:

FGS 5862; 2 left mandibles, 1 right mandible, 1 lower right incisor.

Haile VIIA, Alachua County, Florida; early Sangamon:

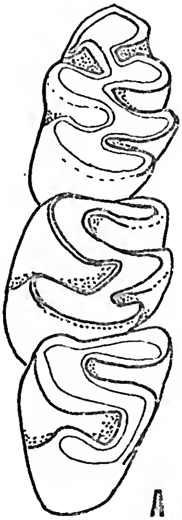
UF 9844; right mandible

UF 15153; 2 right mandibles, 1 left mandible, 3 isolated molars.

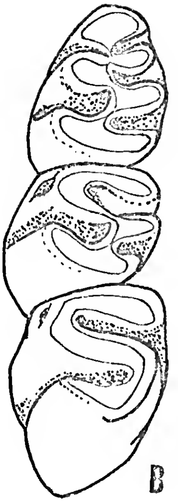
Diagnosis: The first lower molar of Sigmodon bakeri possesses 4 well developed roots, indicating alliance with the hispidus species group as defined on page 42 of this treatment. Sigmodon bakeri differs from all of these species in characteristically lacking an anterior cingulum on the M_2 and M_3 (Figure 5). The configuration of the anteroconid of the M_1 will also separate S. bakeri from other hispidus group species. In S. bakeri the anteroconid is grossly asymmetrical and is extended labially and posteriorly. Other hispidus group species will evidence this character occasionally, but normally the anteroconid is symmetrical or only slightly asymmetrical. Sigmodon bakeri is smaller than any living Sigmodon species except S. ochrognathus (Table 6).

Etymology: This species is named after Dr. Rollin Baker of Michigan State University for his work on living cotton rats.

Figure 5 -- Lower teeth of some fossil and Recent cricetid rodents. A = *Sigmodon bakeri*, holotype UF 11700, Coleman IIA, B = *Sigmodon hispidus*, UF 549, Recent specimen from Brevard Co., Fla., C = *Pitymys pinetorum*, UF 14387, Reddick IA: small numbers correspond to triangles, D = *Pitymys pinetorum* nemoralis, UK 54262, Recent specimen from Greenwood Co., Kansas, E = *Pitymys ochrogaster haydeni*, UK 20772, Recent specimen from Scott's Bluff, Nebraska, F = *P. o. haydeni*, UK 20760, Scott's Bluff, Neb., G = *Pitymys pinetorum*, UF 4860, Haile XIB. The arrows point out the salient feature that separates *Pitymys pinetorum* from *P.* ochrogaster (see discussion under *Pitymys arata*).



A



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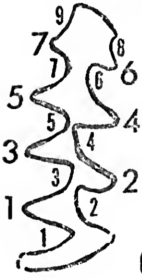
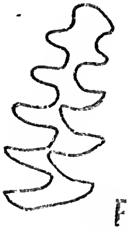


C

D

E



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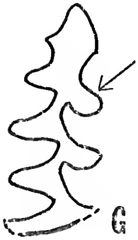


G

Discussion: Discovery of other fossil *Sigmodon* species in Florida, from the Blancan Haile XV deposit in Alachua County and the Inglis IA site in Levy County, prompted a study of other North American fossil samples of this genus. An annotated list of the living and extinct species and extinct subspecies is presented below. Some of these taxa are new, and are described in the species account which follows the list. A cross in front of a taxon indicates that it is extinct.

- *hispidus* species group
  - *hispidus*
  - *alleni*
  - *ochrognathus*
  - *fulviventer*
  - +*bakeri* new species
- *leucotis* species group
  - *leucotis*
  - *perunanus*
  - +*curtisi*
  - +*hudspethensis*
- *alstoni* species group
  - *alstoni*
- + *medius* species group
  - +*medius*
    - +*medius medius* new subspecies
    - +*medius hibbardi* new subspecies
  - +*minor*

Specimens referred to new taxa, except for those of S. bakeri, as well as those of all other fossil Sigmodon taxa studied, are listed under "Fossil Material Examined" at the end of the section of this report dealing with Sigmodon.

Key to the Extinct and Extant Species of Sigmodon

1.a. First lower molar with four well developed roots 2

b. First lower molar with three well developed roots................7

2.a. Relatively low crowned molars; reentrant folds broad and shallow; lingual root reduced ....+S. hudspethensis

b. Hypsodont molars; reentrant folds characteristically narrow and deep; lingual root well developed..........................3

3.a. Mental foramen located at anterior base of M_1 and lingually directed (not visible from labial view) ....S. alleni

b. Mental foramen anterior to the base of M_1 and partly labially directed (visible from labial view)............................4

4.a. Anterior cingulum on M_2-M_3 usually well developed; anteroconid of M_1 anteriorly-posteriorly flattened in specimens with little tooth wear...5

b. Anterior cingulum on M_2-M_3 moderately developed to absent; anteroconid of M_1 not anteriorly-posteriorly flattened in specimens with little tooth wear 6

5.a. Size small; lower third molar relatively short.....S. ochrognathus

b. Size large; lower third molar relatively long......S. fulviventer

6.a. Anterior cingulum on M_2-M_3 grading from moderately developed to absent, characteristically present; M_1 usually without posteriorly extended anteroconid; size large............S.hispidus

b. Anterior cingulum on M_2-M_3 characteristically absent; M_1 with posteriorly extended anteroconid; size small.......+S. bakeri

7.a. Upper incisors grooved..................................S. alstoni

b. Upper incisors, when known, not grooved..........................8

8.a. Anterior cingulum on M_2-M_3 absent.....................S. peruanus

b. Anterior cingulum on M_2-M_3 usually well developed................9

9.a. Size and dental pattern approximating that of S. hispidus..........................+S. curtisi and S. leucotis*

b. Size small; dental pattern not as in S. hispidus................10

10.a. Size relatively large; reentrant folds relatively broad..+S. medius

b. Size relatively small; reentrant folds relatively narrow..+S. minor

* I cannot separate the dentitions of these two species, though perhaps the anterior cingulum on M_2-M_3 is a bit less developed in S. leucotis. As noted in the Species Account, the interparietal bone is absent or at most vestigial in S. leucotis, but as no skull material of S. curtisi has been discovered I retain the integrity of this species.

Account of the Extinct and Extant Species of Sigmodon

Genus Sigmodon Say and Ord 1825

Characteristics of the genus are adequately delimited by Hershkovitz (1955). Taxonomy of the Recent North American species follows Baker (pers. commun.), although the species groups are in part my development. Much work needs to be done with living South American Sigmodon, and for now I have merely lumped all beasts in that continent with three roots on the M_1 into either Sigmodon peruanus or S. alstoni, depending upon the condition evidenced by the upper incisors.

hispidus species group

Diagnosis: This group is characterized by possessing four well developed roots on the first lower molar. All species except S. bakeri are extant and distributed almost entirely in North America.

Geologic Range: Latest Irvingtonian to Recent.

Sigmodon hispidus Say and Ord 1825

Diagnosis: The largest North American cotton rat (Table 6), Sigmodon hispidus is the most advanced cotton rat with respect to dental evolution. The process of lamination as described by Hershkovitz (1962) has proceeded in this species to the point of separation of the anteroconid from the paraconid and entoconid in some specimens. The cheek teeth are highly prismatic and the reentrant folds are deep and narrow. The enamel surface at the termination of each reentrant fold is thinned relative to the enamel occlusal surface along the remainder of the border of each fold. The anterior cingulum on the M_2 and M_3 tends to be reduced.

Geologic Range: Rancholabrean to Recent

Florida:

Devil's Den: Martin, 1968a; Wisconsin
Haile VIIIA: unpubl.; Sangamon
Haile, Locs. XIB, XIIIA, C: unpubl.; ?Sangamon
Withlacoochee River 7A: unpubl.; Wisconsin
Ichetucknee River; unpubl.; Wisconsin
Vero: Weigel, 1962; Wisconsin
Seminole Field: Simpson, 1929; Wisconsin
Melbourne: Ray, 1958; Wisconsin
Reddick IIC: unpubl.; Sangamon
Reddick IA: Gut and Ray, 1963; Sangamon
Sabertooth Cave: Simpson, 1928; Sangamon
Kendrick I: unpubl.; Sangamon
Maximo Moorings: unpubl.; Wisconsin
Arredondo IA: unpubl.; Wisconsin
Arredondo IIB: unpubl.; Sangamon
Arredondo IIC: unpubl.; Sangamon

Louisiana:

Little Bayou Sara: Martin, 1968a; Wisconsin

Georgia:

Ladds: Ray, 1967; Sangamon?

Texas:

Moore Pit: Slaughter, 1966; Sangamon?
Sims Bayou: Slaughter and McClure, 1965; Wisconsin?
Howard Ranch: Dalquest, 1965; Wisconsin
Clear Creek: Slaughter and Ritchei, 1963; Wisconsin
Friesenhahn Cave: Lundelius, 1960; Wisconsin
Longhorn Cavern: Semken, 1961; Wisconsin
Ben Franklin: Slaughter and Hoover, 1963; Wisconsin

New Mexico:

Brown Sand Wedge: Slaughter, 1962; Wisconsin

Aruba:

Isla: Hooijer, 1967; Wisconsin?

Sigmodon alleni Bailey 1902

Diagnosis: *Sigmodon alleni* is best characterized by position of the mental foramen of the mandible. This foramen cannot be seen when the mandible is viewed from the labial side, as it is located close to the base of the first lower molar and more lingually directed than in other *Sigmodon* species. The dental pattern is most similar to that of *Sigmodon hispidus*.

Geologic Range: No fossil record.

Sigmodon ochrognathus Bailey 1902

Diagnosis: *Sigmodon ochrognathus* is the smallest of the living *Sigmodon* species (Table 6), and like *S. fulviventer*, demonstrates a peculiar anteriorly-posteriorly compressed anteroconid on the M_1 in specimens with little tooth wear.

Geologic Range: No fossil record.

Sigmodon fulviventer Allen 1889

Diagnosis: This diagnosis applies to *S. f. minimus*, the only subspecies I have viewed. In size *S. fulviventer* approaches *S. hispidus* (Table 6), and with the exception only of the anteriorly-posteriorly compressed anteroconid of the M_1, the dental pattern approximates that of *S. hispidus*.

Geologic Range: No fossil record.

+ *Sigmodon bakeri* Martin 1969

Diagnosis: As discussed previously. *Sigmodon bakeri* represents the earliest record in North America of the *hispidus* species group, but the specialized condition of absence of the anterior cingulum on the M_2-M_3

disallows it as an ancestor for any other hispidus group species. The dental pattern, with the exception of the character mentioned above, is somewhat intermediate between the primitive 3-rooted M_1 species and the hispidus species group in that the enamel borders of the reentrant folds are not as thinned as they are in the other hispidus group species. The reentrant folds also tend to be wider.

Geologic Range: Latest Irvingtonian through early Rancholabrean of Florida:

Coleman IIA: this report; late Illinoian?
Haile VIIA: this report; Sangamon
Williston III: this report; Sangamon
Bradenton 51st St.: this report; Sangamon

leucotis species group

Diagnosis: Characteristically with three, occasionally with four, roots on the first lower molar.

Sigmodon leucotis Bailey 1902

Diagnosis: The dental pattern of S. leucotis is essentially the same as that of S. hispidus. Examination of 11 specimens demonstrated 7 with three roots on the M_1 (lingual root missing) and 4 with four roots on the M_1; of the latter 4, the lingual root was developed as well as in S. hispidus in 2, and as a small peg in the other 2.

Geologic Range: No fossil record.

Sigmodon peruanus Allen 1897

Diagnosis: Sigmodon peruanus is the largest living Sigmodon species (Table 6). It is further characterized through loss of the anterior cingulum on the M_2-M_3 and by the highly prismatic, flatly worn enamel reentrant fold borders. Of 10 specimens examined, 9 evidenced only three roots on the M_1, and one specimen, USNM 303005 from Tumbes, Peru, possessed four well developed roots on this tooth.

Geologic Range: No fossil record.

+Sigmodon curtisi Gidley 1922

= Sigmodon cf S. hispidus, Hibbard, 1952;
Vertebrata, Art. 2: 1-14.

Diagnosis: Sigmodon curtisi is a large cotton rat (Table 6) which demonstrates a dental pattern as in S. hispidus and S. leucotis. In fact, I am unable to separate the fossil material of S. curtisi from Recent specimens of S. leucotis. The interparietal bone is absent or vestigial in S. leucotis, and is well developed in all other Sigmodon species, but as no skull material of S. curtisi has yet been recovered I retain the integrity of both species. Two out of six first lower molars of S. curtisi from the Inglis IA deposit of north Florida evidence 4 roots on the M_1, placed as in the hispidus species group. Non-Florida curtisi that I have examined apparently evidence only 3 roots on the M_1, but the preservation of this material is not very good and the teeth are imbedded in the mandibles, which makes examination quite difficult.

Geologic Range: Irvingtonian:

Arizona: Curtis Ranch; Gidley, 1922

Kansas: Kentuck Assemblage; Hibbard, 1952

California: Vallecito Creek; unpubl.

Florida: Inglis IA; unpubl.

+*Sigmodon hudspethensis* Strain 1966

Diagnosis: Unfortunately the holotype, a lower right first molar, UT 40857-10, was lost before it could be properly studied. It had been measured, however, and these data are included in Table 6. It, therefore, seems prudent to designate a neotype. The paratype, another lower right M_1, is available, but a more recently collected specimen, found after Strain's (1966) paper was published, makes a better neotype. The new specimen, collected by William Akersten, is described below.

Neotype: UT 40857-10, a left mandible with all cheek teeth. Both anterior and posterior portions of the ramus are broken off, but the incisor is present. Collected by William Akersten from the Hudspeth Fauna (Red Light Local Fauna), Love Formation, Hudspeth County, Texas; late Blancan?

Amended Diagnosis: Contrary to Strain (1966), the dental pattern of *S. hudspethensis* does not vary significantly from that of *S. medius*. It does, however, differ from the *medius* species group in possessing a well developed labial root on the first lower molar, obvious in the neotype. The first lower molar of *S. hudspethensis* also has a fourth peg-like lingual root, developed as in the two speciments of *S. leucotis* mentioned previously that also evidenced peg-like fourth lingual roots. This lingual root is not as well developed as it is in the *hispidus* species group.

Strain (1966) hinted at the fact that *Sigmodon hudspethensis* was larger than either *S. medius* or *S. minor*, but provided no comparative measurements. These data are presented in Table 6, and support Strain's suggestion that *S. hudspethensis* was "A cotton rat about the size of

Sigmodon hispidus . . . "

Geologic Range: Late Blancan? of Texas:

Hudspeth Fauna: Strain, 1966; Akersten, 1968.

alstoni species group

Sigmodon alstoni Thomas 1880

Diagnosis: Sigmodon alstoni is relegated to its own species group by virtue of the fact that it is the only Sigmodon species to have developed grooved upper incisors. The primitive nature of this species is evidenced by the fact that it possesses only three roots (lingual root absent) on the first lower molar.

Geologic Range: No fossil record.

+medius species group

Diagnosis: The members of this group, S. medius and S. minor, are the the most primitive of known Sigmodon species. They are small cotton rats (Table 6) with little to no development of labial and lingual roots on the first lower molar. The incisor capsular process of the mandible is least developed in these species; a primitive trait for cricetid rodents in general.

+Sigmodon medius Gidley 1922

= Sigmodon intermedius; Hibbard, 1938,
Trans. Kansas Acad. Sci. 40: 239-265.

Diagnosis: Sigmodon medius is characterized by having only 2 or 3 roots on the first lower molar. The labial root is always more greatly developed than is the lingual root, but both are usually tiny pegs and may be centrally, rather than lingually and labially, located. The lingual root is about as well developed as is that root in the neotype of S. hudspethensis, but it is much less developed than is the lingual root in the hispidus species group. In two out of fifty-four specimens viewed, solely from the Rexroad Local Fauna, Locality No. 3 (Figure 7), there were four roots on the first lower molar, but the two accessory roots were centrally located and very minute.

There are no morphological differences between Sigmodon medius Gidley and S. intermedius Hibbard, and Figure 8 and Table 6 demonstrate that they are also equal in size.

Compared to all hispidus group species and S. leucotis and S. curtisi of the leucotis species group, the dental pattern of S. medius is much less prismatic. The reentrant folds are not particularly deep as they are in the other species, nor are they as narrow. In the species mentioned above the enamel borders of the reentrant folds are greatly thinned at the termination (apex) of each fold; a development I believe which is correlated with structural relationships allowing the posterior enamel border of a particular reentrant fold to double back (Figure 5) closely adhered to the anterior enamel border of the same fold. Another way of describing this pehnomenon in the hispidus species group and in S. leucotis and S. curtisi is, for example, that the posterior enamel border of the protoconid is closely allied with the anterior enamel border of the hypoconid (dental terminology after Hooper, 1957).

The anteroconid of the M_1 in S. medius is generally small and usually symmetrical, with a wide fourth reentrant fold.

+Sigmodon medius medius, new subspecies

Holotype: USNM 10519, the holotype of Sigmodon medius described by Gidley (1922).

Diagnosis: Species characteristics as described for S. medius. This subspecies differs from S. m. hibbardi by virtue only of smaller size (Figure 8, Tables 6 and 8). The distinction between the subspecies is further discussed under S. m. hibbardi.

Geologic Range: Early Blancan through latest Blancan:

Kansas:

Rexroad Local Fauna, Loc. No. 3; Hibbard, 1938
Sanders Local Fauna; unpubl.

Arizona:

Benson Ranch Local Fauna: Gidley, 1922
Tusker Local Fauna: unpubl.

California:

Arroyo Seco Fauna: unpubl.
Layer Cake Fauna: unpubl.

+Sigmodon medius hibbardi, new subspecies

Holotype: UMMVP 35093, a right mandible with all cheek teeth, from the Wendell Fox Pasture locality, Meade County, Kansas; Blancan.

Etymology: This subspecies is named in honor of Dr. Claude Hibbard of the University of Michigan for his manifold contributions to the field of vertebrate paleontology, and especially for providing a Pleistocene stratigraphic sequence in Kansas, complete with fossil mammals, which is unparalleled in any area of the New World.

Diagnosis: The Wendell Fox Pasture sample of S. m. hibbardi is plotted in Figure 8, and the log difference plot for this subspecies is seen to be different from that of *S. m. medius*. The mean values of four of the seven measurements taken (Table 8, Figure 8) in *S. m. hibbardi* are statistically significantly different from those taken in *S. m. medius* at the 90% level of probability ($p \leq .1$). The dental pattern is otherwise identical to that of *S. m. medius*.

Geologic Range: Early or late Blancan:

Kansas:

Wendell Fox Pasture Locality: unpubl.

California:

Transition zone between the Arroyo Seco Fauna and the Vallecito Creek Fauna: unpubl.

+*Sigmodon medius*, subsp. indeterminate

Sigmodon medius has been recovered from the following localities, but the small samples preclude statistical treatment. Measurements of the samples are presented in Table 6.

Kansas:

Benders Local Fauna: unpubl., early Blancan

Texas:

Blanco Local Fauna: unpubl., Blancan

Florida:

Haile XVA Local Fauna: unpubl., late Blancan?

Nebraska:

Sand Draw Local Fauna: unpubl., Blancan.

+*Sigmodon minor* Gidley 1922

= *Sigmodon hilli*; Hibbard, 1941. State Geol.
Surv. Kansas, Bull. 38: 197-220.

Diagnosis: *Sigmodon minor* is the smallest known species of *Sigmodon* (Table 6), and appears to have been derived directly from *Sigmodon medius*. As seen in Figure 8 there are no dental proportional differences between *S. minor* and *S. medius*. The major difference between *S. minor* and *S. medius* is size. The reentrant folds are deeper and narrower in *S. minor* than they are in *S. medius*, especially obvious in teeth with little wear, but well worn teeth of *S. minor* approximate very closely those of *S. medius*.

There are no qualitative differences between *Sigmodon minor* Gidley and *S. hilli* Hibbard, and Figure 8 and Table 6 demonstrate that these species are equal in size as well.

The Borchers *Sigmodon minor* include five first lower molars with 4 roots; out of 27 specimens studied. A random selection of 27 *S. medius* included two with 4 roots. This difference is not statistically significant ($\chi^2$with Yates Continuity Correction= .657; one degree of freedom).

Geologic Range: Irvingtonian:

Kansas:

Borchers Local Fauna: Hibbard, 1941

Arizona:

Curtis Ranch Local Fauna: Gidley, 1922.

Evolution in the Genus *Sigmodon*

Living sigmodont rodents include the genera *Reithrodon*, *Neotomys*, *Sigmodon*, and *Holochilus* (Hershkovitz, 1955). All but *Sigmodon* are restricted to South America. The genus *Sigmodon* exists now in northern South America and extends northward through Central America into the southern United States. All sigmodonts possess a comlex penis and a long-wide palate. According to Hershkovitz (1955), "Diagnostic characters of sigmodonts include reduced outer hind toes, webbed middle hind toes, spinous process of zygomatic palate, specialized posterior palatal region, simplified molars characterized by absence or obsolescence of a functional mesoloph(id) in, at least, $M\frac{1-2}{1-3}$, and the S-shaped enamel pattern of M_3." Hershkovitz (1955) further suggests that *Sigmodon* is the most generalized form of the living sigmodonts.

"Evolution of American cricetines has paralleled that of the New World Perissodactyla. The primitive brachydont, buno-mesolophodont cricetines have survived, like the tapir, in forested parts of the range. Like the horse, the progressive branch of cricetines, with mesoloph absent or vestigial, has become increasingly specialized for life in open country and a diet of grasses. The young have lost, or are in the process of losing, the distinctive juvenal phase of pelage comparable to the spotted coat of young tapirs and other woodland ungulates. The molars have become higher, their crown surfaces flatter and tending toward lamination. The third molar of grazing cricetines is nearly always precociously functional. This condition provides the needed maximum grinding surface which, in young ungulates, is supplied by deciduous premolars.

Sigmodont rodents are members of the relatively recently evolved, essentially grazing, New World mammalian fauna of open country. Morphologically, they merge into the phyllotine group (*Phyllotis*, *Hesperomys*, and others) by a combination of characters. In both groups the dentition is fundamentally similar (Hershkovitz, 1955)." Hershkovitz (1962) further states, "Phyllotines probably evolved from the same line that gave rise to akodont rodents. The sigmodonts . . . are more specialized but appear to be progressive offshoots from the main phyllotine line."

I. Dental Evolution from Pliocene to Recent Time

The following information is now available:

1) The most generalized South American phyllotine rodents, from which *Sigmodon* was supposedly derived, possess 4 roots on the first lower molar (Hershkovitz, 1962).

2) The earliest fossil *Sigmodon* species known is *S. medius*. This species is found in late Pliocene deposits, has the most primitive dental pattern of all recognized *Sigmodon* species (see the discussion under *S. medius* in the Species Account), and characteristically evidences 2 or 3, rarely 4, roots on the first lower molar. The lingual and labial roots (accessory roots) are typically minute and most often located more towards the center of the tooth than they are in the *hispidus* species group.

3) *Sigmodon hudspethensis*, a larger animal than *S. medius*, approximating the size of *S. curtisi* and *S. hispidus*, is the only *Sigmodon* species other than *S. medius* known from early Pleistocene (late Blancan) deposits. This species may possess 4 roots on the first lower molar,

the accessory roots developed more fully than they are in *S. medius*, but less fully than in the *hispidus* species group.

4) *Sigmodon curtisi*, with a dental pattern as in the *hispidus* species group and as in *S. leucotis*, first appears during the early Irvingtonian (early middle Pleistocene) in North America, and may have 4 well developed roots on the first lower molar.

5) Three living species of *Sigmodon* in the New World characteristically evidence 3 roots on the first lower molar, and all may evidence 4 well developed roots occasionally. One of these species, *S. leucotis*, is restricted to isolated populations at higher elevations in Mexico (Baker, pers. commun.) surrounded by *hispidus* group species. Teeth of *S. leucotis* are similar to those of *S. curtisi*. The remaining two species, *S. alstoni* and *S. peruanus*, are restricted to South America, and appear to have evolved in isolation from their North American relatives.

6) The *hispidus* species group (M_1 with 4 well developed roots and complex molars) is first seen in North America during the latest middle Pleistocene (latest Irvingtonian).

The fossil record for cotton rats is one of the most complete of any genus of small mammal that existed and evolved in the New World through Pleistocene epoch. A perfectly adequate evolutionary scheme can be developed for the genus based solely on the fossil material available from deposits in the United States. However, this scheme will undoubtedly be distasteful to many people, as it requires an evolutionary reversal in root count. An alternative model may also be developed, but it requires hypothesizing extinct creatures which are not represented by fossil material.

If Hershkovitz (1955, 1966) is correct, the first *Sigmodon* species evolved from a generalized phyllotine rodent in South America and then dispersed northward. The living phyllotine forms which according to Hershkovitz (1962) most closely approximate a generalized beast, such as *Phyllotis darwini*, *Galenomys garleppi*, and *Calomys* spp., possess 4 roots on the first lower molar. As demonstrated by the information summarized on page 54 , there is an increase in numbers of roots on the first lower molar and increased dental complexity in fossil *Sigmodon* from the late Pliocene *S. medius* (2 or 3 roots) to the late Pleistocene *hispidus* species group (4 roots). Therefore, if the evolutionary trend disclosed by the available fossil material is valid, an evolutionary reserval in root count is indicated (4-3-2-3-4). This sytem is outlined in Figure 6.

The alternative model would require that: 1) *S. medius* does not give rise to *S. hudspethensis*, 2) *S. curtisi* is not ancestral to the *hispidus* species group, and 3) evolution to the *curtisi* stage in North America is paralleled in Central or South America by another line leading to a *curtisi*-like animal in which, however, *all grades retain 4 well developed roots on the first lower molar*. The resultant end product of this line then evolves into the *hispidus* species group.

Figure 6 -- A possible phylogeny for the rodent genus *Sigmodon*.

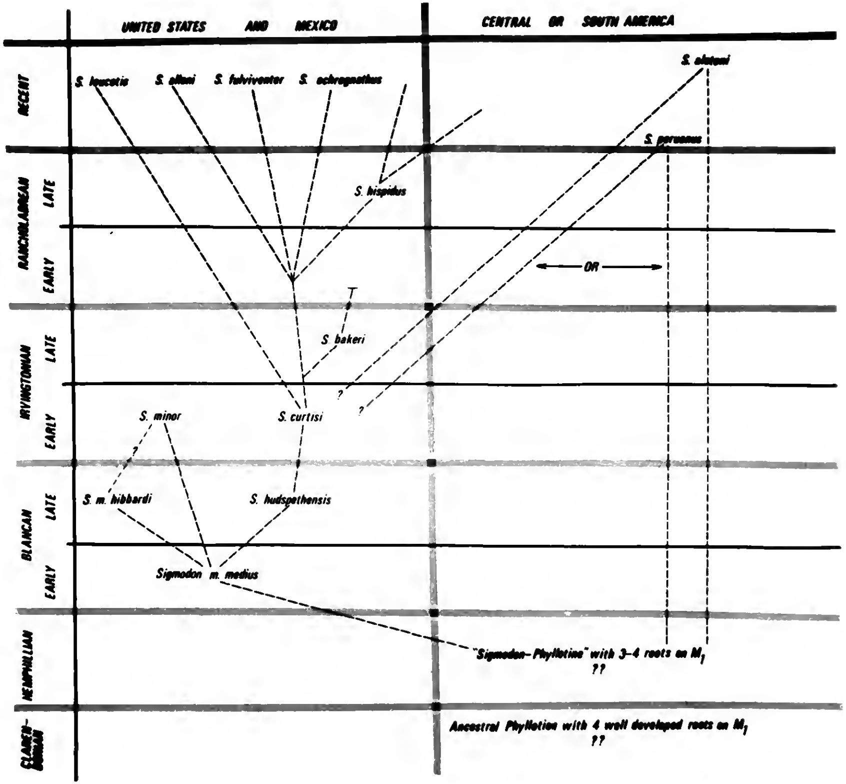
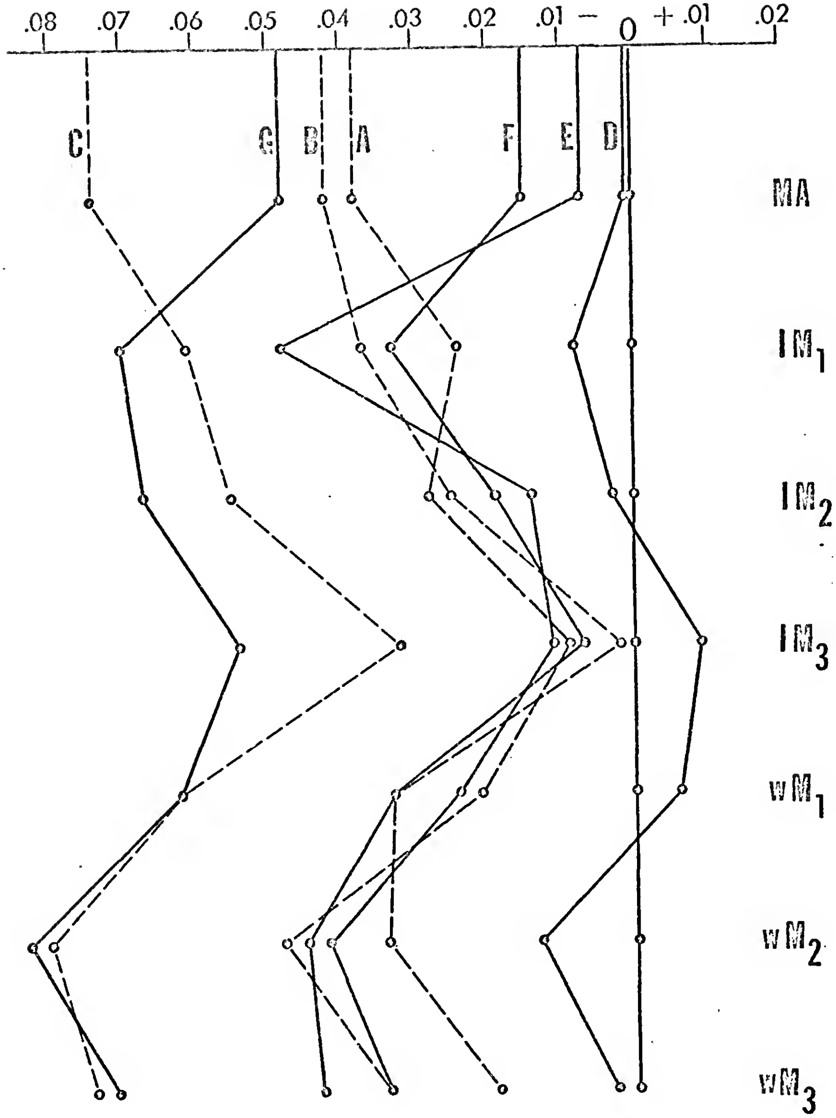

UNITED STATES AND MEXICO
CENTRAL OR SOUTH AMERICA
RECENT
RANCHOLABREAN
LATE
EARLY
IRVINGTONIAN
LATE
EARLY
BLANCAN
LATE
EARLY
HEMPHILLIAN
CLAREN-DONIAN
S. leucotis
S. alleni
S. fulviventer
S. ochrognathus
S. alstoni
S. peruanus
S. hispidus
OR
S. bakeri
S. curtisi
S. minor
?
?
?
S. m. hibbardi
S. hudspethensis
Sigmodon m. medius
"Sigmodon-Phyllotine" with 3-4 roots on M_1
??
Ancestral Phyllotine with 4 well developed roots on M_1
??

Figure 7 -- Correlation of Kansas and Arizona deposits containing members of the *medius* species group of *Sigmodon*. The Kansas sequence is taken from Hibbard (1967).

	PLIOCENE		PLEISTOCENE			
	Hemphillian	Early Blancan	Nebraskan	Aftonian	Kansan	Yarmouth
			Late Blancan		Irvingtonian	
KANSAS	Saw Rock Canyon	Benders–*S.* cf *medius* Rexroad–*S. medius* Fox Canyon	Dixon	Deer Park Sanders–*S. medius*	Cudahy	Borchers–*Sigmodon minor*
ARIZONA		Benson Ranch–*S. medius*		Tusker–*S. medius*		Curtis Ranch–*S. minor*

Figure 8 -- Composite ratio diagram of measurements of the lower dentition and mandible in some members of the *Sigmodon medius* species group from Kansas and Arizona. A = *Sigmodon medius medius*; Benson Ranch, B - *Sigmodon medius medius*; Tusker, C = *Sigmodon minor*; Curtis Ranch, D - *Sigmodon medius hibbardi*; Wendell Fox Pasture, E = *Sigmodon medius medius*; Rexroad Loc. 3, F = *Sigmodon medius medius*; Sanders, G = *Sigmodon minor*; Borchers. MA = mandibular alveolar length, l = length, w = width. The standard is the Coleman IIA *Sigmodon bakeri*.


.08
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+
.01
.02
C
G
B
A
F
E
D
MA
IM_1
IM_2
IM_3
wM_1
wM_2
wM_3

II. Ecological Considerations

Early and middle Pliocene deposits in the United States contain cricetine species referrable to *Copemys*, *Peromyscus*, *Tregomys*, or *Gnomomys*. *Sigmodon* has not been recorded from deposits of the above ages, and yet is the most abundant cricetine in deposits of early and late Blancan age in the United States. One might call the appearance of *Sigmodon* in these deposits "sudden." *Sigmodon* entrance into the United States also corresponds in general to the influx of rooted-cheek-toothed microtines such as *Pliopotamys*, *Ophiomys*, *Pliophenacomys*, *Pliolemmus*, and *Ogmodontomys*. The beginning of this microtine immigration is recorded, for example, in the late Hemphillian McKay Reservoir Local Fauna of Oregon (Shotwell, 1956), a fauna which contains *Teleoceras* and the extinct microtine *Prosomys mimus*. *Teleoceras* is unknown in early Blancan faunas such as Rexroad, and is generally believed to have become extinct by the end of the Hemphillian (Hirschfeld and Webb, 1968).

It is interesting to speculate how, in the earlier Pleistocene, the vole-like *Sigmodon* could be sympatric with such an array of rooted-cheek-toothed microtines, and the answer, I believe, is readily apparent. The dental evolutionary trends which characterize *Sigmodon* in general, and especially the *medius*-*minor* line, are those which point to convergence with the true (rootless-cheek-toothed) voles; notably hypsodonty and involution. Disappearance of the *medius* species group coincides approximately with the appearance of the rootless-cheek-toothed microtines (*Pitymys*, *Pedomys*, *Neodon*) which first appear in the Cudahy Fauna of Kansas, of Kansan age (Paulson, 1961; Hibbard, 1967).

These considerations suggest that the earliest *Sigmodon* species were not in direct competition with the early, rooted-cheek-toothed microtines, and were filling the grassland niche later to be filled more adequately by the rootless-cheek-toothed microtines. I further suggest that most of the early rooted-cheek-toothed microtines were sylvan and aquatic rather than pastoral, as is the case in the living North American rooted-cheek-toothed forms *Clethrionomys*, *Phenacomys*, and *Ondatra*. This hypothesis is partly substantiated by Hibbard's and Zakrzewski's statement (1967) that *Pliopotamys* was ancestral to the aquatic *Ondatra*.

Sigmodon is found today primarily in the Lower Austral and Tropical life zones in North America. Microtines are generally Holarctic mammals, and only *Microtus mexicanus*, *Pitymys pinetorum*, *P. quasiater*, and tiny populations of three species, *Pitymys guatemalensis*, *Microtus umbrosus*, *Pitymys oaxacensis* are able to exist in life zones lower and warmer than the Upper Austral zone. Both *P. pinetorum* and *P. quasiater* are sylvan fossorial species, and thus in general *Microtus* and *Pitymys* are rare in grasslands in the southern United States, Mexico, and Central America. This niche is today filled primarily by *Sigmodon*, although other genera such as *Reithrodontomys* and *Oryzomys* also contribute an appreciable amount of biomass.

III. Fossil Material Examined

Sigmodon medius

S. m. hibbardi:

1. Wendell Fox Pasture Locality, Meade County, Kansas:
   UMMVP 35093, 57050-57054
2. Transition between Arroyo Seco Fauna and Vallecito Creek Fauna, 3200 to 3250 feet from top of sequence,

San Diego County, California:

LACM 1588/4442, 1451/4447

S. m. medius:

1. Arroyo Seco Fauna, 4900 to 5350 feet from top of sequence, San Diego County, California:

   LACM 6554/13754, 6552, 6550, 6552/12505

2. Layer Cake Fauna, 6750 feet from top of sequence, San Diego County, California:

   LACM 1711/7005

3. Rexroad Local Fauna, Locality 3, Meade County, Kansas:

   UMMVP 29162, 29669, 31085, 31086, 41193, 44589, 56249

4. Sanders Local Fauna, Localities 1, 2, 4, Meade County, Kansas:

   UMMVP 32003-32005, 31997, 31998, 56247, 56248, 50263, 50264

5. Tusker Local Fauna, Locality 15-24, Graham County, Arizona:

   UAVP 899, 905, 910, 913, 914, 922, 924, 925, 927-936, 938-941, 945, 949, 966-970, 972-1003, 1007,1020, 1023-1025, 1030, 1036-1042, 1054, 1056, 1057, 1059-1069, 1075, 1077-1079, 1081, 1087, 1089, 1090, 1094, 1100, 1104, 1105, 1111, 1113, 1114, 1118, 2494-2510, 2513, 2514, 2519, 2700-3053

Sigmodon medius

S. m. medius

6. Benson Ranch Local Fauna, Cochise County, Arizona:

   USNM 10520-10523

S. medius, subsp. indeterminate

1. Benders Local Fauna, Meade County, Kansas:

   UMMVP 45820

2. Haile XVA Local Fauna, Alachua County, Florida:

   UF 12334, 12336, 12338, 12342

3. Sand Draw Local Fauna, Brown County, Nebraska:

   UMMVP 57056

4. Blanco Local Fauna, Crosby County, Texas:

   MUVP 7146

Sigmodon minor

1. Borchers Local Fauna, Meade County, Kansas:

   UMMVP 35766, 56244, 56245, 51302, 51312, 51313, 51307, 51305, 51303, 51309, 51311, 51314, 51308, 51306, 51304,

2. Curtis Ranch Local Fauna, Cochise County, Arizona:

   USNM 10512-10518, 16608-16611

Sigmodon hudspethensis

1. Hudspeth Fauna, Madden Arroyo, Hudspeth County, Texas:

   UTMM 40240-1, 40240-2

2. Hudspeth Fauna;

   Red Light Local Fauna, Hudspeth County, Texas:

   UTMM 40857-10, 40857-11

Sigmodon curtisi

1. Curtis Ranch Local Fauna, Cochise County, Arizona:

   USNM 10511, 16606, 16607, 16605

2. Kentuck Assemblage, McPherson County, Kansas:

   UKMVP 7361

3. Vallecito Creek Fauna, 900 to 1520 feet from top of sequence, San Diego County, California:

   LACM 1615/4389, 1114/3394, 1297/6941, 1114/3395, 1461/4445, 1615/4396, 1615/4398

4. Inglis IA Local Fauna, Citrus County, Florida:

   UF 15155

Sigmodon hispidus

1. Reddick IA, rodent beds, Marion County, Florida:

   UF 14347-14360

2. Reddick IIC, Marion County, Florida:

   UF 15204

3. Devil's Den, Levy County, Florida:

   UF 13440, 13453, 13444, 13593-13600

4. Kendrick I, Marion County, Florida:

   UF 2658

5. Maximo Moorings, Pinellas County, Florida:

   UF 3062

6. Haile VIIIA, Alachua County, Florida:

   UF 9844, 15153, 12680-12684

7. Haile XIB, Alachua County, Florida:

   UF 13471-13592

8. Haile XIIIA, Alachua County, Florida:

   UF 13096-13097

9. Haile XIIIC, Alachua County, Florida:

   UF 13049

10. Ichetucknee River, Gilchrist County, Florida:

    UF 15205

11. Withlacoochee River, Locality 7A, Citrus County, Florida:

    UF 15206

12. Arredondo IA, Alachua County, Florida:

    UF 15207

13. Arredondo IIB, Alachua County, Florida:

    UF 12589

14. Arredondo IIC, Alachua County, Florida:

    UF 12297-12303

Table 6

Measurements (in mm) of the lower dentition and mandible in living and extinct species of *Sigmodon*

MA = mandibular alveolar length, l = length, w = width

	MA		
	N	$\bar{X}$	O.R.
Sigmodon medius			
Benson Ranch	3	5.75	5.59-6.01
Tusker	25	5.70	5.30-6.13
Rexroad, Loc. 3	8	6.17	5.97-6.42
Sanders	5	6.07	5.76-6.44
Benders	-	-	-
Sand Draw	-	-	-
Blanco	1	5.58	-
Haile XV	-	-	-
Wendell Fox Pasture	3	6.27	6.18-6.38
Sigmodon minor			
Curtis Ranch	8	5.30	4.97-5.80
Borchers	25	5.63	5.27-6.00
Sigmodon curtisi			
Curtis Ranch	1	7.03	-
Inglis IA	4	6.68	6.27-6.91
Kentuck	1	6.78	-
Sigmodon hudspethensis			
Hudspeth and Red Light	1	6.90	-
Sigmodon bakeri			
Coleman IIA	11	6.28	5.93-6.71
Williston III	2	6.69	6.40-6.98

Table 6 - continued

MA (continued)	N	$\bar{X}$	O.R.
Sigmodon hispidus			
Reddick IA	18	7.27	6.83-7.65
Florida (Recent)	30	7.26	6.56-7.80
Texas (*S. h. berlandieri*)	8	6.68	6.34-6.93
Sigmodon ochrognathus			
Texas	4	6.12	5.81-6.29
Sigmodon fulviventer			
Mexico; Durango	8	7.17	6.95-7.34
Sigmodon alleni			
Mexico; Michoacan and Oaxaca	5	6.64	6.38-7.08
Sigmodon leucotis			
Mexico; Durango, Morelos, Guererro, Guanajuato	11	6.76	6.44-7.05
Sigmodon peruanus			
Ecuador and Peru	10	7.72	7.17-8.23
		LM_1	
Sigmodon medius			
Benson Ranch	4	2.09	1.91-2.29
Tusker	25	2.03	1.86-2.26
Rexroad, Loc. 3	39	1.98	1.80-2.26
Sanders	10	2.05	1.94-2.14
Benders	-	-	-
Sand Draw	1	1.98	-
Blanco	5	1.99	1.98-2.00
Haile XV	2	2.26	2.18-2.58
Wendell Fox Pasture	5	2.16	2.10-2.22

Table 6 - continued

LM_1 (continued)	N	$\bar{X}$	O.R.
Sigmodon minor			
Curtis Ranch	9	1.92	1.73-2.19
Borchers	38	1.88	1.72-2.07
Sigmodon curtisi			
Curtis Ranch	3	2.41	2.28-2.49
Inglis IA	5	2.35	2.22-2.50
Kentuck	1	2.42	-
Sigmodon hudspethensis			
Hudspeth and Red Light	4	2.34	2.19-2.58
Sigmodon bakeri			
Coleman IIA	20	2.21	2.04-2.46
Williston III	3	2.46	2.28-2.61
Sigmodon hispidus			
Reddick IA	18	2.49	2.24-2.72
Florida (Recent)	30	2.47	2.11-2.73
Texas (*S. h. berlandieri*)	8	2.35	2.18-2.49
Sigmodon ochrognathus			
Texas	4	2.15	2.10-2.20
Sigmodon fulviventer			
Mexico; Durango	8	2.27	2.20-2.39
Sigmodon alleni			
Mexico; Michoacan and Oaxaca	5	2.41	2.27-2.57
Sigmodon Leucotis			
Mexico; Durango, Morelos, Guererro, Guanajuato	9	2.54	2.44-2.75
Sigmodon peruanus			
Ecuador and Peru	9	2.68	2.31-3.03

Table 6 - continued

		LM_2	
	N	$\bar{X}$	O.R.
Sigmodon medius			
Benson Ranch	4	1.51	1.43-1.57
Tusker	26	1.52	1.35-1.71
Rexroad, Loc. 3	23	1.56	1.33-1.81
Sanders	9	1.54	1.40-1.69
Benders	1	1.67	-
Sand Draw	1	1.53	-
Blanco	1	1.41	-
Haile XV	1	1.49	-
Wendell Fox Pasture	5	1.60	1.53-1.65
Sigmodon minor			
Curtis Ranch	9	1.42	1.30-1.62
Borchers	40	1.38	1.22-1.54
Sigmodon curtisi			
Curtis Ranch	3	1.87	1.85-1.89
Inglis IA	6	1.80	1.75-1.85
Kentuck	1	1.91	-
Sigmodon hudspethensis			
Hudspeth and Red Light	2	1.75	1.73-1.76
Sigmodon bakeri			
Coleman IIA	13	1.61	1.49-1.75
Williston III	2	1.76	1.66-1.85
Sigmodon hispidus			
Reddick IA	18	1.82	1.67-1.95
Florida (Recent)	30	1.77	1.59-1.96
Texas (*S. h. berlandieri*)	8	1.72	1.57-1.79
Sigmodon ochrognathus			
Texas	4	1.68	1.50-1.82
Sigmodon fulviventer			
Mexico; Durango	8	1.82	1.73-1.91

Table 6 - continued

LM_2 (continued)	N	$\overline{X}$	O.R.
Sigmodon alleni			
Mexico; Michoacan and Oaxaca	5	1.76	1.65-1.87
Sigmodon leucotis			
Mexico; Durango, Morelos, Guererro, Guanajuato	9	1.78	1.63-1.85
Sigmodon peruanus			
Ecuador and Peru	9	2.13	1.83-2.29
		LM_3	
Sigmodon medius			
Benson Ranch	4	1.94	1.88-2.04
Tusker	26	1.97	1.61-2.28
Rexroad, Loc. 3	15	1.93	1.75-2.14
Sanders	7	1.95	1.88-2.14
Benders	1	2.15	-
Sand Draw	-	-	-
Blanco	2	2.02	2.01-2.02
Haile XV	1	1.93	-
Wendell Fox Pasture	2	2.02	1.88-2.16
Sigmodon minor			
Curtis Ranch	6	1.84	1.64-2.12
Borchers	40	1.75	1.40-2.06
Sigmodon curtisi			
Curtis Ranch	1	2.55	-
Inglis IA	2	2.25	2.14-2.35
Kentuck	1	2.49	-
Sigmodon hudspethensis			
Hudspeth and Red Light	2	2.21	2.07-2.35

Table 6 - continued

LM_3 (continued)	N	$\overline{X}$	O.R.
Sigmodon bakeri			
Coleman IIA	13	1.98	1.72-2.37
Williston III	1	2.02	-
Sigmodon hispidus			
Reddick IA	18	2.59	2.24-3.00
Florida (Recent)	30	2.56	2.17-2.89
Texas (S. h. berlandieri)	8	2.40	2.02-2.74
Sigmodon ochrognathus			
Texas	1	1.75	-
Sigmodon fulviventer			
Mexico; Durango	8	2.73	2.59-2.92
Sigmodon alleni			
Mexico; Michoacan and Oaxaca	5	2.33	2.25-2.40
Sigmodon leucotis			
Mexico; Durango, Morelos, Guererro, Guanajuato	9	2.20	2.05-2.41
Sigmodon peruanus			
Ecuador and Peru	9	2.65	2.25-2.87
		WM_1	
Sigmodon medius			
Benson Ranch	4	1.44	1.43-1.71
Tusker	26	1.40	1.29-1.51
Rexroad, Loc. 3	41	1.43	1.27-1.58
Sanders	11	1.40	1.21-1.50
Benders	-	-	-
Sand Draw	1	1.37	-

Table 6 - continued

WM$_1$ (continued)	N	$\bar{X}$	O.R.
Sigmodon medius (continued)			
Blanco	5	1.39	1.20-1.68
Haile XV	2	1.27	1.25-1.29
Wendell Fox Pasture	6	1.53	1.51-1.57
Sigmodon minor			
Curtis Ranch	9	1.31	1.21-1.44
Borchers	39	1.31	1.17-1.48
Sigmodon curtisi			
Curtis Ranch	3	1.62	1.55-1.71
Inglis IA	5	1.67	1.51-1.74
Kentuck	1	1.56	-
Sigmodon hudspethensis			
Hudspeth and Red Light	4	1.48	1.40-1.57
Sigmodon bakeri			
Coleman IIA	20	1.51	1.35-1.86
Williston III	3	1.61	1.56-1.76
Sigmodon hispidus			
Reddick IA	18	1.73	1.63-1.86
Florida (Recent)	30	1.65	1.55-1.88
Texas (*S. h. berlandieri*)	8	1.63	1.56-1.77
Sigmodon ochrognathus			
Texas	4	1.61	1.57-1.64
Sigmodon fulviventer			
Mexico; Durango	8	1.71	1.65-1.81
Sigmodon alleni			
Mexico: Michoacan and Oaxaca	5	1.63	1.53-1.72
Sigmodon leucotis			
Mexico; Durango, Morelos, Guererro, Guanajuato	9	1.67	1.58-1.75

Table 6 - continued

WM_1 (continued)	N	$\bar{X}$	O.R.
Sigmodon peruanus			
Ecuador and Peru	9	1.91	1.76-2.07
		WM_2	
Sigmodon medius			
Benson Ranch	4	1.54	1.43-1.71
Tusker	26	1.55	1.39-1.76
Rexroad, Loc. 3	23	1.56	1.39-1.68
Sanders	9	1.59	1.53-1.68
Benders	1	1.72	-
Sand Draw	1	1.51	-
Blanco	1	1.49	-
Haile XV	1	1.63	-
Wendell Fox Pasture	5	1.67	1.62-1.71
Sigmodon minor			
Curtis Ranch	9	1.43	1.27-1.55
Borchers	40	1.42	1.20-1.55
Sigmodon curtisi			
Curtis Ranch	3	1.89	1.85-1.92
Inglis IA	6	1.87	1.73-1.97
Kentuck	1	1.85	-
Sigmodon hudspethensis			
Hudspeth and Red Light	2	1.52	1.39-1.65
Sigmodon bakeri			
Coleman IIA	13	1.72	1.55-1.86
Williston III	2	1.91	1.74-2.08
Sigmodon hispidus			
Reddick IA	18	2.02	1.88-2.14
Florida (Recent)	30	1.97	1.79-2.13
Texas (*S. h. berlandieri*)			

Table 6 - continued

WM_2 (continued)	N	$\overline{X}$	O.R.
Sigmodon ochrognathus			
Texas	4	1.81	1.77-1.84
Sigmodon fulviventer			
Mexico; Durango	8	1.93	1.86-2.05
Sigmodon alleni			
Mexico; Michoacan and Oaxaca	5	1.87	1.71-2.00
Sigmodon leucotis			
Mexico; Durango, Morelos, Guererro, Guanajuato	9	1.90	1.81-2.06
Sigmodon peruanus			
Ecuador and Peru	9	2.23	2.10-2.33
		WM_3	
Sigmodon medius			
Benson Ranch	4	1.48	1.33-1.62
Tusker	26	1.45	1.31-1.64
Rexroad, Loc. 3	15	1.48	1.34-1.64
Sanders	7	1.53	1.44-1.64
Benders	1	1.72	-
Sand Draw	-	-	-
Blanco	2	1.47	1.45-1.52
Haile XV	1	1.53	-
Wendell Fox Pasture	2	1.59	1.52-1.65
Sigmodon minor			
Curtis Ranch	6	1.35	1.30-1.40
Borchers	40	1.36	1.20-1.50

Table 6 - continued

WM_3 (continued)	N	$\overline{X}$	O.R.
Sigmodon curtisi			
Curtis Ranch	1	1.81	-
Inglis IA	2	1.79	1.76-1.82
Kentuck	1	1.83	-
Sigmodon hudspethensis			
Hudspeth and Red Light	2	1.73	1.70-1.76
Sigmodon bakeri			
Coleman IIA	12	1.60	1.43-1.69
Williston III	1	1.61	-
Sigmodon hispidus			
Reddick IA	18	1.88	1.77-1.96
Florida (Recent)	30	1.91	1.77-2.10
Texas (_S. h. berlandieri_)	8	1.79	1.65-1.89
Sigmodon ochrognathus			
Texas	2	1.73	1.70-1.76
Sigmodon fulviventer			
Mexico; Durango	8	1.98	1.93-2.09
Sigmodon alleni			
Mexico; Michoacan and Oaxaca	5	1.82	1.80-1.88
Sigmodon leucotis			
Mexico; Durango, Morelos, Guererro, Guanajuato	9	1.75	1.66-1.90
Sigmodon peruanus			
Ecuador and Peru	9	2.13	2.00-2.35

Table 7

Measurements (in mm) of the lower dentition and mandible of *Sigmodon* samples from the Vallecito Creek-Fish Creek beds

LCF = Layer Cake Fauna; ASF = Arroyo Seco Fauna; VCF-ASF = transition zone between Arroyo Seco Fauna and Vallecito Creek Fauna; VCF = Vallecito Creek Fauna; MA = mandibular alveolar length; l = length; w = width

	MA	LM$_1$	LM$_2$	LM$_3$	WM$_1$	WM$_2$	WM$_3$
Sigmodon curtisi							
VCF 900	-	-	1.84	-	-	2.02	-
VCF 1100	7.64	-	1.94	2.66	1.98	2.29	2.05
VCF 1450	-	-	1.85	-	-	1.99	-
VCF 1520	7.64	2.79	2.06	2.58	1.85	2.00	1.97
	6.99	2.47	2.00	2.82	2.07	2.24	2.04
	-	2.41	1.96	2.47	2.00	2.27	1.83
	-	-	1.82	-	1.75	1.86	-
$\overline{X}$	7.42	2.56	1.92	2.63	1.93	2.10	1.97
Sigmodon medius hibbardi							
VCF-ASF 3200	6.10	2.14	1.73	2.25	1.47	1.70	1.60
	-	-	1.60	2.08	-	1.50	1.48
	6.20	2.24	1.77	2.04	1.48	1.65	1.63
VCF-ASF 3250	6.53	-	1.69	2.04	-	1.73	1.62
$\overline{X}$	6.28	2.19	1.70	2.10	1.48	1.65	1.58
Sigmodon medius medius							
ASF 4900	5.68	-	1.54	2.06	1.45	1.50	1.36
ASF 5100	-	-	1.70	2.21	-	1.64	1.59
	5.97	-	1.67	1.96	1.66	1.60	1.51
ASF 5350	5.92	-	1.59	1.80	-	1.56	1.39
	6.15	2.14	1.62	1.76	-	1.55	1.49
$\overline{X}$	5.93	2.14	1.62	1.96	1.56	1.57	1.47
Sigmodon medius medius							
LCF 6750	5.79	2.03	1.72	1.89	1.44	1.51	1.45
	-	-	1.51	2.02	-	1.44	1.47
$\overline{X}$	5.79	2.03	1.62	1.96	1.44	1.48	1.46

Table 8

Statistical comparison of *Sigmodon* samples from the Wendell Fox Pasture (WFP) and Rexroad, Loc. 3 (R3) deposits

N = number of specimens; $\bar{X}$ = mean; S^2 = variance; t = student's t value; p = probability value; * = statistically significant difference

	WFP			R3				
	N	$\bar{X}$	S^2	N	$\bar{X}$	S^2	t	p
MA length	3	6.27	.007	8	6.17	.028	.01	.900
Length M_1	5	2.16	.002	39	1.98	.015	*3.09	.010
Length M_2	5	1.60	.002	23	1.56	.009	.90	$.4 > p > .3$
Length M_3	2	2.02	.040	15	1.93	.016	.90	$.4 > p > .3$
Width M_1	6	1.53	.001	41	1.43	.004	*10.46	.001
Width M_2	5	1.67	.003	23	1.56	.005	*3.19	.010
Width M_3	2	1.59	.003	15	1.48	.006	*1.89	$.1 > p > .05$

+*Pitymys arata* new species

Holotype: UF 11685 (Figure 9), a right dentary with all lower molars. Both the coronoid process and the angular process are broken, but the condyloid process is complete. The lower incisor is broken at the anterior edge of the ramus.

Referred specimens: UF 11684, a partial right dentary with incisor but no cheek teeth.

Horizon and locality: Coleman IIA Local Fauna, Sumter County, Florida; late Irvingtonian, ?Illinoian.

Diagnosis: *Pitymys arata* is a large vole, the size of *Microtus richardsoni* (Table 9), and is thus larger than any known *Pitymys*, extinct or extant. Configuration of the first lower molar clearly identifies *P. arata* as a member of the latter genus. The deep sixth reentrant angle and posterior sloping anterior enamel border of the fourth triangle separates *P. arata* from *P. ochrogaster* (Figure 5 and Martin, in prep.).

The pattern of the first lower molar combines characteristics of both *P. pinetorum* and *P. quasiater*. The anterior loop, with incipient sixth and seventh triangles, but with shallow eighth and ninth reentrant angles, best approximates *P. pinetorum*. These reentrant angles are typically deep in *P. quasiater*. The closed anterior loop in *P. arata* (caused by deep penetrance of reentrant angles 6 and 7) is characteristic of *P. quasiater*. Yet I have seen a few specimens of *P. pinetorum nemoralis* (the largest *P. pinetorum* subspecies) from Kansas with this feature. The anterior loop on the M_1 is widely open in Florida fossil and extant *Pitymys pinetorum*. *Pitymys arata* further differs from *P. pinetorum*, but agrees with *P. quasiater*, in possessing a reduced capsular process, especially bulbous in the largest, oldest individuals. The unpronounced capsular process of P. arata, related to short length of the lower incisor, is a primitive trait for all voles.

Etymology: This species is named for Dr. Andrew A. Arata of the World Health Organization (Geneva) for his guidance early in my graduate career.

Remarks: The following is a tentative classification of those fossil and living voles that have cementum in the reentrant angles and rootless cheek teeth. Emphasis is placed on New World species, and the species list for neither the Old World nor New World is meant to be exhaustive. Recent species of the New World are listed only if I have transferred them from the genus in which they were located by Hall and Kelson (1959) to some other genus. The only Old World species I have transferred to another genus are those of the taxon Eothenomys, which for my convenience and for reasons which will be explained, appear to be closely related to those of the genus Anteliomys. Old World species of other genera are listed below only for illustrative purposes and do not, as in the case of the New World species, indicate a change in taxonomic status. This classification is based solely upon the dentition of these animals, and particularly upon evolution of the M_1 as seen in the fossil record (OW = Old World, NW = New World):

Grade I

Arvicola Lacepede 1799- OW
  +A. greenii Hinton
  +A. praeceptor Hinton
   A. amphibius (Linnaeus)

Phaiomys Blyth 1863- OW, NW

Phaiomys (cont'd)

=+*Allophaiomys* Kormos 1933, Neue Jahrb. Paleont. & Miner., Beil-Bd. 69B: 323-346. Munchen.

+*P. pliocaenicus* Kormos- OW, NW

= +*Microtus* (*Pedomys*) *llanensis*, Hibbard, 1952. Vertebrata, Art. 2: 1-14.

+*P. laguroides* Kormos- OW
+*P. ruffoi*- Passa- OW
P. leucurus Blyth - OW

Grade II

Neodon Hodgson 1849- OW, NW
+*N. paroperarius* (Hibbard)- NW

= +*Microtus paroperarius* Hibbard 1944. Bull. Geol. Soc. Amer., Vol. 55: 707-754.

N. irene Thomas- OW
N. sikimensis Hodgson- OW
N. carruthersi Thomas- OW

Grade III

Pitymys McMurtie 1831- OW, NW
= *Pedomys* Baird 1857, in Rept. Expl. Surv., 8(1): 517.

+*P. involutus* (Cope)- NW

=+*Arvicola involuta* Cope 1871. Proc. Amer. Philos. Soc.: 89.

=+*Microtus* (*Pitymys* or *Pedomys*) *involutus*, Hibbard, 1955. Proc. Acad. Nat. Sci. Phila., Vol. CVII: 87-97.

+*P. dideltus* (Cope)- NW

=+*Arvicola didelta* Cope 1871. Proc. Amer. Philos. Soc.; 89.

=+*Microtus* (*Pitymys* or *Pedomys*) *dideltus*, Hibbard, 1955. Proc. Acad. Nat. Sci. Phila., Vol. CVII: 87-97.

+*P. hibbardi* Holman- NW
+*P. arata* Martin- NW
+*P. meadensis* Hibbard- NW
+*P. arvaloides* Hinton- OW
+*P. gregaloides* Hinton- OW
P. guatemalensis (Merriam)- NW

Pitymys McMurtie (cont'd)

=*Microtus guatemalensis* Merriam 1898. Proc. Biol. Soc. Wash., 12: 108.

P. oaxacensis (Goodwin)- NW

=*Microtus oaxacensis* Goodwin 1966. Amer. Museum Novitates, No. 2243: 1-4.

+*P. llanensis* (Hibbard)

=*Microtus* (*Pedomys*) *llanensis* Hibbard 1944. Bull. Geol. Soc. Amer., Vol. 55: 707-754.

P. ochrogaster (Wagner)- NW

= *Hypudaeus ochrogaster* Wagner 1842. in Schreber, Die Saugthiere . . . , suppl., 3: 592.

=*Microtus* (*Pedomys*) *ochrogaster*, Hall and 1959. The Mammals of North America, Ronald Press, New York, Vol. II.

+*P. mcknowni* Hibbard 1937. Jour. Mammal., 18(2): 235.

Microtus Schrank 1798- OW, NW
Alticola Blanford 1881- OW
Neofiber True 1884- NW
Anteliomys Miller 1896- OW

= *Eothenomys* Miller 1896. North Amer. Fauna, No. 12: 45.

My studies of fossil and living voles demonstrate three major grades of dental evolution, each with various side branches. Although characteristics of the other molars are useful taxonomically, only the first lower molar appears to be a reliable indicator of evolutionary grade. The first grade, including *Arvicola* and *Phaiomys*, may be characterized by the presence of only three closed triangles on the M_1. This grade, first seen in either the upper Pliocene or lower Pleistocene of the Old World (Hinton, 1926; Kowalski, 1960; Kurtén, 1968) is clearly derivable (probably polyphyletically) from the Old World rooted-cheek-toothed *Mimomys*. *Arvicola* may be separated from *Phaiomys* by characteristics of the M_3; this tooth in *Arvicola* retains a well developed fourth triangle, making the pattern of M_3 identical to that of M_2. The fourth triangle of M_3 in *Phaiomys* is reduced or is absent. The anterior loop of the M_1 tends to be simpler in *Arvicola*, but in reality there probably is continuing complexity in this feature from *Arvicola* through *Phaiomys* to *Neodon*.

The genus *Neodon* (which may eventually be shown to include *Orthriomys*, *Proedromys*, and *Blanfordimys*) represents the second evolutionary grade, and is intermediate in complexity of the M_1 between grades I and III. The M_1 in grade II may have from three to five well developed triangles, of which only three or four are usually closed. Triangles four and five are usually confluent and open widely into the anterior loop, but these triangles are less confluent than in the genus *Pitymys*, and the anterior loop is, in *Neodon*, usually more elongate, complex, and asymmetrical than it is in *Pitymys*. *Phaiomys ruffoi* (Pasa, 1947) of middle or early Pleistocene sediments from Italy is possibly the ancestor for living *Neodon* species and for the extinct *N. paroperarius* from the Cudahy fauna in Kansas (Hibbard, 1944: Paulson, 1961).

Grade III includes all those voles with an M_1 containing at least five well developed triangles, of which all may be closed. This grade includes the genera *Pitymys* (including *Pedomys* and *Herpetomys*), *Microtus* (including *Aulacomys*, *Chionomys*, *Stenocranius*, *Chilotus*, and *Lasiopodomys*), *Alticola*, *Anteliomys* (including *Eothenomys*), and *Neofiber*. This grade is first seen in lower Pleistocene deposits of Europe (Kurtén, 1968), but does not appear in the New World until the early middle Pleistocene (the Cudahy fauna of Kansas; Paulson, 1961). These early North

American records include only the genus *Pitymys* (sympatric with *Neodon paroperarius*); *Neofiber* appears in North America in Port Kennedy Cave time (Irvingtonian; probably somewhat later than the Cudahy fauna) and *Microtus* is not found in North America prior to the Rancholabrean (*Microtus speothen* of the Port Kennedy Cave site is either a synonym of *Neodon paroperarius* or of the living *Microtus oeconomus*, the latter species which is at the *Neodon* grade of M_1 evolution, and perhaps more properly belongs in the latter genus). The genera *Alticola* and *Anteliomys* are now restricted to the Old World, and I am not aware of any extinct species allocated to these genera. I have included the genus *Eothenomys* within the genus *Anteliomys* because I do not believe that confluency of all triangles evolved more than once. The following is a key to the genera of this grade:

1. Triangles 1 & 2 of M_1 confluent........................ *Anteliomys*
   Triangles 1 & 2 of M_1 not confluent 2
2. Triangles 4 & 5 of M_1 confluent ....*Pitymys*
   Triangles 4 & 5 of M_1 not confluent 3
3. Triangle 6 of M_1 directed posteriorly; triangle 7 not usually developed on M_1 ....*Alticola*
   Triangle 6 of M_1 directed mesially; triangle 7 of M_1 at least incipiently developed.............................4
4. Capsular process of mandible undeveloped in adults; enamel borders of reentrant angles extremely thick; size large..................................*Neofiber*
   Capsular process of mandible usually well developed in adults; enamel borders of reentrant angles relatively thin; size small........................*Microtus*

The following discussion and species treatment are limited to the genus *Pitymys*.

Pitymys fossils are known from early Pleistocene deposits of Europe, but are recorded in North America for the first time in the early middle Pleistocene Cudahy fauna (Paulson, 1961). *Pitymys meadensis* may be the ancestor for most later North American species of the same genus, and based upon published information it is inseparable from the Old World *P. gregaloides* of early Pleistocene age (Hinton, 1926, referred this species to the Upper Pliocene, but the deposits from which this species is known, the upper freshwater beds at West Runton, have since been referred to the earliest Pleistocene; Zeuner, 1959). Both of these species are characterized by the closed anterior loop of M_1 and closed third and fourth triangles on the M_2. The living species *P. oaxacensis* and *P. guatemalensis* also demonstrate these features, and thus are relictual species of this earliest *Pitymys* radiation in North America.

Pitymys llanensis is also recorded from the Cudahy fauna of Kansas, and is separable from *P. meadensis* in that the anterior loop of M_1 is open and triangles three and four of the M_2 are confluent. The shallow sixth reentrant angle and mesially directed anterior enamel border of the fourth triangle of the M_1 indicate affinities with the living *P. ochrogaster*, and I believe that *P. llanensis* is the ancestor of the former species.

Pitymys involutus and *P. dideltus* of the Port Kennedy and Cumberland Cave faunas are inadequately described and illustrated in published accounts, and I have not studied these forms in detail. Both of these faunas are most likely of Irbingtonian age and somewhat younger than the Cudahy fauna (Hibbard, 1958).

The extinct *Pitymys arata* and the living *P. quasiater* are related to *P. meadensis* in possessing a closed anterior loop on the M_1, but are more advanced in that the third and fourth triangles of the M_2 are confluent. The sixth reentrant angle of the M_1 in both these species is deep and may curve up into the anterior loop. The anterior border of the fourth triangle is usually sloped posteriorly as well. Both characteristics indicate alliance with the line leading to *Pitymys pinetorum*.

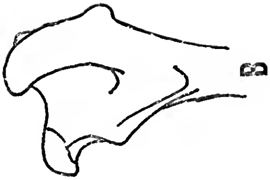
Pitymys pinetorum individuals I have studied usually demonstrate an open anterior loop on the M_1 (it is closed in a few *P. p. nemoralis*, but I have not seen it closed in any other living *P. pinetorum* subspecies) and triangles three and four of the M_2 are open in all specimens I have seen. These characteristics are first seen in a member of the *P. pinetorum* line in the early Rancholabrean species from the Williston III deposit of Florida, *P. hibbardi* (Holman, 1959). This species differs from *P. pinetorum* in its larger size and reduced capsular process. The capsular process is well developed in adult *P. pinetorum*. *Pitymys hibbardi* may have been derived from the Coleman IIA *P. arata*.

Neofiber alleni

Material: UF 11785-11789; 1 femur, 1 humerus, isolated teeth.

Remarks: The fossil material is inseparable from Recent material with which it was compared.

Figure 9 -- The dentition of *Pitymys arata* and *Equus* sp. from the Coleman IIA fauna, and femora of *Lepus alleni* and *Lepus townsendii*.



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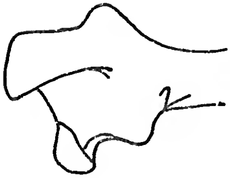

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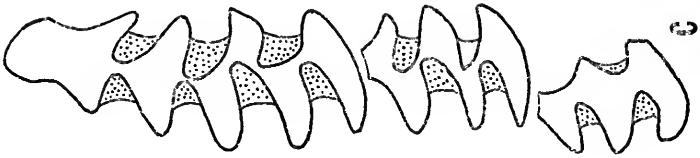

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Table 9

Mandibular dimensions (in mm) of some Recent and fossil samples of the genera *Microtus* and *Pitymys*

(* = fossil)

	M.A.Length		M_1-M_3		M_1		M_2	
	N	O. R.	N	O. R.	N	O. R.	N	O. R.
**Pitymys arata* (this study)	1	8.2	1	8.0	1	3.8	1	2.3
**Pitymys hibbardi* (Holman, 1959)	2	7.2-7.5	1	7.0	2	3.4	-	-
**Pitymys meadensis* (from Hibbard, 1949)	1	6.1	1	5.65	-	-	-	-
Pitymys pinetorum nemoralis (this study)	6	6.2-6.5	-	-	-	-	-	-
Pitymys pinetorum scalopsoides (this study)	5	6.1-6.7	-	-	-	-	-	-
**Pitymys pinetorum* (from Guilday, Martin and McCrady, 1964)	-	-	-	-	128	2.0-2.9	-	-
Pitymys dideltus (from Hibbard, 1955a)	-	-	1	6.5	1	3.8	-	-
**Pitymys involutus* (from Hibbard, 1955a)	-	-	1	4.95	-	-	-	-

Table 9 - continued

	M. A. length		M_1-M_3		M_1		M_2	
	N	O.R.	N	O. R.	N	O. R.	N	O. R.
Pitymys llanensis (from Semken, Jr., 1966; Hibbard and Dalquest, 1966)	-	-	-	-	23	2.6-3.3	5	1.6-1.9
**Pitymys ochrogaster* (from Hibbard, 1955b; Hibbard, 1963; Semken, Jr., 1966)	-	-	3	6,0-6.6	2	2.7-3.0	2	1.6-1.7
Pitymys ochrogaster ochrogaster (this study)	20	5.0-7.0	-	-	-	-	-	-
Pitymys ochrogaster taylori (Hibbard and Rinker, 1943)	31	5.9-6.7	-	-	-	-	-	-
Pitymys ochrogaster haydeni (this study)	11	6.0-7.1	-	-	-	-	-	-
**Microtus xanthognathus* (from Guilday, Martin and McCrady, 1964)	-	-	-	-	100	2.7-4.0	-	-
Microtus xanthognathus (from Guilday and Bender, 1959)	10	7.3-8.2	-	-	10	3.3-3.9	10	1.7-2.3
Microtus richardsoni macropus (this study)	13	7.2-8.6	13	6.8-8.2	13	3.1-4.0	13	1.8-2.3
Pitymys mcnowni (Hibbard, 1937)	1	7.0	-	-	1	3.3	1	2.0

Family Erethizontidae

Erethizon dorsatum (Linnaeus)- porcupine

Material: UF 11774, 11776: partial skull with all cheek teeth and a fragmentary mandible. (Figure 10)

Remarks: John White (1968) has recently described a new species of *Coendu* from middle Pleistocene deposits in California. In the same paper he referred two other fossil porcupines originally described as *Erethizon* to *Coendu*. In doing so, White has implied that the earliest records of *Erethizon* in North America are late Pleistocene, and that perhaps the evolutionary divergence of the two genera is that of age, or at the very earliest middle Pleistocene. The Coleman IIA porcupine, relegated to the late middle Pleistocene, therefore takes on added importance, and a study of the skull from this deposit was undertaken. The Coleman specimen lacks the nasals and the entire braincase.

Palates, upper cheek teeth, and mandibles of *Coendu* adults may be separated from those of *Erethizon* adults by the following criteria:

Coendu	*Erethizon*
1. P^4 equal or slightly wider than M^1.	1. P^4 markedly wider than M^1.
2. Upper tooth rows subparallel.	2. Upper tooth rows widely divergent.
3. Posterior border of palate at midline located opposite center or posterior border of M^3.	3. Posterior border of palate at midline located opposite center or posterior border of M^2.

Coendu (cont'd)	*Erethizon* (cont'd)
4. Angular process of mandible not sharply inflected; not particularly flattened on ventral surface.	4. Angular process of mandible sharply inflected; flattened on ventral surface.
5. Upper cheek tooth row less than 1/4 of skull length.	5. Upper cheek tooth row greater than 1/4 of skull length.

Criteria 1), 2), and 4) are from White (1968). Criterion 3) is the result of my observations on a small sample of *Erethizon* (6 individuals) and *Coendu* (3 individuals). Criterion 5) is taken from the following data made available to me by S. David Webb. Measurements were taken on specimens at the American Museum of Natural History:

Coendu: 19/88, 21/92, 20/87, 19/82, 20/89

Erethizon: 23/83, 25/90, 25/92, 25/88, 25/98

The measurement to the left of the line is the length of the cheek tooth row; to the right of the line is the greatest length of the skull.

Criteria 4) and 5) are not applicable to the Coleman II porcupine skull, but in all other criteria this skull best approximates *Erethizon dorsatum*. Webb excavated the P^4 from beneath the functional premolar, the DP^4, and the former is much wider than the M^1 (width P^4 = 7.2 mm, width M^1 = 6.3 mm). In divergence of the upper tooth rows the Coleman porcupine measurements fall within the variation expressed by *Erethizon dorsatum* as presented by White (1968): width of palate between P^4 alveoli = 2.8 mm; width of palate between M^3 alveoli = 8.6 mm.

A mandible and partial palate (that part housing the M^3s is missing) of a porcupine from the Kansan Inglis IA deposit of Florida is referrable also to *Erethizon*, as the angular process of the mandible is clearly inflected and ventrally flattened and the P^4 is wider than the M^1 (P^4 width - 7.0 mm, M^1 width = 6.3).

Although White (1968) may be correct in his assignment of the Grand View (Wilson, 1935), Aguascalientes (Hibbard and Mooser, 1963), and Vallecito (White, 1968) porcupines to *Coendu*, the data presented by him are far from convincing. The approximation of the M^1 width by the P^4 width in the Vallecito porcupine is certainly suggestive of *Coendu*, but as White (1968) demonstrates, the California fossils are otherwise inseparable from *Erethizon*, cranially and postcranially. I have not found either the scratches on the occlusal surface of the teeth, the configuration of the masseter scars, or the projection of the longitudinal axis of the lower tooth row onto the incisor as described by White (1968) reliable features with small samples. However, if the longitudinal axis of the lower tooth row projects far laterad to the incisor, the individual may be referred to *Erethizon*.

The presence of *Erethizon* in Florida during the Irvingtonian further indicates my reasons for doubting White's (1968) taxonomic references, and suggests that the evolutionary dichotomy between *Erethizon* and *Coendu* occurred prior to Irvingtonian time.

Figure 10 -- Upper dentition of fossil porcupine, UF 11774, from Coleman IIA.

Family Hydrochoeridae

+Hydrochoerus sp. Brunnich- capybara

Remarks: The capybara material from Coleman IIA is being studied by John Lance at the U. S. National Museum. Correspondence with him, and personal observation of some of the material suggests that the capybara represented is Hydrochoerus (rather than either Neochoerus or Hydrochoeropsis); but it may be a new species.

Capybara remains are common in river deposits in Florida, including the Ichetucknee River (Simpson, 1930a), Santa Fe River (unpubl.), Waccasassa River (unpubl.), Withlacoochee River (unpubl.), and Oklawaha River (unpubl.). These materials usually include either Hydrochoerus or Neochoerus or both genera. Capybaras have also been reported from terrestrial deposits at Vero (Weigel, 1962), Seminole Field (Simpson, 1929, 1930a), Sabertooth Cave (Simpson, 1928), and Bradenton Field (Simpson, 1930a), and West Palm Beach (unpubl.).

Order Carnivora

Family Ursidae

+Arctodus pristinus Leidy- eastern short-faced bear

Material: UF 12363; right M^1.

Remarks: The only specimen, an upper right first molar, is the first record of Arctodus pristinus from Florida. Size of the molar (length 23.9 mm, width 20.4 mm) clearly indicates A. pristinus rather than A. simus (Kurtén, 1967). Although there is some overlap in length of the M^1 between the two species Kurtén found no overlap in measurements of the width of this tooth (A. simus: 22.3-27.3 mm; A. pristinus: 20.2-

22.2 mm). Previously this species had been reported from deposits of Irvingtonian age in eastern North America (Port Kennedy Cave, Cumberland Cave) and from deposits of heterogeneous origin in the Ashley River, North Carolina (Kurtén, 1967).

Family Mustelidae

Spilogale putorius (Linnaeus)- spotted skunk

Material: UF 13168; isolated teeth and mandibular fragments.

Remarks: The fossil material is identical to that of Recent *Spilogale putorius* from Florida.

Conepatus sp. Gray- hog-nosed skunk

Material: UF 13169, 13170; 2 right mandibles, one with P_4, the other with P_2-P_4.

Remarks: The crowded condition of the premolars, plus the lingually directed, enlarged posterior heel of the P_4 identify the fossils as *Conepatus*. *Conepatus leuconotus* remains have been reported from the Haile VIIA and Williston III lime pits of Florida (Ray, *et al*., 1963; Churcher and Van Zyll de Jong, 1962), but the measurements of the one complete mandible from Coleman IIA do not allow an identification to species (Table 10). *Conepatus leuconotus* is also known from the Pleistocene Ladds deposit in Bartow, Georgia (Ray, 1967).

Mephitis mephitis (Schreber)- striped skunk

Material: UF 13167; right and left mandibular fragments.

Remarks: *Mephitis* and *Conepatus* are sympatric now only in the arid to semiarid southwest and northern Mexico. An unusual feature of the Florida Rancholabrean faunas is the abundance of skunks (in numbers of

Table 10

Measurements (in mm) of skunk mandibles
N = number of specimens,
mean above and observed range (in parentheses) below,
1 = alveolar length P_2-M_1, 2 = depth of ramus at middle of M_1,
3 = breadth of ramus at middle of M_1

	1	2	3
C. mesoleucas	17.4 (15.9-19.9) N = 8	7.1 (6.0-8.8) N = 7	4.7 (3.9-5.3) N = 7
C. leuconotus	20.1 (19.2-20.9) N = 9	8.1 (6.7-10.3) N = 9	5.4 (5.0-5.8) N = 9
Coleman IIA	19.0	8.0	5.0

individuals fossilized) and almost total absence of weasels. This may be somewhat related to weasel habits; they are taken only infrequently by raptorial birds and possibly were able to escape natural-trap sinkholes. A fossil weasel (*Mustela frenata*) has been reported from only one deposit in Florida; the Wisconsin Seminole Field locality (Simpson, 1929). Although weasel habits may play a part in the scarcity of their remains, it is further conceivable that weasels were Wisconsin immigrants into Florida.

Family Procyonidae

Procyon cf *P. lotor* (Linnaeus)- Raccoon

Material: UF 13163, 13164, 13171-13173; mandible, partial palate, humerus, RP_4.

Remarks: The Coleman IIA raccoon is tentatively identified as P. lotor following Arata and Hutchison (1964) and comparison with Recent Florida material. Study of the Recent material convinces me that Procyon lotor is one of the most variable carnivores, and perhaps mammals in general, in North America. One well preserved fossil mandible, with all teeth save the canine and carnassial, was duplicated by only very young Recent individuals, in both size and dental morphology. A partial upper palate, with the M^1 to M^3 is within the size range of Recent specimens of young individuals, but the fossil is clearly from an old individual, as the teeth are heavily worn and cusp patterns have all but been obliterated. This suggests that the Coleman IIA raccoon may have been smaller than that subspecies which presently inhabits the Coleman area. Yet the fossil sample is so small, and the Recent species so variable, that the material must simply be referred to Procyon lotor.

Family Canidae

+Urocyon minicephalus, new species

Holotype: UF 13146; a skull, complete except for broken zygoma, nasals, and premaxillaries. The dentition lacks the canines and incisors.

Referred specimens: UF 13137-13145, 13147-13151; all cranial and postcranial elements.

Horizon and locality: Coleman IIA Local Fauna, Sumter County, Fla.; late Irvingtonian; ?Illinoian.

Diagnosis: Urocyon minicephalus is a fox similar to the living gray fox, differing in the relatively closely allied sagittal crests and narrow occiput (Table 11; Figure 11). The greatest width between these crests (measured from the outside of each) in three fossil skulls does not approximate that in living or other Pleistocene gray foxes of comparable developmental age (as judged by tooth wear and skull suture patterns). In this respect the Coleman *Urocyon* are similar to the living *Vulpes fulva*, the red fox. The sagittal crests are widely spaced in the California island gray fox, *U. littoralis*, and in the Blancan species from the Rexroad fauna, *U. progressus* (Stevens, 1965 and personal observation).

Remarks: The relationships and origin of this species are unknown, and it is conceivable that *U. minicephalus* was a Florida endemic.

Canis lupus Linnapus- gray wolf

Material: UF 11518-11520, 12113-12126; 4 mandibles, 2 partial skulls, 3 radii, 1 scapula, 6 astraguli, 2 innominates, 6 femora, 4 tibia, 5 humeri, 6 ulnae, 3 phalanges, 8 metapodials.

Remarks: North American Pleistocene canids, especially the wolves, are badly in need of revision. At present five nominal species of wolves are recognized in the Pleistocene: *Canis dirus* Leidy, *Canis ayersi* Sellars, *Canis milleri* Merriam, *Canis armbrusteri* Gidley, and the living *Canis lupus* Linnaeus (= *C. occidentalis* of Merriam, 1912).

The most abundant collections of Pleistocene wolves from a single locality are those from the Rancho La Brea tar pits. Merriam (1912) recognized three species from these pits: *Canis dirus*, *Canis milleri*, and *Canis lupus* (= *C. occidentalis*). This is significant, as it is one of three fossil assemblages in which both living and extinct wolf species have been found together (the others include Fossil Lake; Elftman, 1931, and McKittrick; Schultz, 1938). As these pits are still trapping animals (Stock, 1930) heterochrony may be suspected.

Figure 11 - Recent and fossil skulls of foxes.

A = *Urocyon cinereoargenteus*, UF 2985, Arredondo IIA,

B = *U. minicephalus*, holotype UF 13146, Coleman IIA,

C = *U. minicephalus*, UF 13143, Coleman IIA,

D = *U. minicephalus*, UF 13143, Coleman IIA,

E = Recent *Vulpes fulva*, UF 4001, New York.

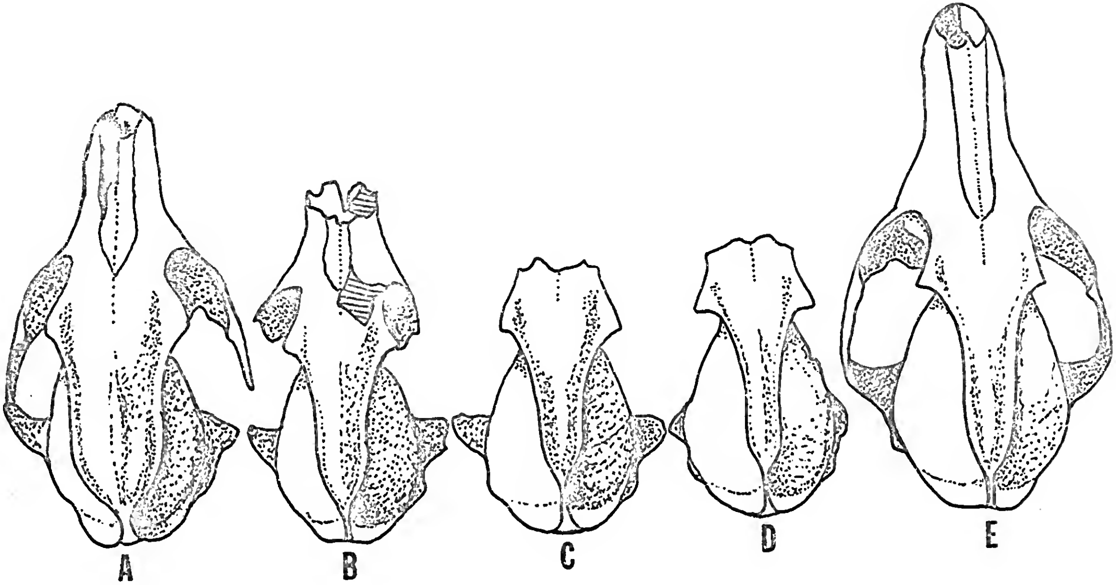
A
B
C
D
E

Table 11

Measurements (in mm) of fossil and Recent fox skulls
N = number of specimens, mean above and observed range (in parentheses) below

	Coleman II	Recent *U. cinereoargenteus*- Florida
Great w across sag. crest	13.5 (11.2-15.1) N = 3	22.4 (17.4-28.1) N = 19
Great w brain-case at zygema	42.0 (41.6-42.5) N = 3	44.3 (42.8-47.0) N = 7
Great l from inion to horiz. line betw. po processes	56.1 (55.0-57.5) N = 3	58.0 (55.2-60.4) N = 7
	Arredondo IIA	Recent *U. cinereoargenteus*- Fla., Ga., Mass., Ill., Ala., Ariz., Ark.,
Great w across	26.4 - N = 1	24.0 (15.8-36.8) N = 58
Great w brain-case at zygoma	44.9 - N = 1	-
Great l from inion to horiz. line betw. po processes	62.3 - N = 1	-
	Vulpes fulva- N.Y., Penn., Md., Del., Va., Alaska	
Great w across sag. crest	11.4 (3.0-16.9) N = 39	

Nevertheless, the fact that Merriam could recognize three wolf species will be important to later considerations.

As shown in Tables 12 and 13, and Figure 14, *Canis dirus* includes some individuals larger than the largest living *Canis lupus*. These data also show that, even in the southeastern states, the extinct dire wolf averaged larger than *lupus*.

After studying over 1,000 Recent wolf skulls at the U. S. National Museum, I am convinced that *Canis dirus* is distinct from *C. lupus*. Two qualitative characters clearly separate these species. First, as noted by Merriam (1912), the well developed inion in *C. dirus* projects backwards and downwards to a greater extent than in *lupus*. Although there is some variability within each species, and between males and females, even the largest male Yukon *lupus* do not demonstrate the pronounced overhang that is characteristic of all dire wolves. The Coleman IIA *Canis* agrees with *lupus* in this respect (Figure 12).

Second, the configuration of the anterior cingulum of the first upper molar appears to be diagnostic. In *Canis dirus* the anterolingual cingulum does not reach the hypocone, but ends at the protocone. If samples of living wolves that approximate the average size of *Canis dirus* are selected (*Canis lupus pambasileus* and *C. l. occidentalis*), in only 4 out of 75 the cingulum fails to reach the hypocone. The vast preponderance exhibit a cingulum that joins the hypocone. If *Canis lupus* subspecies are studied at random, without regard to size, 20% demonstrate an incomplete anterior cingulum. This indicates that, although there is a significant increase in the *dirus* trait in *lupus* from areas other than the Yukon and northern Canada, this increase is present only in wolves smaller than the extinct dire wolf.

The oldest true wolves in North America are not as large as *dirus*, and appear to be good *lupus* (those from Cumberland Cave, Inglis IA, and this fauna). In Florida *Canis dirus* appears during the middle or late Sangamon and lasts until the latest Wisconsin. Although Savage (1951) recorded *Canis dirus* from the Irvington fauna, the materials on which he based his identification (a mandibular fragment with a broken carnassial and a heavily worn P_4) do not permit a positive species reference. Indeed, Savage (1951) noted that a *Canis* femoral shaft from the Irvington, also assigned to *dirus*, appeared shorter and stockier than those of Rancho La Brea *dirus* to which it was compared. This suggests that the Irvington wolf is *lupus*, as *dirus* is characterized partly by "light" limbs (Merriam, 1912).

According to Sellards (1916) *Canis ayersi* from Vero, Florida, has a narrower snout than *C. dirus*, but is otherwise identical to the Rancho La Brea dire wolf. Another dire wolf skull, UF 2923, has since been collected from the Reddick IC Rancholabrean deposit in Marion County, Florida, and measurements of this animal are compared to those of the Vero and Rancho La Brea wolves in Table 13. These data show that the Reddick IC Canis is clearly *dirus*, and as the Vero skull is well within the size range of Rancho La Brea *dirus* it seems reasonable to consider it and other dire wolf material from Florida Rancholabrean deposits as *Canis dirus*.

Canis armbrusteri from the Cumberland Cave fauna presents an enigmatic taxonomic situation. First, the skulls referred to *armbrusteri* range in size from that typical of *lupus* through that typical of *dirus*, the average approximating that of the large northern *lupus* subspecies (Table 13). One skull, USNM 7994, is essentially identical to the Coleman IIA skull UF 11519. In general, the Cumberland Cave wolves approximate large northern *lupus* for all qualitative characters (all traits mentioned as unique by Gidley and Gazin, 1938, can be reproduced in these *lupus*). Yet there is one skull from Cumberland Cave (USNM 1186) in which the inion is as pronounced and hooked as in *dirus*. All but one of the first upper molars in the Cumberland Cave wolves have a complete anterior cingulum as in *lupus*.

The large size of the Cumberland Cave wolves can be explained by deposition during a glacial period (or periods); either Illinoian or Kansan, or both. It is evident from published studies (Dalquest, 1965; Guilday, *et al*., 1964, 1966; Martin, 1968a) that mammals now confined to northerly regions existed in more southerly regions during times of glacial advances. The largest *Canis lupus* now reside in north Canadian and Alaskan woods. During the Kansan and/or Illinoian glacial maxima it is conceivable that wolves of this size would have existed farther south, quite probably as far south as the Cumberland Cave area in Maryland. Therefore, with the exception of skull USNM 1186, it seems reasonable to refer the wolf skulls from the Cumberland Cave deposit to *Canis lupus*. The unusual skull (USNM 1186) with the pronounced inion may represent *Canis dirus*, but it seems more probable to me that it too is *lupus*, perhaps evidencing the first trace of *dirus* features. I suggest that *dirus* is derived from *lupus*; perhaps from the Cumberland Cave *lupus*.

The only wolf species remaining is *Canis milleri* (Merriam, 1912).

This species is represented only by the type skull, UCVP 11257. Supposedly this species differs from *C. lupus* only in greater width of the skull and more massive dentition. My measurements (Tables 12, 13) show no significant difference between this type and *Canis lupus*. As shown by Merriam (1912; figure 31), the anterior cingulum of the M^1 connects with the hypocone.

In summary, I conclude that there are only two wolves common to middle and late Pleistocene deposits of North America, *Canis dirus* Leidy (=*Canis ayersi* Sellards) and *Canis lupus* Linnaeus (=*Canis dirus* of Savage, 1951, =*Canis armbrusteri* Gidley, =*Canis milleri* Merriam, =*Canis occidnetalis* of Merriam, 1912). The typical Irvingtonian wolf is *Canis lupus*. The common Rancholabrean wolf is *Canis dirus*. After the latest Wisconsin extinctions only *lupus* remains.

Family Felidae

Felis onca Linnaeus- jaguar

+*Felis onca augusta* Leidy

Material: UF 12128-12165; 9 partial dentaries, 12 partial maxillae, 1 brain case, numerous skull pieces, 10 calcanea, 7 astraguli, numerous metapodials, 5 humeri, 63 phalanges, 6 femora, 1 sacrum, 6 ulnae, 4 innominates, 7 tibia, 7 radii, 4 scapulae, 1 fibula.

Remarks: Numerous large felines have been reported from Pleistocene deposits in North America (Simpson, 1941; Kurtén, 1965) and to present a complete summary of these forms is now quite unfeasible. The large cat from Coleman IIA is clearly a jaguar, and is referrable to the extinct subspecies *Felis onca augusta* following Simpson (1941) and

Figure 12 -- Skulls of *Canis lupus* from Coleman IIA

(Top: UF 11520;

Bottom: UF 11519)

Figure 13 -- Ventral view of skull of <u>Canis lupus</u>
from Coleman IIA (UF 11519).


#11519

Figure 14 -- Scatter diagram relating Pleistocene and Recent wolves when the length of the P^4 (X axis) is plotted against the width of the P^4 (Y axis). Solid squares = Coleman IIA C. *lupus*, open squares = Cumberland Cave *C. lupus*, closed triangles = Florida Rancholabrean *C. dirus*, open triangles = Rancho La Brea *C. dirus*, closed circles = Recent *C. l. pambasileus* and *C. l. occidentalis*, open circles = Recent *C. l. baileyi*, *C. l. youngi*, and *C. l. fuscus*, crosses = Recent *C. niger gregoryi* and *C. n. rufus*, open circle with solid dot in center = Haile VIIA *C.* cf *lupus*. X^1 = *C. l. occidentalis*, mean of 17 individuals, X^2 = *C. l. pambasileus*, mean of 15 individuals, X^3 = *C. l. youngi*, mean of 13 individuals, X^4 = *C. niger rufus*, mean of 24 individuals.

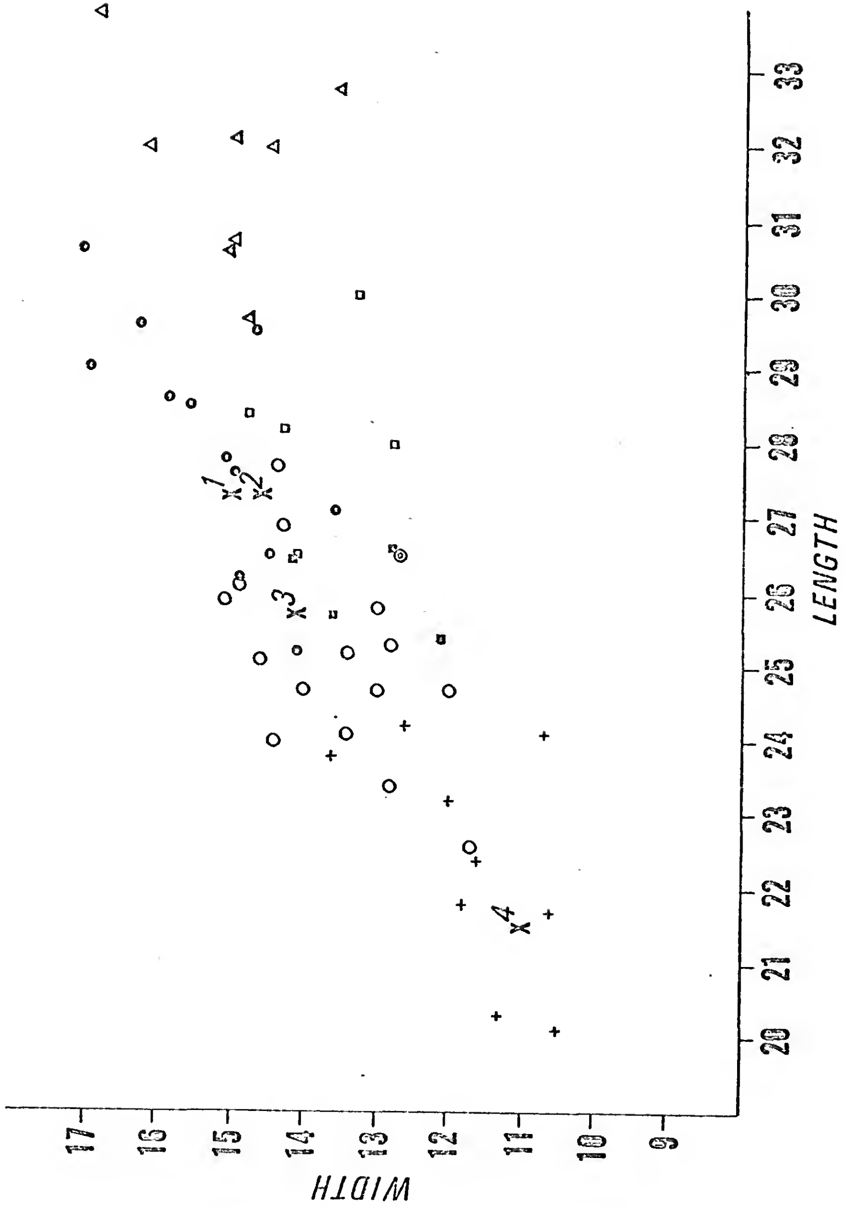
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Table 12

Measurements (in mm) of the upper fourth premolar and upper first molar in fossil and Recent wolves
N = number of specimens, L = length, W - width, min. = smallest specimen measured, max. = largest specimen measured

Recent *Canis lupus* and *C. niger* (data from Young and Goldman, 1944)			P^4				M^1	
	N		L	W	N		L	W
C. l. pambasileus	15	min.	25.2	13.1	15	min.	16.7	22.6
		max.	29.6	16.3		max.	19.2	26.1
C. l. occidentalis	17	min.	25.5	13.4	17	min.	16.3	21.8
		max.	30.6	17.1		max.	19.2	25.5
C. l. youngi	13	min.	24.7	13.2	13	min.	16.2	20.1
		max.	26.9	15.1		max.	17.3	24.8
C. niger rufus	24	min.	20.1	10.0	24	min.	13.0	17.6
		max.	22.7	12.3		max.	15.2	20.2
Fossil Wolves								
Canis milleri (from Merriam, 1912)	1		28.2	15.2	1		16.4	20.7
C. armbrusteri (this study)	5	min.	26.5	12.8	5	min.	17.4	21.9
		max.	30.0	14.8		max.	19.0	23.5
C. lupus (Coleman IIA)	4	min.	25.4	12.1	2	min.	16.5	19.1
		max.	26.6	14.1		max.	16.7	19.9

Table 12 - continued

Fossil Wolves (cont'd)		P^4				M^1	
	N		L	W	N		L	W
C. dirus (=*C. ayersi*; from Sellards, 1916)	1		30.0	15.0	1		20.0	23.0
C. dirus (Florida*; this study)	5	min.	29.7	13.6	7	min.	18.9	18.7
		max.	32.8	15.1		max.	22.1	24.5
C. dirus (Rancho La Brea; from Merriam, 1912)	4	min.	30.7	14.5	2	min.	18.7	23.0
		max.	33.8	16.9		max.	20.0	24.0

*Arredondo IA, Ichetucknee River, Santa Fe River, Reddick IA, Hornsby Springs, Haile VIIIA.

Table 13

Measurements (in mm) of fossil and Recent wolf skulls
1 = greatest breadth at posterior alveolus of P^4,
2 = greatest breadth at posterior alveolus of P^2,
3 = alveolar length P^3-M^2, 4 = distance from posterior end of palate to center of occipital condyles, 5 = width of snout outside canine, 6 = greatest length of skull, 7 = width of snout outside P^1, 8 = zygomatic breadth. = greater than, ap = approximate, min. = smallest specimen measured, max. = largest specimen measured

	1	2	3	4	5	6	7	8
Recent *Canis lupus*								
C. l. occidentalis (mean for 17 individuals; from Young and Goldman, 1964)						276.5		146.7
USNM 214482 (this study)	79.4	41.6	62.4	96.5				
USNM 214480 (this study	79.3	43.7	63.4	99.0				
C. l. pambasileus (mean for 15 individuals; from Young and Goldman, 1964)						283.1		149.4
UCMVZ 984 (from Merriam, 1912)					52	250		138.4
USNM 265576 (this study)	88.0	47.6	67.6	108.2				
C. l. baileyi (mean for 11 individuals; from Young and Goldman, 1964)						241.0		134.5
USNM 3325 (this study)	76.3	41.0	57.5	90.2				

Table 13 - continued

Fossil Wolves		1	2	3	4	5	6	7	8
Canis milleri (from Merriam, 1912)		89.5				50.2	223		134
C. armbrusteri (this study and from Gidley and Gazin, 1938)	min.	77.2	38.3	61.2	86.0		240		130
	max.	88.2	42.0	69.3	116.8		270		160
C. lupus (Coleman IIA; UF 11519)		77.8	37.6	61.0	89.5			39.6	ap134
C. dirus (=C. ayersi; Sellards 1916; FGS 7166)		91				48	300	46	160
C. dirus (Reddick IC; UF 3081)		93	56	ap77		62	ap290	54	ap170
C. dirus (Rancho La Brea; Sellards, 1916)									
UCMVP 10834		96.2				58.5	ap295		164.5
UCMVP 10856		107.5				67.3	ap310		ap175

Kurtén (1965). Some dental measurements of the Coleman IIA jaguar are presented with those of other fossil and living jaguar samples in Table 15.

Large cats such as *Felis atrox* and *Felis onca augusta* were common predators in the Rancholabrean fauna of North America, yet their taxonomic status remains somewhat uncertain. Both Simpson (1941) and Kurtén (1965) related *Felix atrox* to the living jaguar, but Kurtén (1965) states, "Although *Felis atrox* may be related to the jaguar . . . , it must have looked very different in the flesh. With its slim build, long legs, and relatively small head it was obviously highly cursorial." The largest living jaguars, *F. onca milleri* and *F. onca palustris* are found now only in South America, and yet are apparently the only races of the living jaguar which approximate *F. o. augusta* in size (Simpson, 1941).

These considerations occasioned a study of morphometric variation in the lower dentition of most of the New World fossil and living *Felis* (excluding *Lynx*) and the lion, tiger, and leopard of the Old World. One would perhaps expect that the proportions of the teeth would vary significantly in such a widespread and externally variable group of mammals. The measurements of these forms are presented in Table 14. As the most useful graphical method for noting proportional differences is the ratio diagram, the measurements were portrayed by this method in Figure 15.

Surprisingly, there is virtually no difference in the form of these diagrams between the species, although some size differences are obvious. The only possible exception to the above statement is seen in the plot for the puma, Felis concolor. I am not certain of the significance of this dichotomy; if it were to be a fundamental difference between the Panthera and Felis groups, it might be expected that the ratio diagram plots for the margay and ocelot would approximate that of the puma as well, but they do not. Meade (1945) and Savage (1955) also compared members of the Felis and Panthera groups by the ratio diagram method and came to the conclusion, with regard to dental dimensions, that the resultant plots simply do not demonstrate any major differences between the two groups. Simpson (1941) did not present any ratio diagrams comparing only dental dimensions, but rather combined dental with postcranial dimensions or dealt solely with limb material. His plots may demonstrate quite succinct differences between the puma and Recent jaguars. but these differences depend upon the bones compared (e. g., plotted dimensions of metatarsal II will separate pumas from jaguars, but the diagram for dimensions of metacarpal IV will not separate these forms except on size).

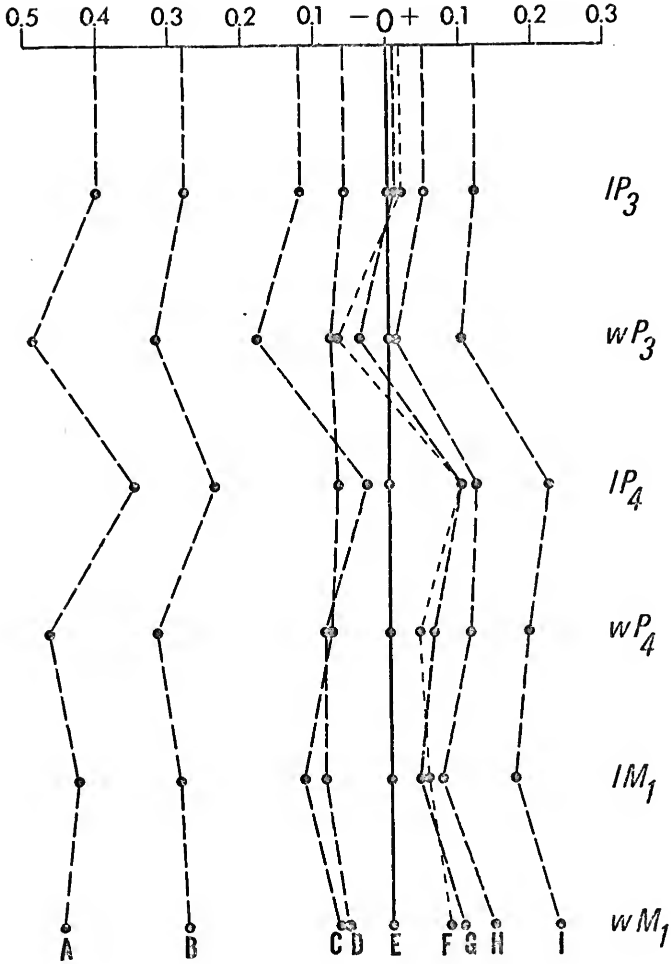
These data suggest that although the pelage and limbs of the cats studied have undergone selective modification, the dentition has remained conservative.

Felis rufus Schreber- bobcat

Material: UF 14996; 1 right humerus and 1 right fibula.

Remarks: The fossil material recovered, although conceivably the remains of a small cat other than the bobcat, was inseparable from the same elements of Recent F. rufus with which it was compared.

Figure 15 -- Ratio diagram comparing the lower dentitions of various felines. A = *Felis wiedii*, B = *F. pardalis*, C = *F. concolor*, D = *F. pardus*, E = *F. onca milleri*, F = *F. tigris*, G = Coleman IIA *F. onca augusta*, H = *F. leo*, I = Ichetucknee River *F. atrox*. Numbers of specimens and sources of measurement data are given in Table 15.


0.5
0.4
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0.2
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0.1
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0.3
lP_3
wP_3
lP_4
wP_4
lM_1
wM_1
A
B
C
D
E
F
G
H
I

Table 14

Measurements (in mm) of the lower dentition of some extinct and living cats
N = number of specimens, $\overline{X}$ = mean, O.R. = observed range

		Length P_3			Width P_3			Length P_4	
	N	$\overline{X}$	O.R.	N	$\overline{X}$	O.R.	N	$\overline{X}$	O.R.
Felis onca milleri (Matto Grosso; from Simpson, 1941)	8	15.4*	14.0-17.3	8	8.5*	7.4-9.5	8	21.4*	19.8-22.9
+*Felis onca augusta* (Coleman IIA)	3	16.1	15.7-16.5	3	8.3	8.2-8.3	4	23.3	22.9-24.0
+*Felis atrox* (Ichetucknee River; from Kurtén, 1965)	1	20.6	-	1	11.3	-	1	30.8	-
Felis tigris (India; from Whitmore and Foster, 1967)	10	16.4	13.5-19.3	10	7.7	7.0-8.4	10	23.2	21.4-25.0
Felis leo (Africa; this study)	6	17.6	15.5-19.1	6	9.3	8.7-10.8	6	24.7	22.8-27.2
Felis pardus (Africa and India; this study)	7	11.9	10.1-12.6	7	5.9	5.3-6.9	7	17.3	14.9-19.2
Felis concolor (Idaho, Arizona, Montana; this study)	8	13.8	11.8-14.6	8	7.5	6.5-8.0	8	16.0	14.0-17.2
Felis pardalis (Brazil and Mexico; this study)	12	8.3	7.1-8.9	12	4.3	3.6-4.8	12	10.8	8.8-11.4
Felis wiedii (Mexico and Costa Rica; this study)	6	6.2	5.3-7.0	6	2.9	2.4-3.3	6	8.4	7.3-9.6

Table 14 - continued

	Width P_4			Length M_1			Width M_1		
	N	$\overline{X}$	O.R.	N	$\overline{X}$	O.R.	N	$\overline{X}$	O.R.
Felis onca milleri (Matto Grosso; from Simpson, 1941)	8	11.3*	9.8-12.8	8	22.0*	20.0-24.0	8	11.6*	10.2-13.0
+*Felis onca augusta* (Coleman IIA	4	11.5	11.2-12.0	4	24.6	21.9-27.2	4	12.9	12.0-14.4
+*Felis atrox* (Ichetucknee River; from Kurtén, 1965)	1	15.6	-	1	33.4	-	1	17.2	-
Felis tigris (India; from Whitmore and Foster, 1967)	10	11.0	10.0-12.0	10	25.2	22.4-28.0	10	12.2	11.0-13.4
Felis leo (Africa; this study)	6	12.9	11.8-14.4	6	26.4	25.7-29.0	7	14.0	13.5-15.5
Felis pardus (Africa and India; this study)	7	8.3	7.5-9.5	7	18.2	16.0-20.8	7	8.8	7.9-10.0
Felis concolor (Idaho, Arizona, Montana; this study)	8	8.4	7.5-9.8	8	17.3	16.5-18.8	8	8.6	8.0-9.8
Felis pardalis (Brazil and Mexico; this study)	12	4.8	4.2-5.3	12	11.7	10.8-12.2	12	5.3	4.8-5.9
Felis wiedii (Mexico and Costa Rica; this study)	6	3.4	3.0-4.0	6	8.4	7.0-9.7	6	3.6	3.1-3.9

*Average of least and greatest measurements.

Table 15

Measurements (in mm) of the lower dentition of fossil and Recent jaguars
Min. = smallest individual measured, max. = largest individual measured

	P_3		P_4		M_1	
	length	width	length	great width	length	width
Recent *F. o. milleri* min. (from Simpson, 1941)	14.0	7.4	19.8	9.8	20.0	10.2
Recent *F. o. milleri* max.	17.3	9.5	22.9	12.8	24.0	13.0
Sante Fe River, loc. unknown FDT 490 (from Kurten, 1965)	14.3	7.8	21.8	10.7	22.6	-
Reddick IA, UF 8879 (from Kurtén, 1965)	-	-	21.3	10.9	22.3	11.4
Reddick IA, UF 8878 (from Kurtén, 1965)	-	-	23.0	12.0	-	-
Melbourne, USNM 11470 (from Kurtén, 1965)	16.1	8.3	21.0	11.0	20.7	11.1
Seminole Field, AMNH 23540 (from Kurtén, 1965)	-	-	-	10.8	-	-
Coleman IIA min.	15.7	8.2	22.9	11.2	21.9	12.0
Coleman IIA max.	16.5	8.3	24.0	12.0	27.2	14.4
Waccasassa River, Loc. 6 UF 14765 (this study)	15.5	8.8	22.4	10.6	21.5	11.3
Laubach Cave* (from Slaughter, 1966)	-	-	23.3	12.0	25.4	12.3
Ladds* USNM 23486 (from Ray, 1967)	16.7	8.2	22.3	11.1	24.0	12.2
Craighead Caverns, AMNH 32633 (from Simpson, 1941)	18.2	9.0	24.7	12.4	24.6	12.7

* Mean between right and left.

Order Artiodactyla

Family Tayassuidae

Platygonus cumberlandensis Gidley- peccary

Material: UF 12070-12112; 28 ulnae, 8 scapulae, 29 humeri, 14 femora, 3 innominates, 22 tibia, 13 astraguli, 14 calcanea, 114 phalanges, 143 metapodials, 2 sacra, 17 dentaries, 8 palates, 1 partial skull, numerous isolated teeth and vertebrae.

Remarks: There are presently five species of Platygonus known from the middle to the late Pleistocene of North America. According to the latest review of these forms (Slaughter, 1966) there are two species groups. The first is represented by P. compressus, P. leptorhinus, and P. alemani. These species are characterized by non-expanded zygoma and are considered synonymous by Slaughter (1966). The second group is represented by P. vetus and P. cumberlandensis, and has characteristically expanded zygoma.

The Florida samples I have measured form a fairly coherent pattern, both in time and in anatomical and morphometric features. Platygonus remains are present in Blancan through latest Rancholabrean deposits in Florida. Measurements of the Florida material and localities are listed in Table 16. When anterior-posterior length of the M_1 is plotted against transverse length of the same tooth, the Florida Platygonus samples form what I consider to be three distinct groups representing three species (Figure 17). The first species, represented in the Santa Fe 1B (late Blancan) and Inglis IA (Irvingtonian; ?Kansan) deposits, is a large form characterized also by the presence of three pairs of lower incisors. Zygomatic structure is unknown in this form, but as this species includes very large animals, presumably it was expanded. The second species in Florida, somewhat smaller than the Santa Fe 1B-Inglis IA form (Figure 17, Table 16), is characterized by the presence of only two pairs of lower incisors and expanded zygoma. This species, found in the Coleman IIA and Haile VIIA faunas, is referrable to *Platygonus cumberlandensis*, and is clearly derived from the Santa Fe-Inglis species. One mandible (UF 12085) from the Coleman IIA fauna demonstrates two shallow alveoli in the position of the third postero-lateral pair of incisors of the earlier species. The alveoli in UF 12085 are so narrow and tiny that I rather doubt if this pair of incisors was present for more than a short period in the individual's development. Two other mandibular symphyses from Coleman IIA do not demonstrate these vestigial alveoli. As can be seen from Figure 17 the Cumberland Cave *P. cumberlandensis* conform to the variation expressed by the Coleman *Platygonus*. Although zygomatic morphology is not known for the Haile VIIA *Platygonus*, first lower molars from this fauna plotted in Figure 17 coincides more with *P. cumberlandensis* than with the later, smaller form, and on this basis I refer the Haile VIIA material to *P. cumberlandensis*.

The third species, which will here be referred to as *P. compressus*, is characterized by small size (Figure 17, Table 16), non-expanded zygoma, and two pairs of lower incisors. Large samples of this species are found in the Illinois Cherokee Cave (Simpson, 1949) and Texas Laubach Cave (Slaughter, 1966) faunas. Although the zygomatic structure of the Florida Rancholabrean *Platygonus* is not known, the variation in size of the M_1 and the other teeth (Figure 17, Table 16) from the Reddick IA, Reddick IIC, Reddick IB, and Devil's Den deposits is contained completely within that expressed by the Laubach Cave and Cherokee Cave samples, and these teeth can therefore be referred with some confidence to *P. compressus*.

Platygonus vetus supposedly differs from *P. cumberlandensis* in lacking accessory structures (lophs and cuspules) on the molars (Gidley, 1920). Such structures are moderately well developed in the Coleman IIA *Platygonus* (Figure 16). Although Slaughter (1966) suggests that dental complexity in these forms may have little taxonomic utility, it is not necessarily valid to cite variation in a Blancan or Hemphillian species (*P. bicalcaratus*) as proof. Besides, the taxonomy of that species too needs review. As I have not completely analyzed dental variation in *P. vetus* or in *P. cumberlandensis* I will temporarily accept their integrity, and refer the Coleman IIA material to *P. cumberlandensis*.

+*Mylohyus* sp. Cope- peccary

Material: UF 14243; upper first or second molar.

Remarks: *Mylohyus* is obviously in need of revision. There are now about eight nominal species of this genus known from both middle and late Pleistocene deposits, which makes allocation of any Florida material somewhat difficult. There is now much more *Mylohyus* material available from Florida than that discussed by Lundelius (1960), some of which has been reported by Semken and Griggs (1965).

The older Pleistocene faunas in Florida, those of Blancan and Irvingtonian age (pre-Coleman IIA) contain only *Platygonus*. *Mylohyus* is first seen in Florida in the Coleman IIA fauna, and was possibly much less abundant during that time than was *Platygonus*. In all of the Sangamon and Wisconsin deposits in Florida *Mylohyus* remains are more common than are those of Platygonus, and some do not contain any Platygonus material. Examples of some Rancholabrean deposits with only Mylohyus are: Arredondo II (Bader, 1957), Vero (Weigel, 1962), Williston (Holman, 1959), and Seminole Field (Simpson, 1929). Although it must be considered as pure speculation, these considerations suggest that Mylohyus was the common peccary in Florida subsequent to the Illinoian glaciation. However, Platygonus was sympatric with Mylohyus during the Sangamon at Reddick IA, Reddick IIC, and Haile VIIIA. The latest occurrence of peccaries in Florida is during Devil's Den time, from which deposit there is Platygonus, but no Mylohyus. Again, in all the above localities, excepting Devil's Den, Mylohyus remains are much more common than are those of Platygonus.

According to Hershkovitz (1962) and Hooper (1957) populations of cricetid rodents that inhabit arid situations have less complicated teeth than do those living in more humid situations. Teeth of Platygonus are much less complicated and more tubercularly hypsodont (terminology after Hershkovitz, 1962) than are those of Mylohyus. Thus, if dental adaptive trends of peccaries correspond at all to those of rodents, and particularly to the cricetid rodents, then the peccaries suggest a change from open, drier country in Blancan and Irvingtonian time to denser, more mesic situations in Rancholabrean time in Florida. Possible corroborative evidence was presented by Lundelius (1960), who considered Mylohyus the ecological equivalent of the European Sus, and associated Mylohyus with mesic forest. The idea that Mylohyus was a woodland peccary and Platygonus a plains form is not a new one according to Slaughter (1961), and was suggested early in this century by Barnum Brown (1908).

Table 16

Measurements (in mm) of fossil dental samples of <u>Platygonus</u>
N = number of specimens, $\bar{X}$ = mean, O.R. = observed range

	Length P_2			Width P_2		
	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.
Santa Fe River, Loc. 1	-	-	-	-	-	-
Santa Fe River, Loc. 1B	-	-	-	-	-	-
Inglis IA	-	-	-	-	-	-
Coleman IIA	4	11.6	11.2-11.9	4	8.6	7.9-9.0
Haile VIIA	1	10.3	-	1	7.8	-
Cumberland Cave[1]	2	9.8	9.5-10.0	2	7.8	7.5-8.0
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	2	10.5	8.7-12.3	1	6.3	-
Laubach Cave[2]	9	10.0	8.8-11.8	9	7.6	6.3-8.5
Cherokee Cave[3]	7	8.9	8.0-10.3	7	6.7	5.2-8.6
P. leptorhinus[4]	4	8.8	7-10	4	6.3	6-7

	Length P_3			Width P_3		
Santa Fe River, Loc. 1	-	-	-	-	-	-
Santa Fe River, Loc. 1B	-	-	-	-	-	-
Inglis IA	-	-	-	-	-	-
Coleman IIA	6	13.9	12.6-14-6	6	10.4	9.5-11.6
Haile VIIA	1	13.3	-	1	9.2	-
Cumberland Cave	2	12.2	11.6-12.8	2	9.5	9-10
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	4	10.5	9.6-11.1	4	9.1	8.1-9.8
Laubach Cave	13	11.4	10.1-12.5	13	9.0	8.5-10.0

Table 16 - continued

(continued)	Length P_3			Width P_3		
	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.
Cherokee Cave	11	10.6	9.7-11.4	24	8.6	7.8-10.2
P. Leptorhinus	4	10.0	10	4	7.8	7-8
	Length P_4			Width P_4		
Santa Fe River, Loc. 1	3	13.2	12.6-13.8	3	12.1	11.5-12.7
Santa Fe River, Loc. 1B	-	-	-	-	-	-
Inglis IA	-	-	-	-	-	-
Coleman IIA	9	14.3	13.3-15.1	9	11.9	11.3-13.2
Haile VIIA	-	-	-	-	-	-
Cumberland Cave	2	12.2	11.6-12.8	2	11.6	11.5-11.7
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	3	12.5	12.3-12.6	3	10.7	10.5-10.9
Laubach Cave	13	12.0	10.3-13.1	13	10.4	9.1-11.3
Cherokee Cave	10	12.1	11.0-13.8	25	9.9	8.9-12.2
P. Leptorhinus	4	10.8	10-12	4	9.5	9-10
	Length M_1			Width M_1		
Santa Fe River, Loc. 1	1	12.6*	-	1	12.0	-
Santa Fe River, Loc. 1B	-	-	-	-	-	-
Inglis IA	1	18.3	-	1	14.1	-
Coleman IIA	15	17.0	15.9-18.0	15	12.2	11.4-13.2
Haile VIIA	4	16.9	16.3-17.8	4	11.6	11.4-11.7
Cumberland Cave	4	16.4	15.5-17.1	4	11.9	11.5-12.7

Table 16 - continued

(continued)	Length M_1			Width M_1		
	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	3	14.6	14.3-15.2	3	10.5	10.2-10.8
Laubach Cave	14	14.7	13.1-16.3	14	11.3	10.5-11.9
Cherokee Cave	15	14.2	13.3-15.0	19	10.3	9.7-11.0
<u>P. leptorhinus</u>	6	12.3	10-15	6	9.8	9-11
	Length M_2			Width M_2		
Santa Fe River, Loc. 1	2	16.4	15.7-17.1	2	14.5	14.0-14.9
Santa Fe River, Loc. 1B	1	18.1	-	1	15.0	-
Inglis IA	1	18.5	-	1	15.4	-
Coleman IIA	12	19.7	18.9-21.1	12	14.6	13.5-15.2
Haile VIIA	2	20.5	20.2-20.8	2	14.9	14.1-15.6
Cumberland Cave	5	20.6	19.1-22.6	5	14.8	14.5-15.0
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	5	17.4	16.8-18.4	5	13.0	12.2-14.1
Laubach Cave	19	18.0	16.9-19.6	19	13.1	12.2-14.5
Cherokee Cave	13	17.0	15.0-19.5	42	12.5	10.4-14.4
<u>P. leptorhinus</u>	5	15.4	15-16	5	11.4	10-13
	Length M_3			Width M_3		
Santa Fe River, Loc. 1	2	26.8	25.6-27.9	1	15.7	-
Santa Fe River, Loc. 1B	-	-	-	-	-	-
Inglis IA	1	25.3	-	1	15.2	-
Coleman IIA	7	26.5	25.8-27.8	7	15.3	14.7-15.9

Table 16 - continued

(continued)		Length M_3			Width M_3	
	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.
Haile VIIA	-	-	-	-	-	-
Cumberland Cave	2	24.2	22.8-25.5	2	15.5	15-16
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	4	23.2	22.8-23.6	4	13.5	12.8-14.2
Laubach Cave	14	24.1	21.6-27.3	14	13.5	12.8-14.6
Cherokee Cave	24	23.7	21.2-26.5	24	13.4	12.0-14.6
P. leptorhinus	5	21.2	20-23	5	11.6	11-12
		Length P^2			Width P^2	
Santa Fe River, Loc. 1	-	-	-	-	-	-
Pool Branch	-	-	-	-	-	-
Inglis IA	-	-	-	-	-	-
Coleman IIA	2	12.1	11.5-12.7	2	11.4	10.1-12.7
Haile VIIA	1	11.3	-	1	10.1	-
Cumberland Cave	2	11.4	11.0-11.7	2	10.9	10.5-11.3
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	-	-	-	-	-	-
Laubach Cave	8	10.7	9.3-11.5	7	9.9	8.2-11.1
Cherokee Cave	7	9.8	9.1-10.7	7	9.8	9.3-10.1
P. leptorhinus	3	10.0	9-11	3	9.7	9-10
		Length P^3			Width P^3	
Santa Fe River, Loc. 1	1	12.5	-	1	12.5	-
Pool Branch	-	-	-	-	-	-
Inglis IA	-	-	-	-	-	-

Table 16 - continued

(continued)	Length P^3			Width P^3		
	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.
Coleman IIA	2	12.9	12.8-13.0	2	13.3	12.7-13.8
Haile VIIA	1	12.6	-	1	12.0	-
Cumberland Cave	2	11.4	11.0-11.7	2	13.4	13.3-13.5
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	-	-	-	-	-	-
Laubach Cave	14	11.3	10.6-13.3	13	11.3	10.8-12.8
Cherokee Cave	12	10.4	9.5-11.5	12	11.5	10.4-12.1
<u>P. leptorhinus</u>	4	10.3	10-11	4	11.3	10-12
	Length P^4			Width P^4		
Santa Fe River, Loc. 1	-	-	-	-	-	-
Pool Branch	-	-	-	-	-	-
Inglis IA	-	-	-	-	-	-
Coleman IIA	3	12.6	11.9-13.0	3	14.7	14.4-15.4
Haile VIIA	1	12.6	-	1	14.5	-
Cumberland Cave	2	11.7	11.6-11.7	2	14.2	14.0-14.3
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	1	12.7	-	1	13.1	-
Laubach Cave	14	11.5	10.7-12.8	14	13.7	12.9-14.6
Cherokee Cave	21	10.8	9.3-12.7	21	13.3	12.3-14.8
<u>P. leptorhinus</u>	4	9.3	9-10	4	12.0	11-13

Table 16 - continued

	Length M^1			Width M^1		
	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.
Santa Fe River, Loc. 1	-	-	-	-	-	-
Pool Branch	1	17.4	-	1	15.7	-
Inglis IA	-	-	-	-	-	-
Coleman IIA	6	16.9	15.7-17.7	6	14.7	13.3-15.8
Haile VIIA	3	16.9	16.2-17.4	3	14.5	13.7-15.0
Cumberland Cave	5	16.2	15.6-16.5	5	14.6	14.1-15.5
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	1	15.3	-	1	13.4	-
Laubach Cave	19	15.1	11.8-16.1	19	14.2	13.5-15.8
Cherokee Cave	19	14.2	13.3-15.4	29	13.6	11.9-16.0
P. leptorhinus	5	12.6	11-14	5	12.2	12-13
	Length M^2			Width M^2		
Santa Fe River, Loc. 1	-	-	-	-	-	-
Pool Branch	-	-	-	-	-	-
Inglis IA	1	22.2	-	1	17.4	-
Coleman IIA	8	19.5	18.9-20.2	8	17.0	16.4-17.7
Haile VIIA	1	19.9	-	1	17.0	-
Cumberland Cave	2	18.8	18-19	2	17.0	16-18
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	2	18.4	18.1-18.6	2	16.6	16.2-16.9
Laubach Cave	19	17.6	16.0-19.7	19	16.3	15.1-17.4
Cherokee Cave	17	17.5	15.1-19.3	34	15.6	13.8-17.4
P. leptorhinus	4	16.0	15-17	4	14.3	14-15

Table 16 - continued

	Length M^3			Width M^3		
	N	$\overline{X}$	O.R.	N	$\overline{X}$	O.R.
Santa Fe River, Loc. 1	-	-	-	-	-	-
Pool Branch	-	-	-	-	-	-
Inglis IA	1	24.6	-	1	19.0	-
Coleman IIA	2	24.3	23.6-24.9	2	18.8	17.4-20.2
Haile VIIA	2	21.4	20.7-22.1	-	-	-
Cumberland Cave	2	22.6	20.6-24.5	2	17.6	17.0-18.2
Reddick IA, Reddick IB, Haile VIIIA, Devil's Den	2	21.4	20.7-22.1	2	16.9	16.2-17.5
Laubach Cave	13	20.5	18.9-23.5	13	16.2	15.0-17.7
Cherokee Cave	12	21.0	19.0-23.6	26	16.2	14.8-17.9
P. leptorhinus	2	19.5	19-20	2	14.0	14

---

[1] P. cumberlandensis; this study and from Gidley and Gazin, 1938.

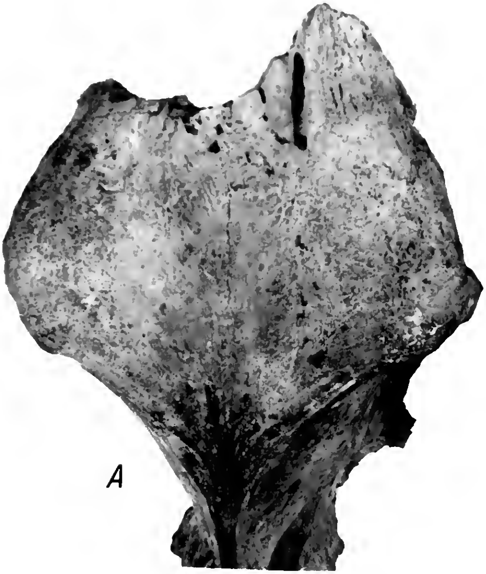
[2] from Slaughter, 1966.

[3] from Simpson, 1949.

[4] recalculated from Simpson, 1949.

*worn down to the roots.

Figure 16 -- Palate and partial skulls of *Platygonus cumberlandensis* from Coleman IIA (A, UF 12077 adult; B, UF 12084 young; C, UF 12084 young; D, UF 12076 adult).


A

B


C

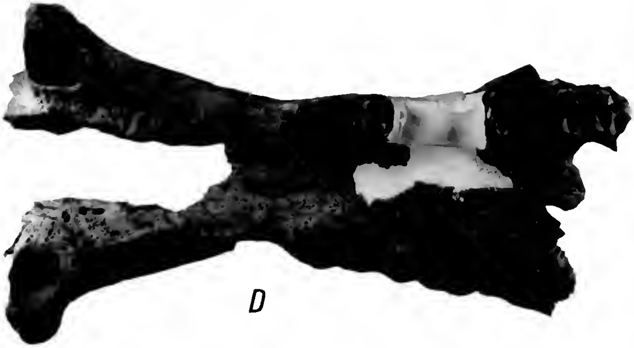
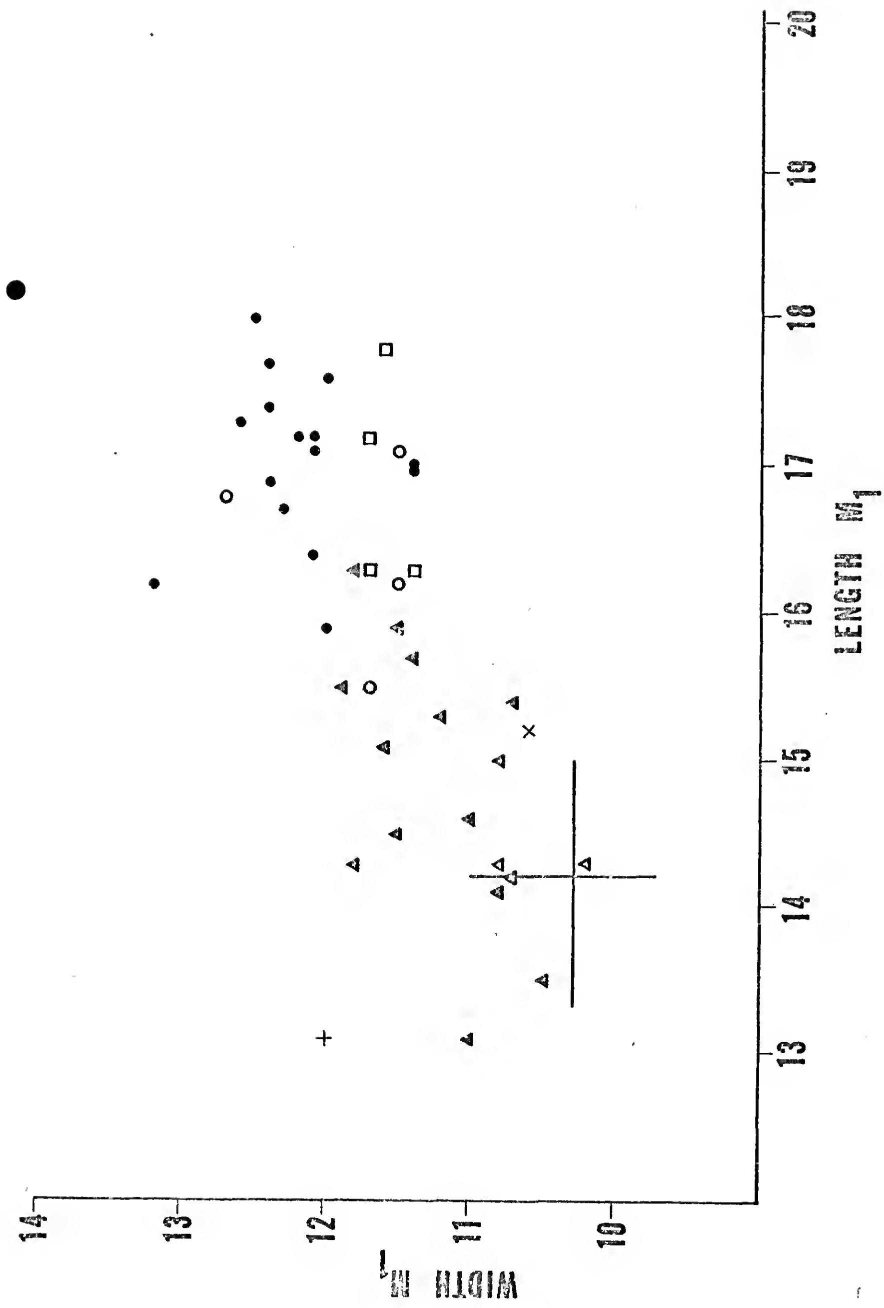

D

Figure 17 -- Scatter diagram relating various samples of fossil *Platygonus* when length of the M_1 (X axis) is plotted against the width of the M_1 (Y axis). Large solid circle = Inglis IA *Platygonus* sp., small solid circles = Coleman IIA *P. cumberlandensis*, open circles = Cumberland Cave *P. cumberlandensis*, solid triangles = Laubach Cave *P. compressus*, open triangles = Reddick IA *P. compressus*, open squares = Haile VIIA *P. cumberlandensis*, cross = aberrant tooth from Santa Fe 1; the crown is worn away exposing the roots, X = Devil's Den *P. compressus*, small X-Y axes = range of measurements of the Cherokee Cave *P. compressus*.


LENGTH M1
13
14
15
16
17
18
19
20
WIDTH M1
10
11
12
13
14

Family Camelidae

+ <u>Tanupolama</u> cf <u>mirifica</u> Simpson- camel

Material: UF 11967-12034, UF 16371; 10 dentaries, 3 palates, 2 fibulae, 60 phalanges, 8 calcanea, 6 scapulae, 10 ulnae, 15 humeri, 13 tibia, 8 femora, 10 astraguli, 17 metapodials, isolated teeth and foot bones.

Remarks: The camelid material from this deposit is from a single species, and includes a good comparative sample. Preliminary investigation by S. David Webb and myself indicatesthat there are at least two species of Pleistocene camels represented in Florida. Although they may be labeled "larger and longer-limbed" versus "smaller and shorter-limbed" it is clear from Figure 20 and Tables 17 and 18 that the main difference between the metapodials of the two species is the ratio of length to width, not the absolute size of either dimension. The Coleman IIA sample consists entirely of the latter species, and is the earliest record of this form in Florida. Earlier faunas (Punta Gorda, Inglis IA, and Payne's Prairie III) contain the other form. We have not as yet worked out the nomenclatorial problems dealing with these beasts, but it appears possible that the "shorter-limbed" variety will eventually bear the name <u>mirifica</u>, a species named by Simpson (1929) from the Florida Seminole Field deposit. Unfortunately the taxonomic characters by which we are now able to adequately separate the two forms do not include the lower molars, and the type specimen of <u>T. mirifica</u> includes only the lower molars. Based upon Simpson's published figures of the camel premolars, both species are represented in the Seminole Field collections. The metapodial figured and labeled by Simpson (1929) as <u>Camelops</u> is from the "shorter-limbed" <u>Tanupolama</u>. The lower dentition and mandible of the Coleman IIA camel may be viewed in Figures 18 and 19.

Family Cervidae

Odocoileus virginianus (Zimmermann)- white-tailed deer

Material: UF 11912-11956; 15 calcanea, 7 astraguli, 12 femora, 15 tibia, 3 scapulae, 4 ulnae, 8 humeri, 19 phalanges, 5 dentaries, isolated teeth.

Remarks: The fossil material appears inseparable from comparable material of the living Florida white-tailed deer.

Order Perissodactyla

Family Equidae

+*Equus* sp.- horse

Material: UF 12035-12050; 1 scapula, 4 ulnae, 2 humeri, 6 metapodials, 2 femora, 2 calcanea, 2 astraguli, 6 phalanges, vertebrae and isolated teeth.

Remarks: To refer any fossil *Equus* (subgenus or subgroup *Equus*) from Florida to species at this time appears to me impossible. Although it would be possible to study the fossil *Equus* of Florida, voluminously represented in Blancan through latest Wisconsin deposits, a study of this nature is beyond the scope of this treatment.

The only conclusion I am now able to reach is that the Coleman IIA horse material is not identical to that of a large horse found in almost all later Pleistocene faunas from Florida. Preliminary analysis by myself and others indicates that horse teeth similar to those of the Coleman IIA species also occur in some of these faunas, but I cannot say whether this represents dental evolution or partial replacement of one species by the other. The premolars of the Equus (Plesippus) from the Blancan Haile XVA Florida deposit show a remarkable similarity to both premolars and molars of the Coleman II horse, teeth of the latter which are pictured in Figure 9 . Molars of the Haile XVA horse are clearly representative of Plesippus.

Order Proboscidea

Family Elephantidae

+ Mammuthus sp.

Material: UF 14389; right lunar.

Remarks: The single lunar is the only element from the Coleman IIA deposit definitely referrable to the Proboscidea. It is almost identical to the same element of a young Mammuthus from the late Wisconsin Aucilla River deposits.

Figure 18 -- Labial view of the lower dentition and mandible of _Tanupolama_ from Coleman IIA (UF 11985).

Figure 19 -- Occlusal view of lower dentition and mandible of *Tanupolama* from Coleman IIA (UF 11983).

Figure 20 -- Regression analysis relating two species of camels from the Pleistocene of Florida when proximal width of the metapodial (X axis) is plotted against the greatest length of the metapodial (Y axis). The regression line was fitted by the method of least squares. Line A: 1 = Payne's Prairie III, 2 = Punta Gorda, 3 = Pool Branch, 4 = Haile VIIIA, 5 = Santa Fe River 1-6; Line B: 1 = Ichetucknee River, 2 = Bradenton 51st St., 3 = Arredondo IA, 4 = Sebastian Canal 2, 5 = Manatee Springs, 6 = Reddick IIC, 7 = Reddick ID, 8 = Coleman IIA.

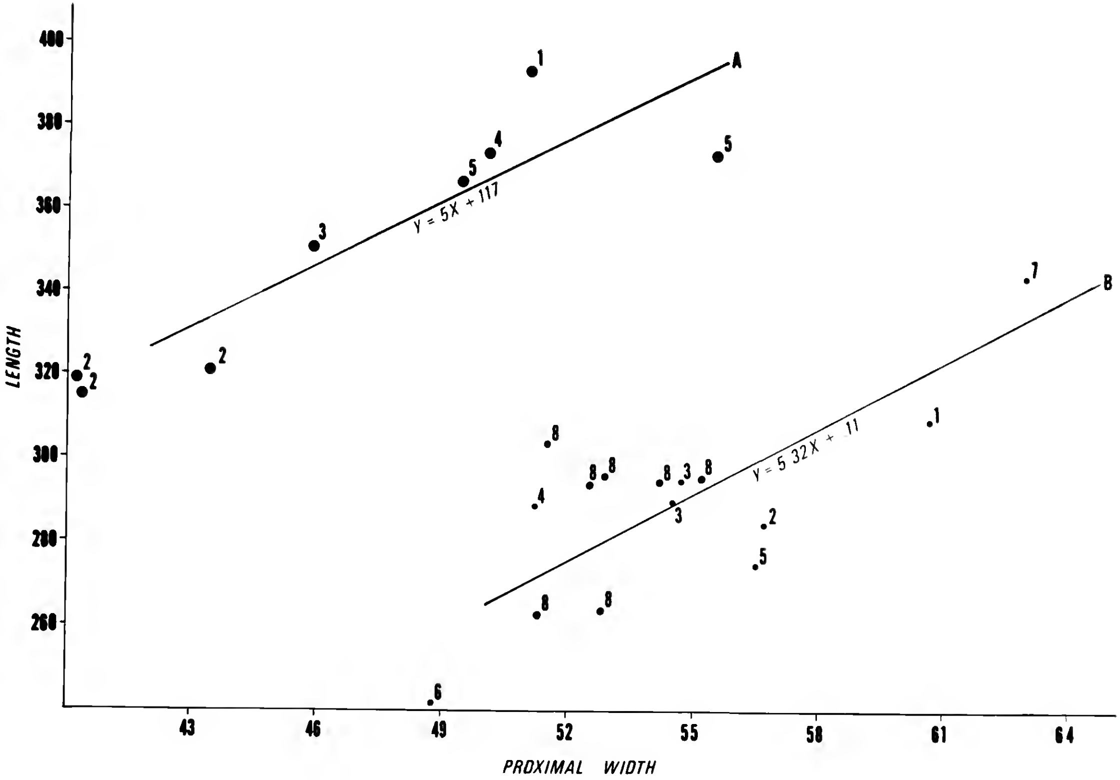

LENGTH
400
380
360
340
320
300
280
260
PROXIMAL WIDTH
43
46
49
52
55
58
61
64
A
Y = 5X + 117
B
Y = 5 32X + 11
1
4
5
5
3
2
2
2
7
1
8
8
8
8
3
8
4
3
2
5
8
8
6

Table 17

Tanupolama ("short-limbed" species); measurements (in mm) of metapodials
I/II = greatest length divided by greatest proximal width
Regression line B in Figure 21 corresponds to these measurements

	I Greatest Length	II Greatest Proximal Width	I/II
Coleman IIA			
UF 11977	263	51.3	5.13
UF 11976	304	51.5	5.90
UF 11976	295	54.2	5.44
UF 11976	296	52.9	5.60
UF 11991	294	52.5	5.60
UF 11994	264	52.8	5.00
UF 11994	296	55.2	5.36
Ichetucknee River			
UF 11320	310	60.7	5.11
Bradenton 51st Street			
UF 3546	285	56.7	5.03
Arredondo IA			
UF 828	295	54.7	5.39
UF 828	290	54.5	5.32
Sebastian Canal 2			
UF 14247	289	51.2	5.64
Manatee Springs			
UF 15159	275	56.5	4.87
Reddick IIC			
UF 14173	242	48.8	4.96
Reddick ID			
UF 10930	345	63.0	5.47

Table 18

Tanupolama ("long-limbed" species); measurements
(in mm) of metapodials
I/II = greatest length divided by greatest proximal width
Regression line A in Figure 21 corresponds to
these measurements

	I Greatest Length	II Greatest Proximal Width	I/II
Payne's Prairie III			
UF 12521	394	51.0	7.73
Punta Gorda			
UF 11187	314	40.3	7.79
UF 9717	321	43.4	7.40
UF 9718	319	40.2	7.94
Pool Branch			
UF 11432	351	45.8	7.80
Haile VIIIA			
UF 10928	374	50.0	7.48
Santa Fe River, Loc. 1-6			
UF 11560	374	55.5	6.74
UF 10855	367	49.4	7.43

AGE AND CORRELATION

The Coleman IIA Local Fauna apparently stands at the Irvingtonian-Rancholabrean boundary (Figure 21). We may tentatively label the fauna as latest Irvingtonian rather than earliest Rancholabrean because the fauna lacks *Bison* and includes mammals unknown in the majority of later Pleistocene faunas of Florida (some of these forms include *Pitymys arata*, *Urocyon minicephalus*, *Sigmodon bakeri*, *Lepus alleni*, and *Platygonus cumberlandensis*), some of which may well be ancestral to later Pleistocene species. In Florida the Irvingtonian-Rancholabrean boundary is no longer clear. The Coleman IIA, Williston III, Haile VIIA, and Bradenton localities bridge the gap between "typical" Irvingtonian faunas such as Inglis IA and "typical" Rancholabrean faunas such as Reddick IA. Of course, even if the boundary is no longer clear, the names serve to denote periods of time in Florida (and elsewhere) which in general evidenced quite distinct faunas.

Auffenberg's (1958, 1967) studies of the fossil and living box turtles of Florida suggest that correlation may be made between certain *Terrapene carolina* subspecies and sea level in the past. The large, extinct subspecies *T. c. putnami* is considered a coastal, savanna form, whereas the smaller *T. c. carolina* is considered a forest race which occurred at higher elevations. The Coleman IIA *Terrapene* are small, and although they may represent *T. c. putnami* and *T. c. carolina* intergrades, they are not good *putnami*. According to Auffenberg (1958) this suggests either that sea level was not much above its present level or that sea level may have been lower than at present. However, if H. K. Brooks (pers. comm.) is correct in his view that the 25 foot stand of sea level corresponds to the latest Yarmouthian, then it is conceivable that Terrapene carolina putnami might not be expected as far inland as Coleman during this time. If the Coleman IIA site represents deposition during a glacial period, it is fairly certain that this period would be of Illinoian, rather than of either Wisconsin or Kansan time. Faunas of known Wisconsin age, such as Vero (Weigel, 1962), Devil's Den (Martin and Webb, in prep.; H. K. Brooks, pers. comm.), Melbourne (Ray, 1958), Seminole Field (Simpson, 1929; Auffenberg, 1958), contain the extant species Pitymys pinetorum and Sigmodon hispidus as well as the extinct species Platygonus compressus, whereas Coleman IIA contains the extinct species Pitymys arata, Sigmodon bakeri, and Platygonus cumberlandensis. Further, a fauna in Florida assigned to the Kansan glaciation, Inglis IA, contains the extinct Sigmodon curtisi (a more primitive grade than S. bakeri), the antelope Capromeryx, and an undescribed species of Platygonus that was clearly ancestral to the Coleman IIA P. cumberlandensis.

My present ideas on mammalian faunal changes in Florida during the Pleistocene are noted in Figure 21. Florida is the only area in the New World in which four species of Sigmodon, representing three evolutionary grades, have been recovered. These species, along with others noted in the same illustration (Figure 21), facilitate correlation of most major Pleistocene deposits of Florida. The following deposits correspond to the sequence noted in Figure 21:

Hemphillian

- McGehee Farm
- Withlacoochee River, Loc. 4A
- Manatee Dam

Hemphillian (continued)

- Bone Valley
- Mixson's Bone Bed
- Emathla

Late Blancan

- Santa Fe River, Locs. 1B, 4A, 8A
- Haile XVA

Irvingtonian

- Punta Gorda (includes *Mammuthus* (*Archidiskodon*) *haroldcooki*)
- Inglis IA
- ?Payne's Prairie III
- ?Pool Branch
- Coleman IIA

Sangamon

- Early
  - Williston III
  - Bradenton 51st St. and ?Bradenton Field
  - Haile VIIA
- Late
  - Reddick IA, IB, IIC
  - Haile VIIIA
  - ?Haile XIIIA, B, C
  - ?Arredondo IIA, B
  - Sabertooth Cave
  - ?Payne's Prairie B

Wisconsin

- Early ($>$30,000 years B.P.)
  - Vero, Bed 2 ($>$30,000 years B. P., c14; Weigel, 1962)
  - Melbourne, Golf Course Loc.
  - Seminole Field
  - ?Arredondo IA
- Middle (c. a. $<$ 30,000, $>$ 11,000 years B.P.)
  - Ichetucknee River (part; H. K. Brooks, pers.comm.)
  - Withlacoochee River, Loc. 7A
  - Aucilla River (part)

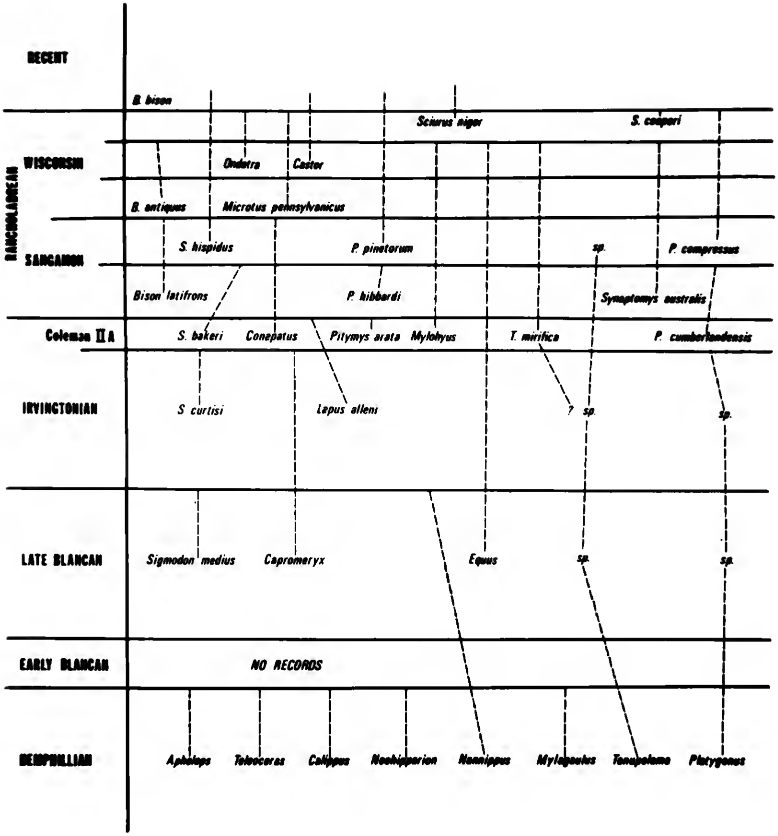
Wisconsin (continued)

Late ($<$ 11,000 years B.P.)

Devil's Den (c. a. 8,000 years B. P., c14; H. K.
Brooks, pers. comm.)

Coleman IIA cannot clearly be correlated with any deposit outside of Florida. The closest approximation appears to be the Cumberland Cave fauna of Maryland (Gidley and Gazin, 1938), which contains *Platygonus cumberlandensis*, *Canis lupus* (see my discussion in the Species Account) and at least one extinct species of *Pitymys* (personal observation). Although the Cumberland Cave fauna appears to be of Irvingtonian age, the mammalian remains have not been reviewed in 30 years, and until this is done it would be too hazardous to speculate further.

Figure 21 -- Replacement of mammals in Florida during the Pleistocene.


RECENT
RANCHOLABREAN
WISCONSIN
SANGAMON
Coleman II A
IRVINGTONIAN
LATE BLANCAN
EARLY BLANCAN
HEMPHILLIAN
B. bison
Sciurus niger
S. cooperi
Ondatra
Castor
B. antiquus
Microtus pennsylvanicus
S. hispidus
P. pinetorum
sp.
P. compressus
Bison latifrons
P. hibbardi
Synaptomys australis
S. bakeri
Conepatus
Pitymys arata
Mylohyus
T. mirifica
P. cumberlandensis
S. curtisi
Lepus alleni
? sp.
sp.
Sigmodon medius
Capromeryx
Equus
sp.
sp.
NO RECORDS
Aphelops
Teleoceras
Calippus
Neohipparion
Nannippus
Mylagaulus
Tanupolama
Platygonus

AFFINITIES OF THE COLEMAN IIA MAMMALS

The Coleman IIA fauna contains four living taxa, *Erethizon dorsatum*, *Conepatus* sp., *Lepus alleni*, and *Felis onca*, that are no longer found in Florida. *Erethizon* could have entered Florida either from the north or from the west, but as the fauna contains other obvious western immigrants (*Lepus*, *Conepatus*), and lacks any mammals now confined north of Florida, it seems more likely that the porcupine also wandered in along the Gulf Coast corridor during the Illinoian. In fact, it is quite probable that almost the entire body of Coleman IIA mammals, and most of the living mammals of Florida as well, entered Florida from the west along the Gulf Coast. Table 19 shows the Coleman IIA mammal species (exclusive of the bats) of which any dispersal and evolutionary centers are known or can be postulated with any degree of confidence. Only two out of eighteen (11%) possibly entered Florida from the north, or Appalachian route, while sixteen (89%) presumably entered Florida from the west along the Gulf of Mexico. The balance of living Florida terrestrial mammals may be added to this list (Table 19): of the six species for which immigration routes can be determined, four entered via the Gulf Coast route. Thus, approximately 83% of the living terrestrial mammalian fauna of Florida has ultimately western affinities.

Table 19, however, requires some discussion. Including the most closely related living species to the Coleman IIA mammalian species in many cases was useful in defining the evolutionary and dispersal centers for the latter species, but in other cases actually clouds the issue. For instance, it was assumed by the author that those areas which now attain the highest density of living species related to the Florida fossil and living species represents the general areas from which the Florida forms originated. In general this may be valid, but in certain instances this is clearly not the case.

The Coleman IIA *Glaucomys* cannot be identified to species. It may be either *G. sabrinus*, *G. volans*, or an intermediate between the two. At any rate, the geographic (and evolutionary) connection between the two appears most probably to be the Appalachian chain. *Glaucomys sabrinus* exhibits a positive Bergmann's response, with populations of small individuals, such as *G. s. coloratus*, located on isolated mountain tops in the southern Appalachians. I believe that one of these small subspecies ultimately gave rise to *G. volans* during and subsequent to a major glacial period; probably Illinoian.

The fossil *Geomys* are referred to *G. pinetis* purely on a geographical basis; they are morphologically referrable to *G. personatus* as well. Pocket gophers probably existed in continuous populations across the Gulf Coast in either or both Illinoian and Wisconsin time. High sea levels, plus the great Mississippi alluvial fan, probably isolated the eastern *Geomys pinetis* from its western relatives.

Reithrodontomys humulis is a grassland or field rodent, most closely related to the Latin American *R. burti* (Hooper, 1952) of the subgenus *Reithrodontomys*. There is little doubt that the ultimate roots of *R. humulis*, and most of the other species of the genus, are in southwestern North America.

Sigmodon bakeri may be most closely related to *S. hispidus*, an extant Florida species. However, both may trace their ancestry to the hodgepodge of Mexican *Sigmodon*.

Dasypus bellus is most closely related to the living *D. novemcinctus* which, until rather recently, was confined south of the Rio Grande. In recent time *D. novemcinctus* has moved northward and eastward (movement of this species in Florida is not relevant to this discussion, as *D. novemcinctus* was recently introduced into Florida; Neill, 1952). This same Gulf Coast pathway was undoubtedly utilized also by *D. bellus*, which reached Florida in the late Blancan (Haile XVA time) and remained there until the late Wisconsin.

Lepus alleni now exists primarily in northwest Mexico. Perhaps its closest living relative is *L. californicus*, but recording this fact has no application to the origin of *L. alleni*, the latter species which simply moved into Florida from the west.

Peromyscus floridanus has no close living relative. It lives almost exclusively in open, sandy, scrubby areas. According to Layne (1963), its origin was in the west.

The western mule deer, *Odocoileus hemionus*, is the most closely related living species to the white-tailed deer, *O. virginianus*, but recording this fact, as in the case of *Lepus californicus*, simply fulfills the requirements of the table. The evolutionary and dispersal patterns of these species are unknown.

Peromyscus gossypinus was probably derived from its *leucopus*-group relative, *P. leucopus*, as the latter species' Austroriparian equivalent, much in the same fashion as *Synaptomys australis* was derived from *S. cooperi*. I suggested (1967) that speciation of the *leucopus* group may have been a Wisconsin or post-Wisconsin phenomenon, but new evidence proves that *P. gossypinus* was present in Florida during the early Sangamon. *Peromyscus gossypinus* probably evolved from a *P. leucopus* population pushed south into the Gulf Coast region during the latest Illinoian. Although *P. leucopus* can now be found in Texas and Louisiana, and is sympatric in east Texas and parts of Louisiana with *P. gossypinus*, in these areas *P. leucopus* is always smaller than elsewhere (the smallest *leucopus* subspecies is the east Texan *texanus*; Martin, 1968b), while *P. gossypinus* is larger in these areas of sympatry than it is elsewhere (e. g., *P. g. megacephalus*). This perhaps represents character displacement to a certain extent, and I look for another area to the east, where the morphological traits overlap more (Dismal Swamp, Virginia; Dice, 1940; Martin, 1967) for the species connection. Speciation of the two forms perhaps culminated in the early or middle Sangamon as sea level rose and warming trends separated populations of the two forms.

I do not know which living species of squirrels are most closely related to *Sciurus carolinensis* and *S. niger*, unless they are each other, which avails nothing in determining past dispersal patterns. The origin of *S. carolinensis* is obscure, but *S. niger* did not appear in Florida until about 8- to 10,000 years ago, and is recorded as a fossil only in the Devil's Den fauna (Martin and Webb, in prep.), the latest, coldest time period in the Pleistocene history of Florida. Mammals from this fauna indicate movement solely from the north.

According to Bowen (1968) the ancestor of *Peromyscus polionotus* was not, as Osgood (1909) suggested, the Texas *P. maniculatus pallescens*, but rather another *maniculatus* subspecies such as *bairdii*, the latter ranging now as far south as southern Arkansas, and typically an animal of the Upper Austral and Transition Life Zones (Hall and Kelson, 1959). Bowen suggests this to explain the absence of P. polionotus in apparently suitable habitat west of the Alabama River. He states (1968), "Had the species evolved from an eastward extension of maniculatus stock in Texas, the suitable habitats in western Alabama would surely be occupied today." This is not convincing, as the same could be said of Geomys pinetis, which was obviously derived from some ancestral Gulf Coast stock (possible G. personatus of eastern Texas), and which also does not cross the Alabama River into "suitable habitats." The Mobile Bay beaches west of the Alabama River are isolated and not extensive. Woodland comes down very close from the narrow beaches there from the north, and the Mississippi delta encroaches from the west as the Alabama River alluvial plain does from the east. Minor glacial retreats coincident with raised sea levels during the Wisconsin are recognized[1], and a good example is the Two Creeks interstade at ca. 11,800 years B. P. Minor interstades would possibly be capable of flooding out the entire Mobile Bay region and connecting the Mississippi and Alabama River flood plains, or at the very least producing riparian forests in this region. Such minor sea level fluctuations would effectively decimate any grassland or beach mammals west of the Alabama River,

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[1] The position of Bowen that some subspecies of P. polionotus had evolved by the Yarmouthian is very unlikely, especially considering that the 150 foot Okefenokee shoreline which he correlated with this interglacial is in actuality of Pliocene age (Brooks, 1968).

but would not be capable of removing all such populations to the east, as any part of Florida would make an adequate refugium. In actuality it does not appear to me to be particularly significant that neither G. pinetis nor P. polionotus occurs west of the Alabama River. Although I believe that my explanation is more reasonable than that of Bowen (1968), there are so many examples of areas that appear hospitable to a particular species that remain unoccupied that I must agree with Deevey (1967) who suggested that " . . . a niche not occupied, or occupiable, by a known organism is an unhelpful construct, like a hoop snake."

Table 19

Relationships of the Coleman IIA mammals
The terms Gulf Coast and Appalachian refer to the route of entrance into Florida
The species above the broken double line are found in Coleman IIA; the species below the broken double line are extant but were not recovered from Coleman IIA
I = most closely related living species of same genus; II = closest proximity of I to Florida

	Gulf Coast	Appalachian	I	II
Didelphis marsupialis	X		-	-
Cryptotis parva	X		C. mexicana	N. E. Mexico
Blarina brevicauda		?X	B. telmalestes	E. North Carolina
Scalopus aquaticus	X		S. inflatus	N. E. Mexico
+Dasypus bellus	X		D. novemcinctus	Mississippi
+Holmesina septentrionalis	X		-	-
Lepus alleni	X		?L. californicus	E. Texas
Sylvilagus sp.	?	?	S. floridanus or S. palustris	Florida
Sciurus carolinensis	?	?	?	-
Glaucomys sp.		X	G. volans or G. sabrinus	Florida; S. Tennessee
Geomys cf pinetis	X		G. personatus	E. Texas
Reithrodontomys humulis	X		R. burti	N. W. Mexico
Peromyscus floridanus	X		-	-
Ochrotomys nuttalli	?	?	-	-
+Sigmodon bakeri	X		?S. hispidus	Florida
+Microtus arata	X		?M. quasiater	S. E. Mexico
Neofiber alleni	?	?	-	-
Erethizon dorsatum	?X		-	-
+Hydrochoerus sp.	X		H. isthmius	Panama
Canis lupus	?	?	C. latrans	W. Louisiana
+Urocyon minicephalus	?	?	?U. cinereoargenteus	Florida
+Arctodus pristinus	?	?	-	-
Procyon lotor	?	?	?	-
Spilogale putorius	X		S. pygmaea	S. W. Mexico

Table 19 - continued

	Gulf Coast	Appala-chian	I	II
Mephitis mephitis	?	?	M. macroura	N. C. Mexico
Conepatus sp.	X		C. leucontus or C. mesoleucus	S. E. Texas
+Felis onca augusta	X		?	-
Felis rufus	?	?	F. canadensis	N. Virginia
+Equus sp.	?	?	-	-
+Platygonus cumberlandensis	?	?	-	-
+Mylohyus sp.	?	?	-	-
+Tanupolama cf mirifica	?	?	-	-
Odocoileus virginianus	?	?	O. hemionus	W. Texas
Peromyscus gossypinus		X	P. leucopus	C. Mississippi
Peromyscus polionotus	?X		P. maniculatus	C. Texas
Sigmodon hispidus	X		?S. fulviventer	W. Mexico
Ursus americanus	?	?	U. horribilis	C. Kansas
Felis concolor	?	?	?	-
Sorex longirostris	?	?	?	-
Sciurus niger		X	?	-
Oryzomys palustris	X		?O. couesi	S. E. Texas
Neotoma floridana	X		N. micropus	S. E. Texas
Mustela frenata	?	?	?	-
Mustela vison	?	?	M. macrodon	S. Maine
Lutra canadensis	?	?	L. annectens	E. C. Mexico

PALEOECOLOGY

There is actually very little that can be said of the paleoecology of an isolated aggregation of fossil mammals which accumulated over an interval of unknown duration. The limited area and depth (less than 3 feet) from which the Coleman fossils were collected, the good preservation of these fossils, and the associated elements of single individuals which transgress the facies boundaries, suggest rapid deposition (perhaps less than 1,000 years), but there is no way that this may be substantiated. The term isochronous may be applied to the Coleman IIA fauna as a unit relative to other faunas of, for example, early or late Sangamon time, but to consider the mammalian remains from the Coleman sink as a homogeneous, natural unit, analagous to what one could slaughter in a year or so on an African savanna, would be making an assumption which, although conceivable, is highly unlikely. Further, there is not now an adequate body of information concerning the habitat preferences of living Florida mammals on which to draw for comparison to the fossil fauna. Some data may be gleaned from the works of Layne (1963), Pournelle (1947), Ivey (1947), Barrington (1949), and Pearson (1951), but there is a good deal of disagreement among these authors, and a more thorough, Florida-wide study is required.

Peromyscus floridanus is one of the few Florida mammals for which there is enough data to conclusively determine its habitat preference (Layne, 1963). This species is confined almost entirely to sand pine scrub and longleaf pine/turkey oak sandhill associations. According to Layne (1963) these two habitats are relatively xeric and attain the highest overall evaporation rates of Florida plant communities.

Peromyscus floridanus remains were the most numerous of all peromyscine rodents recovered from the Coleman IIA deposit. The predominant vegetation surrounding the Coleman IIA deposit now is mesic hardwood forest, which does not support any populations of this species.

Although the number of fossil specimens is small, the six to one ratio of least shrew (*Cryptotis parva*) to shorttail shrew (*Blarina brevicauda*) remains are further suggestive of a drier situation than dense mesic hammock. Both Pournelle (1947) and Barrington (1949) testify that the shorttail shrew is most common in mesic forest and forest border areas; found especially in deep humous and forest bottom litter. The least shrew was most commonly found by these authors in pine flatwoods and burned marginal thicket, and I have trapped this species mostly in grass or sedge fields in *Sigmodon* runways.

Remains of the antelope jackrabbit *Lepus alleni* also support a suggestion of xeric habitat during the Coleman IIA time. This species, now confined to western Mexico and southern Arizona, is found primarily in the open, arid to semi-arid Pacific coastal lowlands (Burt, 1938; Hall and Kelson, 1959).

The presence of gray squirrel (*Sciurus carolinensis*) and golden mouse (*Ochrotomys nuttalli*) remains suggest that some denser, perhaps more mesic vegetation was also being sampled, but these species have been recorded in xeric habitats (Ivey, 1947; Pournelle, 1947), and the small number of individuals fossilized does not allow anything other than this suggestion.

The above information, scanty though it is, leads me to believe that the Coleman area during Coleman IIA time was somewhat more open and more xeric than it is today. The predominance of savanna species in the earlier Inglis IA fauna, and the predominance of mesic forest and mesic forest border species in faunas later than Coleman IIA suggest that Coleman represents the transition between a purely savanna mammalian fauna to one of subtropical to tropical mesic forest nature. Concordantly, the species diversity increases (Martin, 1969b) from 35 in Coleman IIA time to 39 during the early Sangamon, and to 48 in the middle to late Sangamon time.

SUMMARY AND CONCLUSIONS

Fossil mammals from the Coleman IIA local fauna were apparently trapped and died during a relatively xeric period between classical Irvingtonian and classical Rancholabrean time as recognized by most mammalogists. The Coleman IIA local fauna clearly demonstrates affinities to the earlier Irvingtonian Inglis IA deposit, both faunas containing Lepus alleni, Erethizon, and Canis lupus. The fossil Sigmodon from the Inglis deposit, S. curtisi, is of a more primitive grade than the Coleman S. bakeri. Sigmodon bakeri is found also in the Haile VIIA, Bradenton Field, and Williston III deposits, but Coleman IIA is clearly older than these three deposits because they contain Pitymys hibbardi, Synaptomys australis, or Bison latifrons. The Coleman IIA Pitymys arata is of more primitive nature than is P. hibbardi. The new species described from Coleman IIA, Sigmodon bakeri, Pitymys arata, and Urocyon minicephalus do not appear readily derivable from any known extinct species.

The Coleman IIA wolf is Canis lupus. Canis lupus was replaced by C. dirus throughout most of North America during the Rancholabrean.

The Inglis IA Platygonus was ancestral to the Coleman IIA P. cumberlandensis, and as a clear trend in size diminution can be seen in Platygonus throughout the Pleistocene, it seems reasonable to conclude also that P. cumberlandensis gave rise to the smaller P. compressus.

Coleman IIA time is the earliest period from which Tanupolama mirifica, or if that name does not prove to be valid, "the shorter-limbed" Tanupolama with complex fourth upper and lower premolars," has been recorded. This species is apparently an immigrant as it was probably not directly derived from the large, "longer-limbed" *Tanupolama* which has been recorded from earlier Florida deposits such as Inglis IA and Punta Gorda.

The Coleman IIA *Sigmodon bakeri* is a member of the *hispidus* species group of *Sigmodon*, and in that respect heralds the Rancholabrean period in North America, dominated by *Sigmodon hispidus*. *Sigmodon hispidus* replaces *S. bakeri* during the Sangamon in Florida, and is the living Florida representative of the genus.

The Coleman IIA local fauna has aided immensely in solving some of the major problems of mammalian immigration, evolution, and extinction during the Pleistocene, in Florida especially, but also throughout North America. It is my hope that soon we will be able to sequence all the North American Pleistocene deposits as now appears possible for those from Florida.

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BIOGRAPHICAL SKETCH

Robert A. Martin was born in New York City on February 19, 1944. He lived on Long Island in the town of Westbury until 1965, graduating from W. Tresper Clarke High School and obtaining a Bachelor of Arts degree in Biology from Hofstra University. From there he journeyed to New Orleans, and earned a Master of Science degree in Biology from Tulane University in 1967. Since that time he has been working towards a Doctor of Philosophy degree in Zoology at the University of Florida.

This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Arts and Sciences and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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