THE PLEISTOCENE VERTEBRATE FAUNA OF ROBINSON CAVE, OVERTON COUNTY, TENNESSEE

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SUMMARY

Aus der Robinson Höhle, Overton County, Tennessee, U.S.A. wird eine spätpleistozäne Ablagerung mit 60 Vertebraten- und 12 Invertebraten-Spezies beschrieben. 48 Säuger-Spezies sind durch mindestens 2.483 Individuen vertreten; davon sind 10 % ausgestorben, 10 % kommen noch als boreale Relikte in den Great Smoky Mountains (Tennessee), 23 % kommen nicht weiter südlich als Tennessee vor. 57 % finden sich heute bei oder in der Nähe der Höhle. 91 % dieser rezenten Säuger-Spezies werden heute noch lebend im Minnesota-Wisconsin-Gebiet, d.h. ungefähr 10 Breitengrade weiter nördlich, angetroffen. Fluor-Analysen lassen eine lange Ablagerungszeit vermuten.

Die nachstehend angeführten 10 Säugerarten sind zum ersten Mal in Tennessee nachgewiesen : *Sorex arcticus, Microsorex hoyi, Citellus tridecemlineatus, Clethrionomys gapperi, Microtus pennsylvanicus, Synaptomys cooperi, Synaptomys borealis, Zapus hudsonius, Napaeozapus insignis, Martes americana.*

Sechs weitere Arten kommen gegenwärtig als boreale Reilkte in den Great Smoky Mountains *dispar, Sorex* Tennessee, nicht jedoch an der Fundstelle, vor : *Sorex cinereus, Sorex* ues östlichen *palustris, Parascalops breweri, Glaucomys sabrinus, Mustela nivalis.*

Sechs Formen sind ausgestorben : *Canis dirus, Ursus americanus amplidens, Sangamona furtiva, Dasypus bellus, Mammut americanus, Megalonyx jeffersoni.*

Sechsundzwanzig weitere Säuger-Arten, sämtliche Schnecken, Vögel, Reptilien und Amphibien der Fauna leben heute noch in der Nachbarschaft des Fundortes. Die Fauna weist auf eine kühl-gemäßigte Klima-Phase des Wisconsin-Glazials hin, kann aber eine chronologische Mischung darstellen.

A late Pleistocene deposit of 60 species of vertebrates and 12 of invertebrates is described from Robinson Cave, Overton County, Tennessee, U.S.A. Forty-eight species of mammals are represented by at least 2,483 individuals; 10 % are extinct, 10 % occur in the state only as boreal relicts in the Great Smoky Mountains; 23 % no longer occur as far south as Tennessee; 57 % occur at or near the site today. Ninety-one percent of the Recent mammal species can be found living today in the Minnesota-Wisconsin area, approximately 10 degrees farther north. Fluorine analysis suggests a long period of accumulation. The following 10 mammalian species are recorded from Tennessee for the first time. *Sorex arcticus, Microsorex hoyi, Citellus tridecemlineatus, Clethrionomys gapperi, Microtus pennsylvanicus, Synaptomys cooperi, Synaptomys borealis, Zapus nudsonius, Napaeozapus insignis, Martes americana.* Six additional species are present as boreal relicts in the Great Smoky Mountains of eastern Tennessee but not at the site today : *Sorex cinereus, Sorex dispar, Sorex palustris, Parascalops breweri, Glaucomys sabrinus, Mustela nivalis.* Six forms are extinct : *Canis dirus, Ursus americanus amplidens, Sangamona furtiva, Dasypus bellus, Mammut americanus,Megalonyx jeffersoni.* Twenty-six additional species of mammals, all of the snails, birds, reptiles, and amphibians recovered from the fauna still inhabit the area today. The fauna is indicative of a cold-temperate climatic episode associated with the Wisconsin glaciation, but may be chronologically mixed.

Description d'un dépôt pléistocène supérieur de la Grotte Robinson (Overton County, Tennessee, U.S.A.), riche de 60 espèces de vertébrés et 12 d'invertébrés. 48 espèces de mammifères sont représentées par 2 483 individus au moins; 10 % d'entre elles sont éteintes 10 % se rencontrent dans le Tennessee à l'état de reliques boréales dans les Great Smoky Mountains; 23 % ne dépassent pas le Tennessee au Sud, 57 % se rencontrent actuellement à proximité de la localité. 91 % des espèces de Mammifères actuels se rencontrent vivantes sur le territoire du Minnesota et du Wisconsin, à environ 10° plus au Nord. Le dosage du fluor suggère une accumulation étendue sur une longue période.

Les dix espèces suivantes sont trouvées dans le Tennessee pour la première fois : *Sorex arcticus, Microsorex hoyi, Citellus tridecemlineatus, Clethrionomys gapperi, Microtus pennsylvanicus, Synaptomys cooperi, Synaptomys borealis, Zapus hudsonius, Napaeozapus insignis, Martes americana.* Six autres espèces sont actuellement présentes à l'état de reliques boréales dans les Great Smoky Mountains de l'Est du Tennessee, mais non dans le voisinage de la localité : *Sorex cinereus, Sorex dispar, Sorex palustris, Parascalops breweri, Glaucomys sabrinus, Mustela nivalis.* Six formes sont éteintes : *Canis dirus, Ursus americanus amplidens, Sangamona furtiva, Dasypus bellus, Mammut americanus, Megalonyx jeffersoni.* Vingt-six autres espèces de mammifères, tous les gastéropodes, les oiseaux, les reptiles et les ampibiens recueillis persistent de nos jours dans la région de la Grotte Robinson. Cette faune indique un épisode climatique de basse température associé à la glaciation du Wisconsin, mais peut aussi représenter un mélange chronologique.

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FIG. 1. Artist's conception of Jefferson's ground sloth, *Megalonyx jeffersonii* (DESMAREST) See page 65.

INTRODUCTION

Robinson Cave is located on the Walter Robinson farm about 8 miles southwest of Livingston, Overton County, Tennessee, latitude 36°17′25″ N, longitude 85°22′25″ W, altitude c. 1200 feet; Okalona Quadrangle, U.S.G.S. 7½′ map (fig. 2). It lies at the head of a dry wash that at one time formed the bed of a stream, since pirated by the cave, about halfway up the east slope of Maxwell Mountain. The site is located about 40 miles south of the northern border of the state in the headwaters of the Cumberland drainage just west of the Cumberland Plateau.

It was discovered in 1961 by Messrs. Jimmy, Charles and Robert Young of Livingston, Tennessee. Four field trips by Carnegie Museum parties were made to the cave in 1962. A total of 22 days were spent in the recovery of vertebrate remains from three distinct sites in the cave, the Sloth Pit, the Young Brothers' Room and the Armadillo Pit (the latter formerly called the " Caribou " Pit, a name based upon an erroneous identification).

Overton County lies on the dissected western rim of the Cumberland Plateau, an area underlain with Mississippian limestones. As a result caves

and sinkholes are extremely numerous. In the immediate vicinity of the cave the valleys of the Roaring River drainage are broad and gently sloping. The divides such as Maxwell Mountain and Hellhole Mountain rise sharply to about 1400 feet. Several miles to the east, in the true rim of the plateau,

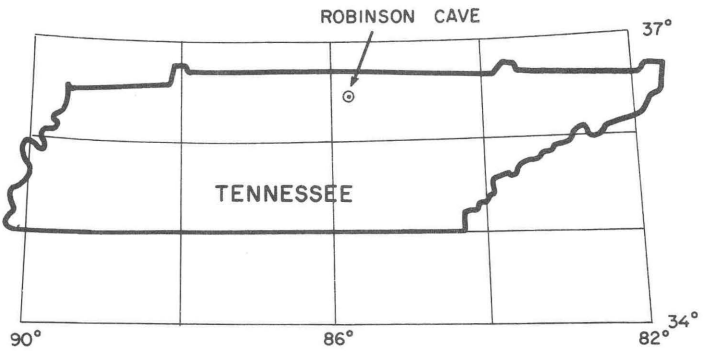

FIG. 2. Location of Robinson Cave, Overton County, Tennessee.

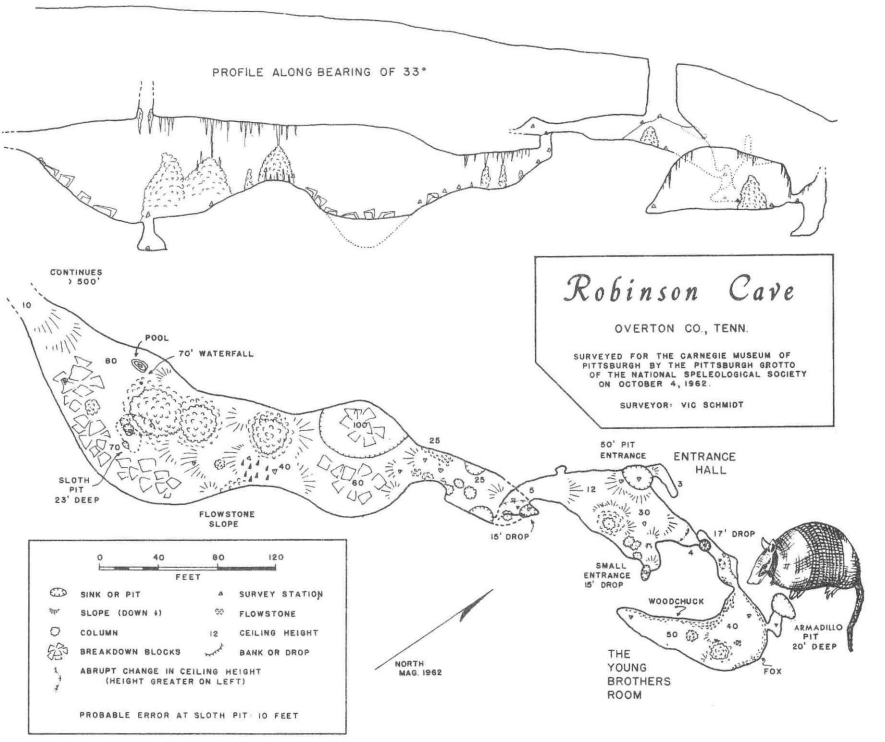

FIG. 3. Map of Robinson Cave, Overton County, Tennessee.
Vertical cross section above, horizontal cross-section below.

FIG. 4. View looking west at Maxwell Mountain on Walter Robinson farm, Overton County, Tennessee.
Robinson Cave in wooded hillside.

topography becomes rougher and local relief may reach 700 feet. To the west the terrain is less precipitous and more rolling. The valley bottoms and the lower hill slopes are cultivated. The uplands are covered with second or third growth deciduous woodland (fig. 4).

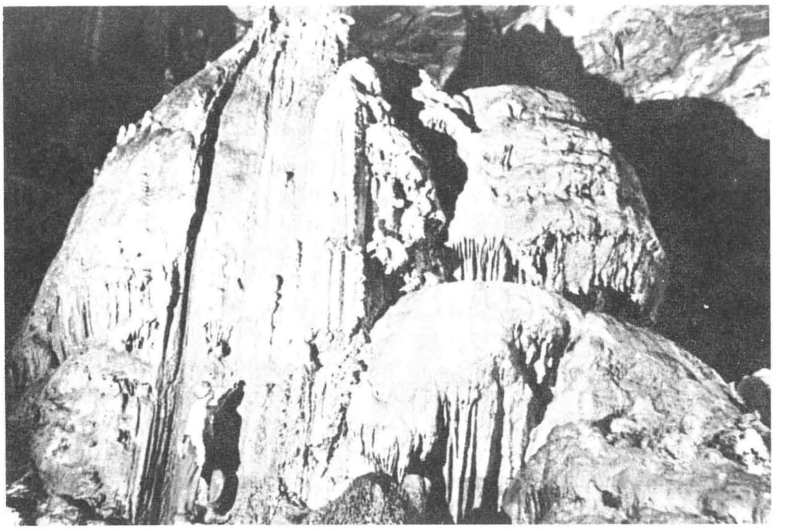

FIG. 5. Forty-foot stalagmite directly above Sloth Pit, Robinson Cave, Overton County, Tennessee.
Photo by H. Hamilton.

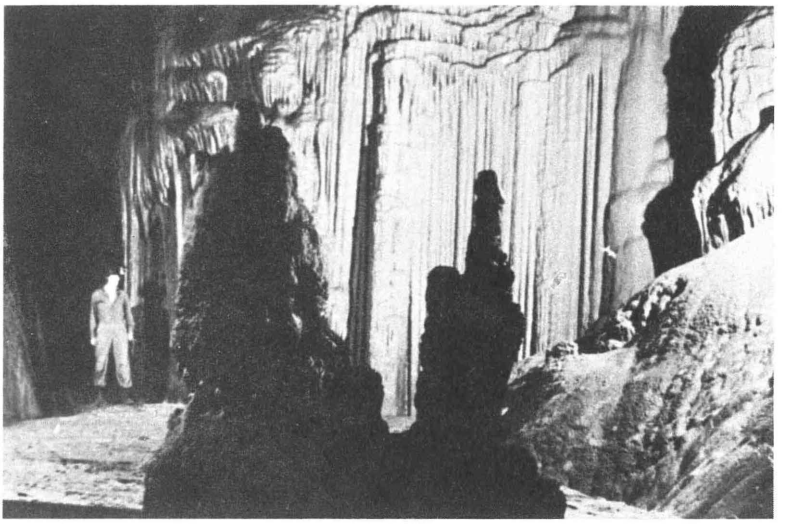

FIG. 6. Young Brothers' Room, Robinson Cave, Overton County, Tennessee. Photo by H. Hamilton.

SITE DESCRIPTION

The cave is large and awesome. There are two entrances. The lower one is a narrow 20-foot deep fissure leading to a slippery mud-and-rock talus at the side of a room highly decorated with cave formations. From there one proceeds down a slope for 100 feet to the bottom of the main entrance. The larger entrance, about 200 feet farther up the ridge is a large sinkhole 30 feet in diameter and 50 feet deep.

" A large talus cone occupies the bottom of this pit composed of breakdown, organic matter and soil... Proceeding from the room at the bottom of the first entrance one turns left into a chamber which narrows into a stoopway and after curving to the left approximately 50 feet ends at a fissure leading down. This is an awkward little climb of perhaps 20 feet... At the bottom of this pitch a talus leads into a huge chamber... a path... winds across the breakdown-filled room up a slope to a " notch " leading to the back portion of the room separated from the rest by high breakdown... Down the breakdown on the other side of the notch, approximately 600 feet from the fissure entrance into the " inner cave " looms the base of one of the elder statesmen of all stalagmites, perhaps 40 feet in diameter (fig. 5). The breakdown to the left at its base conceals the 20 foot pit from which the pine marten, sloth and bob-cat remains were taken [" sloth pit ", map, fig. 3]. A waterfall splashes onto the stalagmite, issuing from the ceiling 60 feet above ". (McCrady, 1962, p. 157). In a small grotto in the side of the stalagmite, bones of chipmunk, flying squirrel and red squirrel were found.

FIG. 7. Present entrance from Young Brothers' Room photographed from the floor of the Armadillo Pit, 20 feet below.
Photo by H. Hamilton.

THE SLOTH PIT

The sloth pit was at one time the plunge basin for the waterfall, at least during periods of heavy surface run-off. The entire floor of the cave is composed of ceiling breakdown irregularly cemented with flowstone. The pit is merely a deep hole in the breakdown, its walls gradually built up by roof-fall around the periphery of the plunge hole above. The deposits on the floor of the pit, however, are sedimentary in origin and were surface-derived. The waterfall has since retreated higher up the mountain slope and its acidic water is now actively eroding channels in the large stalagmite down which it cascades. The pit at one time may have held standing water — at present it is extremely wet and muddy. It is floored with a thin layer of pebbly sand, varying from two to five inches in depth at the periphery. This is underlain with a 1" to $1\frac{1}{2}$" layer of breccia composed of cemented pebbles, sand and clay, followed by nine inches of fine, homogeneous brown clay. In the area where the larger, more incomplete sloth was found " ... this changed to a thin layer (one-half

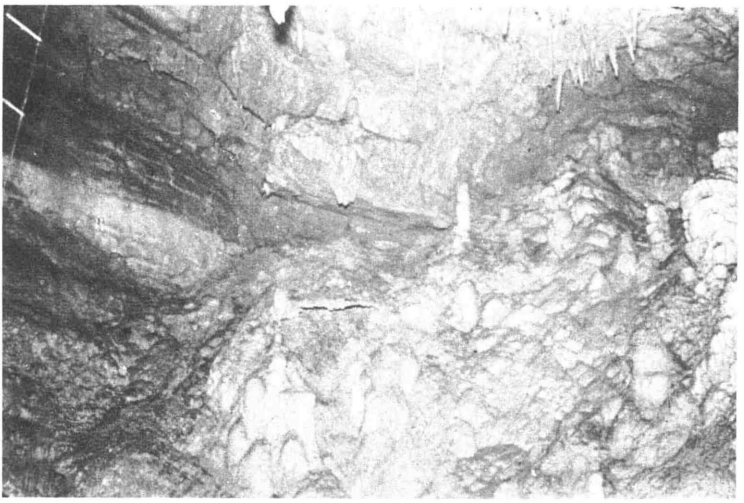

FIG. 8. Floor of Armadillo Pit, Robinson Cave, Overton County, Tennessee. Note flowstone-mantled talus from overhead entrance now brecciated shut. The ladder in the upper left is the same as the one in Fig. 7. White object to left of top center is the tip of a stalagtite.

to one-eighth of an inch) of gray clay followed by a three-eighths inch layer of bright red clay, followed by a brown clay interbedded with thin layers of sand. In the other sloth area the homogenous brown clay was followed by a layer of weathered calcite and gray clay, then the red clay and brown clay again. In addition, the small sloth area had numerous active drips and splashes falling from the ceiling and striking the bone-bearing matrix. This caused a third, or surface layer of calcite to form as an over-all crust. The smaller, more complete sloth remains extended down to (and into one small area) the gray clay level. Thus the second sloth was covered with four layers of material, alternating hard and soft. Bone located under the first inch or so was in a uniform condition-wet through, rotten and fragile, much the consistency of wet chalk. ... the bones rested in a disorganized heap. Either the bones had been swirled about by water action or the animal had died in the breakdown above and filtered to the bottom of the pit ". (McCrady, 1962, p. 158-159).

ARMADILLO PIT

Remains of at least 2,615 individual mammals, 14 individual birds, 10 species of reptiles and amphibians and 461 individual gastropods were recovered from approximately 5 square yards of matrix from the floor of this pit (figs. 3 and 8). The matrix was a jumbled mass of limestone fragments, broken jagged speleothems averaging 20 mm in diameter, fragmented cave coral and flowstone mixed with both consolidated and unconsolidated light yellow-brown cave sediments derived from chemical breakdown of the parent rock.

The pit floor was the talus cone of a now extinct sinkhole. The ceiling of this chamber, now sealed with large blocks of limestone wedged and cemented with a thick flowstone morter, was apparently the entrance that admitted most of the fauna. A second entrance from the Young Brothers' room (fig. 6) enters the Armadillo Pit high on its southwest wall (fig. 7). This is now the only entrance. A few species (see below) apparently entered by this route in later years.

From the state of preservation of the bones, at least three phases of accumulation suggest themselves. 1. All of the artiodactyls, the larger carnivores, the armadillo and the mastodon were represented only by teeth, fragments of teeth, or, in the case of the armadillo, by broken scutes. *Mammut,* for example, was represented by thick fragments of molariform enamel, the largest, 28 mm × 17 mm × 5 mm. These specimens, representing only the most durable structures, all broken into fragments, represent a phase of deposition not very conducive to skeletal preservation. Possibly the animals fell into a pit that was being constantly flooded and drained with the fluctuating water table. This flushing (if such was the case) would keep any accumulating talus in a constant state of adjustment and promote a grinding action which would reduce the skeletons and remove any small mammal remains. Even today the talus appears to have been inundated at its lowest point by water table fluctuations. On the evidence of the high fluorine content of the *Dasypus* scutes this seems to be the earliest episode recorded in the deposit, presumably late Sangamon/early Wisconsin. 2. A change to a continually aggrading talus, suggesting a drier period during which the talus was not reworked by water action is postulated on the condition of most of the smaller vertebrate remains, disarticulated but in a relatively good state of preservation. The sinkhole may now have been closed to such an extent that it ceased to operate as a trap for larger mammals. There was a resident bat colony, primarily *Eptesicus.* For reasons discussed on p. 46 it was presumably a hibernating colony. Woodrats inhabited the pit, presumably at all periods of its history. After the talus ceased to accumulate, with the sealing of the roof by speleothems, access was still afforded to the pit by the entrance from the Young Brothers' room. This entrance is some 200 feet from the main cave entrance and 70 feet below it in total darkness. Apparently some mammals, raccoon, gray fox, and woodrat utilized the entrance. Skeletons of these species were picked up uncrushed and in an attitude of articulation on the surface of the talus. Fluorine analysis of the raccoon as well as a gray fox and woodchuck skeletons from the surface of the Young Brothers' room showed them to be relatively low in fluorine, hence presumably younger in age than the bulk of the deposit. Woodrat, as suspected, tested lowest.

RESULTS OF FLUORINE DATING

Quantitative chemical analysis of bone as a method of determining relative age is effective in some instances, in others (Stewart, 1952) it is not,

depending upon such factors as the amount of available fluorine and the rate of chemical activity in a given deposit. Inter-site comparisons are usually inconclusive and may even be misleading, but intra-site comparisons, given an adequate rate of chemical exchange, may be reliable if allowance is made for the fact that chemical activity may vary from point to point within a single specimen, see Guilday, Hamilton and McCrady, 1966. Binford has also demonstrated that rates of beta radiation may vary inversely with bone density. He concludes, " These findings make it imperative that in further investigations designed for answering questions about the depositional or hydrological history of deposits specimens of the same species and preferably bones of the same anatomical part be used for the comparisons " (Binford, 1965, p. 40).

The Robinson Cave fauna is composed of some species of mammals that are ecologically incompatible today, such as the arctic shrew, *Sorex arcticus* and the armadillo, *Dasypus*. Also specimens were not necessarily deposited at the same time. For example, crushed mastodon molar fragments in close approximation to complete uncrushed woodrat skulls indicate that whatever geological forces were in operation during the crushing and scattering of the mastodon teeth, possibly stream churning, were not operative by the time of deposition of at least some of the woodrats.

Six bone samples from the Sloth Pit, two from the Young Brothers' Room, and six from the Armadillo Pit were submitted to Mr. Joseph Ryan, Garber Research Center of the Harbison-Walker Refractories Company for spectrochemical analysis. Fluorine percentages varied from 0.8 % to 1.2 % in the Sloth Pit, from 0.5 % to 0.7 % in the Young Brothers' Room, and from 0.5 % to 1.35 % in the Armadillo Pit. *Urocyon* (0.5 %) and *Marmota* (0.7 %) from the Young Brothers' Room were complete skeletons lying on the cave floor and relatively Recent. Results from the Sloth Pit are ambiguous. Three samples of *Megalonyx* gave values of 1.2 % (humerus shaft), 0.9 % (same humerus, cancellous marrow bone), and 0.6 % (rib believed contaminated with Plaster of Paris $2CaSO_4.H20$). *Lynx rufus* found under the *Megalonyx jeffersonii* material tested at 0.8 %, the same as surface find of *Glaucomys volans,* while *Martes americana* found above the sloth material tested 1.0 %. *Megalonyx* is now extinct, *Martes* has since retreated 400 miles to the north, other species still inhabit central Tennessee.

The largest range of concentrations were from the Armadillo Pit, *Neotoma* 0.5 %, *Ursus* 0.6 %, *Procyon* 0.8 %, *Synaptomys cooperi* 0.8 %, *Eptesicus* 1.1 % and *Dasypus* 1.35 %. *Neotoma* 0.5 %, *Ursus* 0.6 % and *Procyon* 0.8 % were bone samples from the surface talus. The *Procyon* sample, although heavily spattered with a carbonate patina, was a complete skeleton still in an attitude of articulation. *Synaptomys cooperi,* also 0.8 %, no longer occurs as far south as Robinson Cave. The high percentage of fluorine in the *Dasypus* sample, 1.35 %, suggests that the armadillo may predate the boreal component of the fauna. *Dasypus bellus,* osteologically identical to the modern nine-banded armadillo except for greater size, but presumably of similar habits (insectivorous and poorly adapted for cooler temperatures), may be indicative of warmer conditions.

FAUNAL LIST-ROBINSON CAVE LOCAL FAUNA

N = ranges north of Tennessee today

GS = ranges only in Great Smoky Mountains, extreme eastern Tennessee, otherwise north of state

E = extinct

P = occurring locally during historic times

I = Young Brother's Room

II = Armadillo Pit

III = Sloth Pit

	Minimum number of individuals			Range data
	I	II	III	
MOLLUSCA				
GASTROPODA		461		
Pomatiopsidae				
Pomatiopsis aff. *praelonga* BROOKS	—	8	—	P
Valloniidae				
Vallonia, ? species	—	7	—	P
Succineidae				
Succinea ovalis SAY	—	3	—	P
Polygyridae				
Triodopsis, ? species	—	1	—	P
Stenotrema stenotrema (FERRUSAC)	—	1	—	P
Endodontidae				
Helicodiscus parallelus (SAY)	—	1	—	P
Anguispera alternata SAY	—	24	—	P
Zontidae				
Euconulus fulvus (MUELLER)	—	2	—	P
Paravitrea multidentata (A. BINNEY)	—	400	—	P
Ventridens, ? species	—	8	—	P
Pupillidae				
Gastrocopta contracta (SAY)	—	1	—	P
Vertigo pygmaea (DRAPARNAUD)	—	5	—	P

		Minimum number of individuals			Range data
		I	II	III	
PISCES					
A few unidentified cyprinid ? vertebrae	fish				
AMPHIBIA					
Ambystomidae					
Ambystoma, ? species	salamander	—	⩾ 1	—	P
Hylidae					
Hyla, ? species *	tree frog	—	1	—	
Bufonidae					
Bufo americanus (HOLBROOK)	toad	—	⩾ 1	—	P
Pelobatidae					
Scaphiopus, ? species	spadefoot toad	—	⩾ 1	—	P
REPTILIA					
Turtle, ? species	small fragment	—	⩾ 1	—	
Scincidae					
Eumeces, ? species	skink	—	⩾ 1	—	P
Colubridae					
Lampropeltis, ? species	milk snake	—	⩾ 1	—	P
Elaphe, ? species	rat snake	—	⩾ 1	—	P
Thamnophis, ? species	garter snake	—	⩾ 1	—	P
Carphophis, ? species	worm snake	—	⩾ 1	—	P
AVES					
Tetraeonidae					
Bonasa umbellus (LINNAEUS)	ruffed grouse	—	2	—	P
	grouse, ? species	—	2	—	
Columbidae					
Ectopistes migratorius (LINNAEUS)	passenger pigeon	—	1	—	E
Strigidae					
cf. *Otus asio* (GMELIN)	screech owl	—	1	—	P

(*) One ilium (CM 12579) originally identified as *Hyla femoralis* SONNINI and LATREILLE (Lynch, 1966, p. 267) is questioned on both ecological and anatomical grounds (letter, Lynch to Guilday, Oct. 30, 1967).

		Minimum number of individuals			Range data
		I	II	III	
Parulidae					
	wood warbler, ? species	—	1	—	
Corvidae					
cf. *Cyanocitta cristata* (LINNAEUS) ..	blue jay	—	1	—	P
Passeriformes, ? species (at least 6 species)..		—	6	—	
MAMMALIA					
INSECTIVORA					
Soricidae					
Sorex arcticus KERR	arctic shrew	—	10	—	N
Sorex cinereus KERR	masked shrew ...	—	70	—	GS
Sorex dispar BATCHELDER	big-tailed shrew ..	—	9	—	GS
Sorex fumeus MILLER	smoky shrew	—	37	—	P ?
Sorex palustris RICHARDSON	water shrew	—	2	—	GS
Microsorex hoyi (BAIRD)	pygmy shrew ...	—	17	—	N
Blarina brevicauda (SAY)	short-tailed shrew.	—	83	—	P
Cryptotis parva (SAY)	least shrew	—	5	—	P
Talpidae					
Parascalops breweri (BACHMAN)	hairy-tailed mole.	—	3	—	GS
CHIROPTERA					
Vespertilionidae					
Myotis cf. *keenii* (MERRIAM)	Keen's bat	—	1	—	P
Myotis cf. *grisescens/keenii* group ..	little brown bats.	—	15	—	P
Myotis cf. *lucifugus/sodalis* group ..	little brown bats.	—	96	—	P
Pipistrellus cf. *subflavus* (CUVIER) ..	pipistrelle	—	2	—	P
Eptesicus fuscus (Palisot de BEAUVOIS)	big brown bat ...	—	1,582	—	P
Plecotus GEOFFROY, ? species	long-eared bat ...	—	131	—	P
RODENTIA					
Sciuridae					
Tamias striatus (LINNAEUS)	chipmunk	—	9	—	P
Marmota monax (LINNAEUS)	woodchuck	1	1	—	P
Citellus tridecemlineatus (MITCHELL)	thirteen-lined ground squirrel.	—	3	—	N
Sciurus niger LINNAEUS	fox squirrel	—	2	—	P
Sciurus LINNAEUS, ? species	squirrel	—	3	—	P
Tamiasciurus hudsonicus (ERXLEBEN)	red squirrel	—	3	1	P ?
Glaucomys sabrinus (SHAW)	northern flying squirrel	—	5	—	GS

		Minimum number of individuals			Range data
		I	II	III	
Glaucomys volans (LINNAEUS)	southern flying squirrel	—	13	3	P
Cricetidae					
Peromyscus cf. *leucopus* (RAFINESQUE)	white-footed mouse	—	1	—	P
Peromyscus cf. *maniculatus* (WAGNER)	deer mouse	—	2	—	P
Peromyscus GLOGER, ? species		—	75	—	
Neotoma cf. *floridana* (ORD)	woodrat	—	130	—	P
Clethrionomys cf. *gapperi* (VIGORS)	red-backed mouse.	—	40	—	GS
Microtus cf. *pennsylvanicus* (ORD) ..	meadow vole	—	85	—	N
cf. *Pitymys pinetorum* (LE CONTE) ..	pine vole	—	110	—	P
Ondatra zibethicus (LINNAEUS)	muskrat	—	1	—	P
Synaptomys cooperi BAIRD	southern bog lemming	—	41	—	GS
Synaptomys borealis (RICHARDSON) ..	northern bog lemming	—	1	—	N
Zapodidae					
Zapus hudsonius (ZIMMERMANN)	meadow jumping mouse	—	4	—	GS
Napaeozapus insignis (MILLER)	woodland jumping mouse	—	9	—	GS
Erethizontidae					
Erethizon dorsatum (ERXLEBEN)	porcupine	—	2	—	P ?
LAGOMORPHA					
Leporidae					
Unidentified rabbits		—	3	—	
CARNIVORA					
Canidae					
Canis cf. *dirus* LEIDY	wolf	—	1	—	E
Urocyon cinereoargenteus (SCHREBER)	gray fox	1	4	—	P
Ursidae					
Ursus americanus cf. *amplidens* LEIDY	black bear	—	2	—	E
Procyonidae					
Procyon lotor (LINNAEUS)	raccoon	—	6	—	P
Mustelidae					
Martes americana (TURTON)	pine marten	—	1	1	N
Martes pennanti (ERXLEBEN)	fisher	—	3	—	P

		Minimum number of individuals			Range data
		I	II	III	
Mustela cf. *frenata* LICHTENSTEIN ..	long-tailed weasel.	—	1	—	P
Mustela cf. nivalis LINNAEUS	least weasel	—	1	—	GS
Mustela LINNAEUS, ? species	weasels	—	5	—	
Felidae					
Lynx cf. *rufus* (SCHREBER)	bobcat	—	2	1	P
ARTIODACTYLA					
Cervidae					
Sangamona cf. *furtiva* HAY	extinct deer	—	3	—	E
Odocoileus cf. *virginianus* (ZIMMERMANN)	white-tailed deer.	—	1	—	P
EDENTATA					
Dasypodidae					
Dasypus cf. *bellus* SIMPSON	armadillo	—	1	—	E
Megalonychidae					
Megalonyx jeffersonii (DESMARET)	Jefferson's ground sloth	—	—	2	E
PROBOSCIDEA					
Mammutidae					
Mammut americanus (KERR)	mastodon	—	1	—	E

Order **INSECTIVORA**

Family **Soricidae**

Sorex arcticus KERR — Arctic Shrew

Material : CM 8206-8223, 8265. 5 partial skulls; 5 left, 10 right mandibles.

Remarks : The southern range limit of this species lies today in southern Wisconsin. In late Pleistocene times it ranged much farther south and has been reported from Bootlegger Sink (Guilday, Hamilton & Mc Crady, 1966) and New Paris No. 4 in Pennsylvania (Guilday, Martin & McCrady, 1964) as well as Natural Chimneys, Virginia (Guilday, 1962), and Crankshaft Pit, Missouri (Oesch, 1967), all late Pleistocene cave deposits.

TABLE 1
Measurements in mm, *Sorex arcticus* KERR.

	Robinson Cave			New Paris No. 4		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
length, dentary	9.2	9.1-9.3	3	8.9	8.7-9.3	5
C - M_3	5.4	–	2	4.4	4.2-4.5	6
M_1	1.6	1.5-1.6	7	1.4	1.3-1.5	7
length, palate	7.8	7.7-8.1	5	7.8	–	1

Sorex cf. ***cinereus*** KERR — Masked Shrew

Material : CM 8175-8205, 8266. 9 partial skulls; 1 left maxilla; 49 left, 72 right mandibles.

Remarks : *Sorex cinereus* occurs only in the mountains of extreme eastern Tennessee (Kellogg, 1939). In the Midwest it does not occur south of the northern border of Kentucky. The common *Sorex* of the southern lowlands is *Sorex longirostris* BACHMANN, a species that occurs throughout the state. Mandibles of the two species are identical except for a slightly greater average size in *S. cinereus*. All of the specimens are referred to *S. cinereus* for two reasons : 1. They average slightly larger than modern comparative material of that species from Pennsylvania. 2. The rest of the fauna is distinctly a cool-weather association in which *S. longirostris* would not be expected to occur.

TABLE 2
Measurements in mm, *Sorex cinereus* KERR, various localities.

	Robinson Cave			*New Paris No. 4			* Recent		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
length, dentary	7.4	7.2-8.0	8	7.6	7.2-7.8	17	7.3	7.1-7.7	22
$C_1 - M_3$	3.9	3.6-4.5	18	3.9	3.7-4.3	29	3.7	3.6-3.9	20
M_1, length	1.4	1.3-1.5	66	1.3	1.2-1.5	44	1.3	1.2-1.4	22
length, palate	6.1	–	1	6.4	6.3-6.6	5	6.1	5.5-6.6	23

* data from Guilday *et al.*, 1964

Sorex dispar BATCHELDER — Rock Shrew

Material : CM 8155-8174. 4 partial skulls; 8 left, 9 right mandibles.

Remarks : This shrew is characteristic of cool, moist, rocky situations in the Appalachian Mountains from Maine to North Carolina. It has been taken in extreme eastern Tennessee, Walker Prong, Smoky Mountains National Park, alt. 4400-5500 feet (Schwartz, 1956). It apparently enjoyed a wider distribution during late Pleistocene times and has also been recorded from New Paris No. 4, Pennsylvania.

TABLE 3
Measurements in mm, *Sorex dispar* BATCHELDER.

	Robinson Cave			New Paris No. 4		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
length, dentary	8.4	8.3-8.5	2	8.2	–	2
M_1	1.5	1.4-1.5	3	1.3	1.3-1.5	3
length, palate	6.7	5.8-7.5	2	–	–	–
$P^4 - M^3$	4.2	4.1-4.3	2	–	–	–

Sorex fumeus MILLER — Smoky Shrew

Material : CM 8224-8232. 29 left, 28 right mandibles.

Remarks : *Sorex fumeus* is closely confined to cool, moist woodland from southeastern Canada and the Appalachian Mountains south to Georgia. It has been recorded from Tennesseé only from Campbell County in the northern part of the state (Kellogg, 1939) and Banshee Hole, Cumberland County, approximately 60 miles southwest of Campbell County and 40 miles southeast of Robinson Cave (Guilday, MS). In the Midwest it apparently occurs no farther south than extreme northern Ohio, except for an isolated colony at Mammoth Cave, Kentucky, a relict of a formerly more extensive distribution in the American midlands.

TABLE 4
Measurements in mm, *Sorex fumeus* MILLER, Robinson Cave, Tennessee.

	$\bar{X}$	O.R.	N
length, dentary	9.2	9.0-9.7	9
C-M_3	5.4	5.2-5.5	8
M_1	1.7	1.5-1.8	16

Sorex palustris RICHARDSON — Water Shrew

Material: CM 8152-8154. 1 left, 2 right mandibles.

Remarks: Although this northern species occurs as far south as the Great Smoky Mountains in extreme eastern Tennessee (Conaway and Pfitzer, 1952) it occurs only as far south as central Wisconsin and central Michigan in the Midwest. Also recorded from Natural Chimneys, Va., New Paris No. 4 and Bootlegger Sink, Pa., and Ramp Hole, Pocahontas County, W. Va. (Handley, 1956), and Crankshaft Pit, Mo., as a late Pleistocene fossil.

TABLE 5
Measurements in mm, *Sorex palustris* RICHARDSON.

	Robinson Cave			New Paris No. 4		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
length, dentary	10.2	10.0-10.4	2	9.5	–	1
C - M_3	6.1	–	2	5.2	–	1
M_1 - M_3	4.4	4.3-4.5	3	–	–	–

Microsorex hoyi (BAIRD) — Pygmy Shrew

Material: CM 8234-8259. 2 partial skulls; 3 left, 1 right maxillae; 17 left, 11 right mandibles.

Remarks: This is the first Tennessee record of *Microsorex*. It has been taken in the mountains of western North Carolina, however, and may possibly occur on some of the higher peaks of eastern Tennessee. It ranges throughout the Canadian and Hudsonian life zones of North America today. The nearest modern record in the Midwest is central Michigan.

During the late Pleistocene *Microsorex* ranged much farther to the south and, far from being a rare species as it is today, was apparently a common shrew. At New Paris No. 4, Pa., *Microsorex* made up 10 % of all soricids; at Robinson Cave, 7 %; at Natural Chimneys, Va., 5 %. *Microsorex* has also been recorded from Bootlegger Sink, Pa. (Guilday, Hamilton and McCrady, 1966), Meyer Cave, Ill. (Parmalee, 1967), Conard Fissure, Ark. (Brown, 1908), and Crankshaft Pit, Mo.

TABLE 6
Measurements in mm, *Microsorex hoyi* (BAIRD).

	Robinson Cave			New Paris No. 4		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
length, dentary	6.5	5.9-7.0	7	6.5	6.4-6.6	10
height, ascending ramus	3.2	2.9-3.5	20	2.9	2.9-3.0	9
M_1 - M_3	2.9	2.8-3.1	12	2.9	2.8-3.1	8
length, palate	5.1	4.8-5.3	3	5.2	5.1-5.3	4
P^4 - M^3	3.5	3.2-3.8	3	3.45	3.4-3.5	4

Blarina brevicauda (SAY) — Short-tailed Shrew

Material : CM 8133-8144, 8146, 8150-8151. 21 partial skulls ; 18 left, 12 right maxillae; 62 left, 71 right mandibles.

Remarks : Tennessee, except for the Great Smoky Mountains along its eastern border, lies within the range of the small southern race, *Blarina brevicauda carolinensis,* but the Robinson Cave late Pleistocene sample rivaled the size of the present northern stock of *B. b. brevicauda* in the Minnesota-Wisconsin area. This is in keeping with the boreal character of the Robinson Cave local fauna. Late Pleistocene *Blarina,* presumably representing a large northern stock that advanced to the south with mounting glacial conditions are also known from New Paris No. 4, Pa. and Natural Chimneys, Va. Hibbard (1963) discusses à case of a late Illinoian (glacial) fauna in Kansas that contains *B. b. brevicauda* followed in Sangamon (interglacial) beds by a small *B. b. carolinensis*-like form.

TABLE 7
Measurements in mm, *Blarina brevicauda* (SAY), various localities.

Recent, Minnesota *B. b. brevicauda*			Recent, Pennsylvania *B. b. kirtlandi*			Pleistocene New Paris No.4, Pennsylvania			Pleistocene Robinson Cave, Tennessee		
$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
length, upper toothrow, P^4-M^3											
6.4	5.6-7.2	21	6.2	5.8-6.6	77	6.4	6.2-6.7	2	6.6	6.6-7.0	7
maxillary breadth											
8.4	8.0-9.2	21	7.0	7.8-8.3	77	8.5	8.1-8.9	2	7.6	7.1-8.0	3
total length, mandible											
16.2	14.9-17.6	19	15.1	14.6-16.0	17	15.3	13.8-17.2	29	17.2	15.6-18.3	21

Cryptotis parva (SAY) — Least Shrew

Material : CM 8260-8264. 3 partial skulls; 5 left, 4 right mandibles.

Remarks : Relatively common in the area today, the least shrew prefers open fields and prairie situations and avoids deep woodland, but may, on occasion, occur in open grassy enclaves surrounded by densely timbered country. Although more common to the south, *Cryptotis* has been recorded from as far north as southern Minnesota and Wisconsin. It accounted for only 2.0 % of the Robinson Cave soricids.

Family **Talpidae**

Parascalops breweri (BACHMAN) — Hairy-tailed Mole

Material : CM 12970. 6 humeri, 1 radius, 2 ulnae, 6 fragments of mandibles.

Remarks : The hairy-tailed mole has been reported from the mountains of extreme eastern Tennessee (Kellogg, 1939) but does not occur in central or western parts. The eastern mole, *Scalopus aquaticus,* a species which did not occur in the deposit, is the only species of mole living in the area at the present time.

Order **CHIROPTERA**

Family **Vespertilionidae**

Myotis KAUP, ? species — Little Brown Bat

Remarks : There were at least 111 little brown bats represented in the collection. Only one, a partial *Myotis keenii* skull could be identified to species, CM 12053. Two size classes of little brown bats were noted but no attempt was made to identify them further. The larger group could be either *M. keenii* or *M. grisescens.* CM 12508-12509, 15 left, 14 right mandibles. The smaller size group may be *M. lucifugus* or *M. sodalis* or *M. austroriparius,* all species living in the state at the present time. This group consists of 9 partial skulls, 79 left, 96 right mandibles catalogued under CM 8417-8422, 12500-12502, 12506-12507. The remaining 10 partial skulls, 10 left, 9 right maxillae, 1 left and 1 right mandible were catalogued under CM 12504-12505, 12511, 12515, 12530.

TABLE 8
Measurements in mm, C-M_3, *Myotis*, ? species, Robinson Cave, Tennessee.

Range	5.1-5.2	.3-.4	.5-.6	.7-.8	.9-6.0	.1-.2	.3-.4	.5-.6	.7-.8	.9
Number of individuals	2	46	21	12	1	3	4	17	3	1

Range of measurements, C-M_3, 6 species of modern *Myotis* from Handley, 1956, p. 253;after Miller and Allen, 1928. O.R. followed by number of observations in parentheses. *M. grisescens*, ♂.2-6.6 (54) ; *M. keeni*, 6.0-6.6 (49) ; *M austroriparius*, 5.4-6.2 (14); *M. lucifugus*, 5.4-6.2 (60) ; *M. sodalis*, 5.5-6.0 (40) ; *M. subulatus*, 5.2-5.6 (5).

Pipistrellus cf. ***subflavus*** (CUVIER) — Pipistrelle

Material : CM 8416. 1 partial skull, 2 right mandibles.

Remarks : P^4-M^3 = 3.5 mm.

Eptesicus fuscus (Palisot de BEAUVOIS) — Big Brown Bat

Material : CM 8147-8149, 12512-12529. 89 partial skulls; 219 left, 235 right maxillae; 1582 left, 1511 right mandibles.

Remarks : A minimum of 1582 big brown bats were recovered from the Armadillo Pit matrix. Their taxonomic status, and that of *E. grandis* (BROWN) are discussed in Guilday, 1967. It was concluded that *E. grandis* was a synonym of the Recent *E. fuscus*, and not an extinct form as originally described.

The abundance of this species at Robinson Cave may be of some climatic significance. One of the hardiest of our eastern cave bats, it hibernates as far north as the northern shore of Lake Superior (Fort William, Ontario, lat. 48° N., Beer and Richards, 1956). Its relative abundance would be compatible with the boreal element of the fauna.

Christian measured the anterior lateral canine length of 43 *Eptesicus fuscus* from a summer colony in Maryland (see Christian, 1953 for definition of measurement). Because parturition takes place at a certain time of year he was able to place his specimens into five age classes, presumably annual, on the basis of increasing amounts of toothwear. The same measurement was taken on 87 upper canines from the Armadillo Pit. The sample produced a roughly quadrimodal curve (fig. 9), with modes falling at about 2.4 mm, 2.0 mm, 1.5 mm, and 0.8 mm.

In each case, the canine length for each successive toothwear class averages smaller than in Christian's Recent sample, although the Robinson Cave bats averaged larger in most other dimensions. If the Robinson Cave sample represents a hibernating population, it would be expected to have

more advanced toothwear than a group collected earlier in the year, such as Christian's.

Christian noted that toothwear accelerates with age. This is due not only to the thinning of the enamel toward the root of the tooth, as he points out, but also to the increasing inefficiency of the canine as a piercing and holding organ. The stump-like canine of advanced age, composed largely of dentine at this stage, is more liable to wear by virtue of its own increasing inefficiency as well as because of its softer composition. This is noticeable in the Robinson Cave sample as well. Christian's accelerations proceed : 0.1 mm, 0.3 mm, 0.4 mm, 0.5 mm. Robinson Cave accelerations proceed : 0.4 mm, 0.5 mm, 0.7 mm.

As suggested by Christian, length of annual flight time may vary with latitude. Individuals from lower latitudes, enjoying a longer frost-free flight period, might be expected to wear their teeth down more rapidly than specimens from higher latitudes. The same might be said of the effects of climatic change at any one locality. Cool climatic episodes might retard annual tooth wear, milder episodes accelerate it. Because of such variables toothwear classes of the Robinson Cave sample may not be directly comparable to

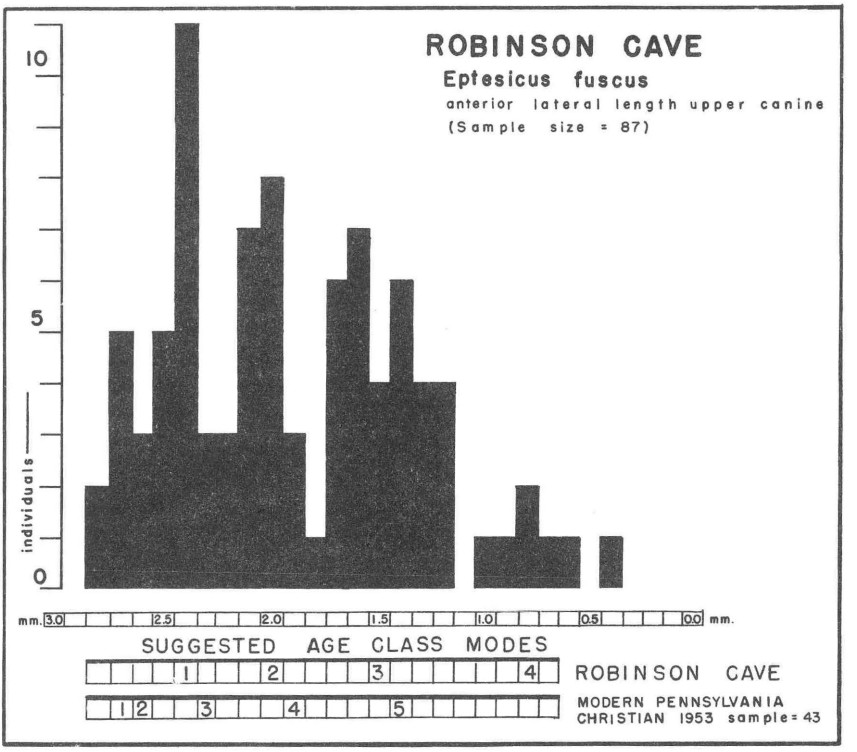

FIG. 9. Histogram, anterolateral upper canine length *Eptesicus fuscus* (Palisot de BEAUVOIS), Robinson Cave, Overton County, Tennessee, See text, page 45-46.

Christian's age classes in terms of actual years. The presence of toothwear classes in the Robinson Cave sample, however, despite any lack of chronological equivalence, does suggest that mortality was largely confined to a specific time of year. That this was probably winter is shown by the absence of Christian's group 0 (about 10 % of his sample), young bats with deciduous teeth, erupting permanent canines, and no noticeable toothwear.

Although there are unusual cases of mortality on record attributed to disease (Raun, 1960; Booth, 1965), flash flooding (Griffin, 1953), and predation by birds of prey (Taylor, 1964; Hall & Blewett, 1964), Beer (1955), basing his judgement on an extensive study of banded *Eptesicus* in the Wisconsin-Minnesota area, estimates the average mortality rate of a hibernating population to be 40 %.

If we assume a sustained resident *Eptesicus* population of 100 individuals in Robinson Cave during depositional times and a 40 % hibernation mortality (justified, perhaps, by the observation that the postulated climate of the bulk of the Armadillo Pit depositional time approached closely that of the Wisconsin-Minnesota area today), it would have required only 40 years to account for the number of *Eptesicus* in the faunal sample from the Armadillo Pit. Many more remain in the unexcavated portion of the deposit and nothing is inferred about either the size of the original resident population, which undoubtedly fluctuated, or the time involved. But, based upon what we know of the life history of this bat on the northern fringe of its modern hibernating range, deposition of what at first sight seems an extraordinary high number of bat remains would not necessarily require a large resident population or any great length of time to account for it.

Although female big brown bats average some 5 % larger than males (Engels, 1936), this could not be demonstrated statistically in the Robinson Cave sample. Hibernating clusters may be sexually biased. Rysgaard (1942)

TABLE 9

Cranial measurements in mm, *Eptesicus*, Robinson Cave, Tennessee.

$\bar{X}$	O.R.	S.D.	C.V.	N
length of upper toothrow, p^4-M^3				
6.09-.01	5.6-6.5	.18-.01	2.95-.20	108
width across palate at and including M^2's				
8.21-05	8.0-8.4	.13-.02	1.56-.33	11
length of palate excluding central spine				
7.77-.11	7.3-8.1	.27-.07	3.47-1.00	6
breadth, interorbital				
4.58-.05	4.3-4.9	.17-.03	3.17-.79	11
width, lower canines				
1.43-.007	1.3-1.5	.04-.005	2.79-.35	31

working in Minnesota and Davis and Hitchcock (1964) in New York found that hibernating clusters were often high in male individuals. Scattered hibernants were more likely to be female.

Plecotus GEOFFROY ? species — Big-eared Bat

Material : CM 8355-8371. 1 partial skull; 9 left, 11 right maxillae; 131 left, 124 right mandibles.

Remarks : *P. rafinesquei* is the only big-eared bat found in the state today. It is sympatric with the closely related *P. townsendii* in the northern part of its range from southern Illinois east to West Virginia. The two species could not be separated due to the fragmentary condition of the collection.

TABLE 10
Measurements in mm, *Plecotus*, ? species, Robinson Cave, Tennessee.

	$\bar{X}$	O.R.	N
total length, mandible	11.1	10.8-11.6	13
P^4-M^3	4.2	3.9-4.5	4
M^1-M^3	3.6	3.1-3.7	6
M_1-M_3	4.1	3.9-4.3	15

Order **RODENTIA**

Family **Sciuridae**

TABLE 11
Squirrels from various eastern North American cave deposits.
Minimum numbers of individuals and percent of Sciuridae

Species	Robinson Cave, Tenn.		New Paris No. 4, Pa.		Natural Chimneys, Va.	
		%		%		%
Marmota monax	2	4.5	1	1.2	2	4.5
Tamias striatus	9	20.4	27	32.9	6	13.6
Citellus tridecemlineatus	3	6.8	8	9.7	2	4.5
Glaucomys volans	16	36.3	2	2.4	15	34.0
Glaucomys sabrinus	5	11.4	14	17.0	13	29.5
Tamiasciurus hudsonicus	4	9.0	30	36.5	5	11.3
Sciurus niger	2	4.5	-	-	-	-
Sciurus carolinensis	-	-	-	-	1	4.5
Sciurus , species ?	3	6.8	-	-	-	-

Tamias striatus (LINNAEUS) — Chipmunk

Material : CM 8105-8128, 8130. 1 partial skull; 3 left, 5 right maxillae; 9 left, 7 right mandibles.

Remarks : This small fragmentary collection averages somewhat larger than either modern populations or the late Pleistocene New Paris No. 4 collection, but considerably smaller than *Tamias aristus* RAY from the late Pleistocene of Georgia. Ray (1965, p. 1021) states, « This radical gap in observed size ranges well might disappear if more Pleistocene samples were available. The late Pleistocene sample from New Paris No. 4 represents a population larger than a Recent population from the same area and, along with the samples from Conard Fissure and Hartman's Cave, perhaps slightly larger than the largest living populations. If other late Pleistocene populations of *Tamias* prove to be similarly scaled upward in size, as experience with other mammalian groups leads one to expect, then *T. aristus* could represent a large (southern) extreme in the geographic variation of late Pleistocene *Tamias* ».

TABLE 12
Alveolar length lower dentition, in mm, *Tamias striatus*.

	$\bar{X}$	O.R.	N
Pleistocene			
New Paris No. 4, Pennsylvania	6.74	6.3-7.1	30
Hartman's Cave, Pennsylvania	6.90	6.2-7.7	9
Cherokee Cave, Missouri	-	6.4-6.7	2
Robinson Cave, Tennessee	7.5	7.3-7.8	2
Recent			
New Paris No. 2, Pennsylvania	6.28	5.8-6.8	114
T. s. pipilans	6.76	6.3-7.4	19

* Data, in part, from Ray, 1965.

Marmota monax (LINNAEUS) — Woodchuck

Material : CM 8041, 8145. 1 skeleton, isolated molars.

Remarks : The skeleton (CM 8041) picked up on the floor of the Young Brothers' Room, is not considered a part of the Armadillo Pit fauna. It could not have entered the cave from the now-sealed Armadillo Pit chimney top because the Young Brothers' Room opens into the Armadillo Pit through a small hole high on the northwest wall. The animal may have entered the present cave entrance and simply wandered about until it expired. The bones were covered with a calcite rime but appear strong and well preserved. Isolated

molars were found in the Armadillo Pit however and *Marmota* was a component of the fauna. Measurements in mm, CM 8041 : P^4-M^3, 17.5; P_4-M_3, 18.9, 19.0.

Citellus tridecemlineatus (MITCHELL) — Thirteen-lined Ground Squirrel

Material : CM 8409-8410. 1 partial right mandible with M_1; 1 right, 1 left M_1; 1 right M_3; 2 left M^2's; 1 left P^4.

Remarks : This is the first record of *Citellus tridecemlineatus* from Tennessee. The animal inhabits the short grass prairie of the American midlands. Although it occurs as far east as central Ohio at the present time, it does not occur south of the Ohio River nor east of the Mississippi River south of Illinois. It is known from numerous eastern caves as a Pleistocene fossil; New Paris No. 4, Pa., Bootlegger Sink, Pa., Cumberland Cave, Md., Natural Chimneys, Va., Welsh Cave, Ky. (CM collection), and Trout Cave, W. Va. (CM collection). This ground squirrel occurs as far north as Lake Winnipeg, Canada, approximately 50 degrees north latitude. Its presence is indicative of at least an open parkland situation at the time of deposition.

TABLE 13
Measurements in mm, *Citellus tridecemlineatus,* Robinson Cave, Tennessee.

	$\bar{X}$	O.R.	N
length M_1	1.6	1.5-1.7	4
width M_1	2.3	2.1-2.5	4

Sciurus niger LINNAEUS — Fox Squirrel

Material : CM 8050-8052. 2 skulls; 1 left mandible.

Remarks : A squirrel primarily found in open deciduous mast-producing woodlands, the fox squirrel occurs as far north as Minnesota and Wisconsin. The two skulls uncrushed and covered with a thin layer of calcium carbonate were picked up on the surface of the Armadillo Pit talus, indicating that they were among the last specimens to find their way into the deposit. Alveolar length of P_4-M_3 = 13.1 mm; M_1-M_3 = 10.2 mm; M^1-M^3 = 10.0 mm.

Sciurus LINNAEUS, ? species — Fox or Gray Squirrel

Material : CM 8069-8074, 8145. 3 left, 3 right mandibles.

Remarks : Specimens too fragmentary to identify to species.

Tamiasciurus hudsonicus (ERXLEBEN) — Red Squirrel

Material : CM 8049, 8064-8068, 8129, 8131-8132, 8145, 12525. 1 partial skeleton with skull and mandibles; 3 left maxillae; 3 left, 3 right mandibles.
Remarks : A nominally northern forest form, the red squirrel occurs in both coniferous and deciduous forest as far south as Ohio in the American midlands. It occurs in the Appalachian Mountains as far south as the Smoky Mountain region of eastern Tennessee. Its presence like that of so many other species in the deposit may be indicative of cooler climate, but remains have been found in Banshee Hole, Cumberland County and the Westmoreland-Barber Site (40-Mi-11) (Parmalee & Guilday, 1966), a late Prehistoric Indian site in Marion County, that may indicate that the red squirrel survived to a relatively recent date in the Cumberland County area. The specimen, from a tiny niche on the side of the huge stalagmite directly above the mouth of the Sloth Pit, was the anterior half of an articulated skeleton nicely cemented with a patina of flowstone. One of the original claws was still in place. This is not necessarily a sign of modernity, though. *Megalonyx* remains retaining claws and ligaments are known from Big Bone Cave, Tennessee. (O. P. Hay, 1923). Pleistocene red squirrel remains are also known from Whitesburg, Hamblen County, Tenn. (O. P. Hay, 1920, p. 92).

TABLE 14
Measurements in mm, *Tamiasciurus hudsonicus*, Robinson Cave, Tennessee.

	$\bar{X}$	O.R.	N
P_4-M_3	8.2	-	1
alveolar length, P_4-M_3	8.7	8.6-8.7	2

Glaucomys sabrinus (SHAW) — Northern Flying Squirrel

Material : CM 8054-8063, 8100, 12518-12522. 1 skull; 4 left, 2 right maxillae; 6 left, 4 right mandibles.

Remarks : The modern southern range of this squirrel is central Michigan, except in the higher areas of the Appalachian Mountains where it occurs as far south as eastern Tennessee (Blanket Mountain, 4000 feet, Kellogg, 1939). Throughout its range it is confined to Canadian or Hudsonian life zone situations.

The Robinson Cave population sample agrees with the New Paris No. 4 and Natural Chimneys samples in large size, much larger than present eastern populations.

TABLE 15

Measurements, alveolar length, lower toothrow, *Glaucomys sabrinus* (SHAW), in mm*.

	$\bar{X}$	O.R.	N
Pleistocene			
New Paris No. 4, Pennsylvania	7.7	7.6-8.1	3
Natural Chimneys, Virginia	7.8	7.3-8.4	14
Robinson Cave, Tennessee	7.8	7.0-8.7	8
Recent			
Eastern United States			
G. s. coloratus	6.9	6.7-7.1	7
G. s. fuscus	6.7	6.5-6.9	5
G. s. macrotus	6.6	6.0-7.0	23
Canada			
G. s. sabrinus	7.2	6.8-7.6	4
G. s. makkovikensis	7.1	6.9-7.4	2
Alaska			
G. s. zaphaeus	7.6	7.3-7.9	5
Idaho			
G. s. bullatus	8.7	8.6-8.7	7

* Measurements from Howell 1918 ; Handley, 1953 ; Guilday, 1962 ; Guilday, Martin, and McCrady, 1964. Alveolar length of upper toothrow, when found in the literature, was converted into alveolar length of lower touthrow by multiplying by . 94, a constant found to work among modern Pennsylvania specimens.

Glaucomys volans (LINNAEUS) — Southern Flying Squirrel

Material : CM 8075-8099, 8101-8104, 12517. 3 skulls; 6 left, 2 right maxillae; 14 left, 9 right mandibles.

Remarks : The ranges of the northern and the southern flying squirrel overlap in the Great Lakes area and down the Appalachian Mountains. In such areas they may occur in close proximity. Both species were also together in the New Paris No. 4, Pennsylvania and the Natural Chimneys, Virginia local faunas. The Robinson Cave *G. volans* sample agrees with other late Pleistocene populations of this animal in being larger than its modern equivalent.

TABLE 16
Alveolar length lower toothrow, in mm, *Glaucomys volans* (LINNAEUS)*.

	$\bar{X}$	O.R.	N
Pleistocene			
New Paris No. 4, Pennsylvania	6.4	-	2
Natural Chimneys, Virginia	6.5	6.3-6.9	17
Robinson Cave, Tennessee Armadillo Pit	6.3	6.2-6.6	5
Robinson Cave, Tennessee above Sloth Pit	6.6	6.4-6.8	4
Recent			
Pennsylvania**	6.0	5.6-6.4	38

* Data from Howell, 1918 ; Guilday, 1962 ; Guilday, Martin, and McCrady, 1964.
** Doutt, unpublished.

Family **Cricetidae**

Peromyscus cf. ***leucopus*** (RAFINESQUE) — White-footed Mouse

Material : CM 8339. 1 partial skull.

Remarks : Although primarily a deciduous forest species of southern affinities, the white-footed mouse is found as far north as Wisconsin, Minnesota and southern Alberta.

Peromyscus cf. ***maniculatus*** (WAGNER) — Deer Mouse

Material : CM 8340-8341. 2 partial skulls.

Remarks : The deer mouse ranges throughout eastern North America north to the southern limit of the tundra. It is scarce, local, and on the southern edge of its range in Tennessee today. The present midwestern subspecies, *P. m. bairdi,* is a short-grass prairie form that ranges north into Wisconsin and Minnesota where the coniferous forest form, *P. m. gracilis,* occurs. Because of the pronounced habitat preferences shown by subspecies that cannot be differentiated from fragmentary skeletal remains, and the evidence of major mammalian range adjustments implied by the rest of the fauna, the presence of *P. maniculatus* in the fauna adds nothing of any paleoecological value. Length of three M^1's = 1.7 mm (1.7-1.8).

Peromyscus GLOGER, ? species

Material : CM 8336-8338, 8407-8408, 8342-8343. 1 partial skull; 12 left, 12 right maxillae; 75 left, 62 right mandibles.

Remarks : This material is too fragmentary to identify to species. Remains of both *P. maniculatus* and *P. leucopus* are probably present. No specimens were thought to represent *P. gossypinus* or *Ochrotomys nuttalii*. The latter has been found in Recent deposits in Banshee Hole, Cumberland County, Tennessee. Length of 46 M_1's = 1.5 (1.3-1.6).

Neotoma cf. *floridana* (ORD) — Wood Rat

Material : CM 8305-8308, 8412-8415. 1 partial skull; 12 left, 14 right maxillae; 121 left, 130 right mandibles or M_1's; 580 isolated molars.

Remarks : The woodrat is a common resident of Tennessee caves. Although it does not occur north of southern Illinois and Indiana in the Midwest today, it does ascend the Missouri River valley into the Dakota region at the same latitude as central Minnesota and Wisconsin. Since *Neotoma* inhabits caves of the area, its remains may postdate the boreal component. But the woodrat may well have survived the Wisconsin glaciation in place at Robinson Cave. Its present range follows closely the southern limit of the Wisconsin ice advance. Perhaps this relatively slow breeder has failed to colonize northern areas for reasons other than climatic. It is known to have been present in the late glacial boreal fauna of New Paris No. 4.

The Armadillo Pit is too isolated from the surface to support a resident population of these rats at the present time and the remains in all probability are contemporaneous with the late glacial fauna.

Seven M_1's measured length 3.6 mm (3.1-4.0), width 1.8 (1.5-2.2).

Clethrionomys cf. *gapperi* (VIGORS) — Red-backed Vole

Material : CM 8296-8304, 8335. 29 left, 40 right mandibles or M_1's (fig. 10d).

Remarks : A common mammal in the Robinson Cave local fauna, *Clethrionomys* does not occur at the site today. With the exception of the Appalachian arm of its distribution, which extends south along the mountain summits into extreme eastern Tennessee, the southern limit of this animal in the American midlands is central Minnesota and Wisconsin. It is a woodland form of the Canadian Zone and its ecotones. *Clethrionomys* has been recorded south of its modern range from at least two other late Pleistocene cave deposits in the Midwest, Meyer Cave, Monroe County, Illinois, and Crankshaft Pit, Jefferson County, Missouri.

Length of five M_1-M_3 = 5.3 mm (5.1-5.4). Length of 63 M_1's = 2.1 (2.0-2.5).

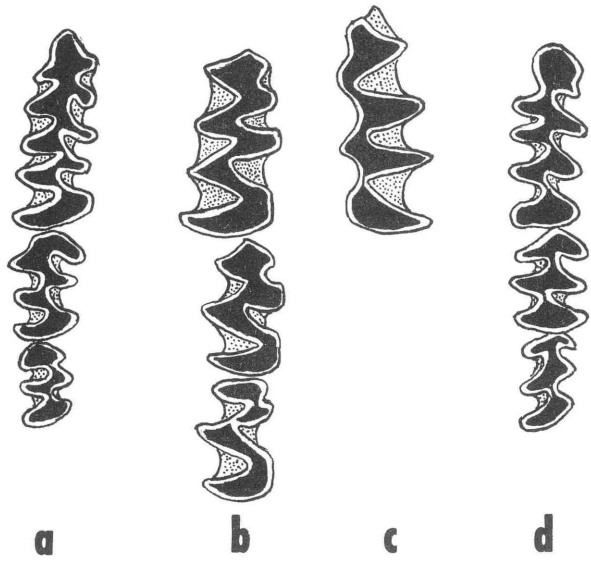

FIG. 10. Crown view molar patterns, various microtines, Robinson Cave, Overton County, Tennessee.
Black = dentine; white = enamel; stipple = cementum.
a) *Pitymys pinetorum* (LE CONTE) CM 8322, right M_1-M_3.
b) *Synaptomys cooperi* BAIRD CM 8277, right M_1-M_3.
c) *Synaptomys borealis* (RICHARDSON) CM 8275, left M_1.
d) *Clethrionomys* cf. *gapperi* (VIGORS) CM 8298, right M_1-M_3.

Microtus cf. ***pennsylvanicus*** (ORD) — Meadow Vole

Material : CM 8268-8274, 8329, 8334. 3 partial skulls; 1 right maxilla; 85 left, 76 right mandibles or M_1's.

Remarks : There is a possibility that some of the lower mandibles may be those of *M. chrotorrhinus* (MILLER). The dental configuration of the lower tooth row of the two species is identical. Both species no longer occur as far south as central Tennessee except in the Great Smoky Mountains of extreme eastern Tennessee. Both species do occur in the Wisconsin area. *M. pennsylvanicus* is a moist grasslands form. *M. chrotorrhinus* inhabits cool, moist, rocky forests of the Canadian Life Zone.

Judging from the length of the lower molar row, this population sample agrees in size with modern Pennsylvania comparative material and is distinctly larger than the late Pleistocene New Paris No. 4 local fauna.

TABLE 17

Length of lower molar row, *Microtus pennsylvanicus* (ORD), late Pleistocene. Measurements in mm.

	$\bar{X}$	O.R.	N
New Paris No. 4, Pennsylvania	5.7	5.0-6.4	65
Robinson Cave, Tennessee	6.4	6.1-7.0	10
Modern, Pennsylvania*	6.4	-	104
* Data from Goin, 1943.			

cf. ***Pitymys pinetorum*** (LE CONTE) — Pine Vole

Material : CM 8318-8326, 8330-8332. 5 partial skulls; 1 right maxilla; 110 left, 102 right mandibles or M_1's. (fig. 10*a*).

Remarks : There is a distinct possibility that some of the lower jaws may have been *M. ochrogaster,* the prairie vole, a grasslands form whose range closely approximates that of the thirteen-lined ground squirrel. The thirteen-lined ground squirrel, although not a member of the Recent mammal fauna of the area, was present in the Robinson Cave local fauna. *Microtus ochrogaster* does not occur in the area today, but may well have in late Pleistocene times.

Dentitions are indistinguishable morphologically, but the small average dimension of the sample as well as the morphology of the skulls demonstrates that at least part of the sample is unequivocably *M. pinetorum,* the common vole of the area today. Both *M. pinetorum* and *M. ochrogaster* occur as far north as Wisconsin today, *M. ochrogaster* much farther. *M. pinetorum* has been taken in Canadian Zone situations (Hamilton, 1943) but is more characteristic of temperate conditions.

TABLE 18

Dental measurements, length in mm, cf. *Pitymys pinetorum* (LE CONTE), Robinson Cave, Tennessee.

	$\bar{X}$	O.R.	N
M^1-M^3	6.3	6.2-6.5	2
M_1-M_3	5.6	5.3-6.0	12
M_1	2.6	2.1-3.1	127

Ondatra zibethicus (LINNAEUS) — Muskrat

Material : CM 8411. 4 isolated molars.

Remarks : This aquatic rodent is found throughout most of North America from Louisiana to Alaska. One M_2 = length 3.5 mm, width 2.2 mm.

Synaptomys cooperi BAIRD — Southern Bog Lemming

Material : CM 8276-8295, 8327, 8333, 8380. 3 partial skulls; 40 left, 41 right mandibles or M_1's. (fig. 10*b*).

Remarks : Except in the Appalachian Mountains, where its range extends as far south as the Great Smokies of eastern Tennessee, *S. cooperi* occurs no farther south than central Kentucky at the present time. Its range extends as far north as northern Minnesota and southern Manitoba where it overlaps that of the northern bog lemming, *S. borealis*. *Synaptomys cooperi* today exhibits a negative Bergmann's response, i. e. the farther south one gets in its range the larger the animals become. The New Paris No. 4 late Pleistocene population was composed of small animals comparable to those of the northeastern fringe of the present range of the species. The Robinson Cave population sample was composed of relatively large animals. In both cases a range shift to the south during glacial times is indicated. As stated in Guilday *et al.*, 1964, p. 161, this would seem to indicate that the modern clinal pattern was established before the reinvasion of the north by *S. cooperi* in post-glacial times. Indeed the pattern may antedate the Wisconsin glaciation itself as seems to have been the case with *Blarina* (Hibbard, 1963).

TABLE 19
Length in mm, *Synaptomys cooperi*.

	Robinson Cave, Tennessee			New Paris No. 4, Pennsylvania		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
M^1-M^3	6.79	-	1	-	-	-
M_1-M_3	6.4	6.1-6.7	4	5.6	5.4-5.9	8
M_1	2.7	2.4-2.9	26	2.4	2.3-2.5	20

Synaptomys borealis (RICHARDSON) — Northern Bog Lemming

Material : CM 8275. 1 left M_1 (fig. 10*c*).

Remarks : Closely confined to the Hudsonian Life Zone of Canada and Alaska, the northern bog lemming occurs as far south as extreme northern Minnesota and Maine at which points its range overlaps that of *S. cooperi*. Both species are known from at least two other sites in eastern North America, but in varying proportion. At New Paris No. 4 in central Pennsylvania, *S. borealis* accounted for 78 % of all *Synaptomys;* at Natural Chimneys, Va., 23 % ; and at Robinson Cave, Tenn., only 2 %. Length M_1 = 3.0 mm.

Synaptomys borealis has been recently discovered from Pleistocene deposits as far south as Bat Cave, Pulaski County, Mo., by Dr. Oscar Hawksley. The specimen, a partial left mandible with full dentition, is in the

collections of Central Missouri State Teachers College, cat. no. 352. The occlusal length of M_1-M_3 is 6.1 mm. This falls within the range of the New Paris No. 4 local fauna sample.

Family **Zapodidae**

Both the woodland and the meadow jumping mouse were present in the deposit. Only the latter occurs in the state today (if we except the Great Smoky Mountain area of extreme eastern Tennessee). In the American Midlands the woodland jumping mouse occurs no farther south than central Wisconsin and Michigan.

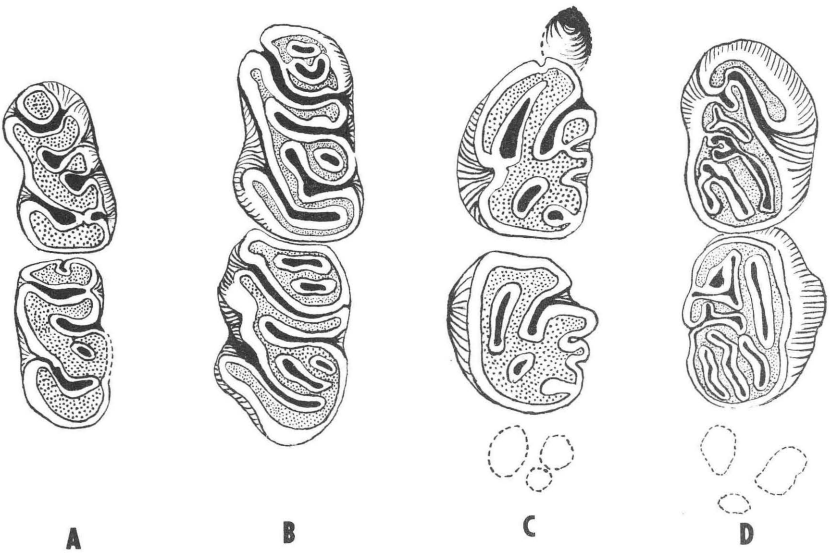

FIG. 11. Crown view molars Zapodidae, Robinson Cave, Overton County, Tennessee.
Zapus hudsonius (ZIMMERMANN) :
A. CM 8403, left M_1-M_2.
C. CM 8409, left M^1-M^2, P^4 and M^3 missing.
Napaeozapus insignis (MILLER) :
B. CM 8381, left M_1-M_2.
D. CM 8394, right M^1-M^2, M^3 missing.

Zapus hudsonius (ZIMMERMANN) — Meadow Jumping Mouse

Material : CM 8400-8406. 2 left maxillae; 4 left, 1 right mandible or M_1 (fig. 11 *a* & *c*).

Napaeozapus insignis (MILLER) — Woodland Jumping Mouse

Material : CM 8381-8399. 3 left, 2 right maxillae; 8 left, 8 right mandibles or M_1's (fig 11 *b* & *d*).

TABLE 20
Measurements in mm, *Zapus hudsonius* and *Napaeozapus insignis*, Robinson Cave, Tennessee.

	Zapus hudsonius			*Napaeozapus insignis*		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
M^1, length	1.5	1.45-1.55	2	1.6	1.5-1.7	6
M^2, length	1.3	-	1	1.5	1.35-1.55	4
M^3, length	-	-	-	.95	-	1
M_1-M_3, length	3.5	-	1	-	-	-
M_1, length	1.4	1.2-155	3	2.1	1.55-1.8	12
M_2, length	1.3	1.2-1.35	2	1.6	1.45-1.7	13
M_3, length	0.8	-	1	.97	-	1

Family **Erethizontidae**

Erethizon dorsatum (ERXLEBEN) — Porcupine

Material : CM 8379. Partial palate; partial left mandible; isolated molars; skeletal fragments.

Remarks : Although not known to range as far south as Tennessee within historic times, porcupine remains are known from Indian sites in Marion County, about 80 miles south of the cave (Parmalee and Guilday, 1967) and from deposits in various cave and fissure deposits, Bigbone Cave, Van Buren County (Kellogg, 1939), and Craig Marble Quarry County (Maher, letter, USNM 240920) and Banshee Hole, Cumberland County (CM collections). The porcupine ranges north to Alaska. It has a predilection for caves and rocky areas and is a common Pleistocene cave fossil.

Order **LAGOMORPHA**

Family **Leporidae**

cf. ***Lepus*** or ***Sylvilagus*** — Cottontail ? Rabbit or Snowshoe ? Hare

Material : CM 12523, 12531. Isolated molars; fragments of maxillae, premaxillae; fragments of skeletal elements.

Order **CARNIVORA**

Family **Canidae**

Canis cf. ***dirus*** LEIDY — Dire Wolf

Material: CM 12510. 1 M^2.

TABLE 21
Length and width of crown, M^2, in mm, *Canis*.

Locality	Catalogue No.	length	width
Bedford County, Pennsylvania	*Canis lupus*, CM 6548	9.0	13.0
Cayuga County, New York	*Canis lupus*, G-756	11.5	13.0
Rancho la Brea, California	*Canis dirus*, CM 3995	9.2	12.5
Welch Cave, Kentucky	*Canis dirus*, CM 12625	11.0	15.7
Robinson Cave, Tennessee	*Canis* cf. *dirus*, CM 12510	11.0	16.0

Urocyon cinereoargenteus (SCHREBER) — Gray Fox

Material: CM 8042-8043, 8311. Two partial skeletons: isolated molars.

Remarks: Two skeletons, one from the Young Brothers' Room, the other from the Armadillo Pit, were unbroken and essentially complete. Both were sprawled in an attitude of articulation on the cave floor, and, although heavily spattered with "cave coral", are younger than the rest of the fauna. Isolated molars of at least three other individuals from the Armadillo Pit, however, indicate that the gray fox was probably a temporal member of the Armadillo Pit fauna. It ranges throughout North America, exclusive of the Great Plains and Rocky Mountain area north to northern Minnesota.

Family **Ursidae**

Ursus americanus cf. ***amplidens*** LEIDY — Pleistocene Black Bear

Material: CM 8312. 1 left, 1 right I^3; 1 left, 1 right M^2; 1 left P_4; 1 left, 1 right M_1; 1 left, 1 right M_2; 1 left tibia.

Remarks : Referred to *U. a. amplidens,* these isolated black bear teeth agree in large size with the referred Texas material reported on by Kurtén, 1963. One partial tibia recovered from the Armadillo Pit is not exceptionally large. Dimensions as restored are : total length 263 mm, width of proximal end 69 mm, width of distal end 46.9 mm.

TABLE 22
Measurements in mm, *Ursus americanus* cf. *amplidens,* Robinson Cave, Tennessee.

CM 8213	length	width
M^2	30.3	17.4
M_1	23.5	14.3
	23.5	14.3
M_2	18.0	13.8
	18.0	13.8

Family **Procyonidae**

Procyon lotor (LINNAEUS) — Raccoon

Material : CM 8044, 8309-8310, 8313. Partial skeleton with baculum; isolated deciduous and permanent molars.

Remarks : Arata and Hutchison (1964) reviewed the Pleistocene *Procyon* from North America and concluded that were all *Procyon lotor.* The skeleton, complete, uncrushed, but covered with a cave coral rime, as were the fox squirrel and gray fox, was lying on the surface of the Armadillo Pit talus and appeared to postdate the bulk of the fauna. The animal, a male, measured : total length of skull, 113 mm, P^4-M^2, 23.2 mm.

Family **Mustelidae**

Martes americana (TURTON) — Pine Marten

Material : CM 8045-8046, 8316-8317. 1 partial skull, no dentition; 1 right M_1; 2 mandibles.

Remarks : Closely confined to the coniferous forest of the Hudsonian and Canadian Life zones, the pine marten in Historic times ranged as far south as northern Pennsylvania and extreme northeastern Ohio. The record from Chillicothe in southcentral Ohio is hearsay only (Bole and Moulthrop, 1942).

In the Midwest the pine marten occurs as far south as northern Illinois, about 650 miles north of Robinson Cave. The partial skull was found with the *Megalonyx* skeletons in the Sloth Pit, the remaining specimens were found in the Armadillo Pit.

Martes pennanti (ERXLEBEN) — Fisher

Material: CM 8314-8315. 1 left maxilla with P^3-P^4; 1 left, 1 right P^4; 2 left, 3 right M^1's.

Remarks: Although primarily a Canadian Life zone mammal, the fisher apparently ranged throughout the Appalachian and Cumberland plateaus. Remains are known from the late Prehistoric Westmoreland-Barber Site, a former Indian village in Marion County, 80 miles south of Robinson Cave (Parmalee and Guilday, 1967). Length of five M^1's averages 6.4 mm (5.8-7.2 mm); width of five M^1's averages 10.1 mm (9.6-10.7 mm). Length and width of one P^4 equals 10.7 × 6.1 mm.

Mustela cf. ***frenata*** LICHTENSTEIN — Long-tailed Weasel

Material: CM 8345. 1 partial right mandible.

Remarks: Common throughout the eastern United States, the long-tailed weasel occurs as far north as northern Wisconsin and Minnesota. Length and width of crown of P_4 = 2.7 mm × 1.45 mm; of M_1, 5.4 mm × 2.0 mm.

Mustela cf. ***nivalis*** LINNAEUS — Least Weasel

Material: CM 8352. 1 left M_1.

Remarks: The smallest of all living mustelids, the least weasel occurs throughout most of Canada and Alaska south to central Illinois and Ohio in the Midwest. It also occurs in the Appalachian Mountains and has been taken at an altitude of 4800 feet on Roan Mountain, Carter County in eastern Tennessee (Tuttle, 1968).

Mustela LINNAEUS, ? species — Weasels

Material: CM 8344, 8346-8351, 8353-8354. Isolated teeth and mandible fragments.

Remarks: Isolated teeth and mandible fragments of at least four individuals were found in the Armadillo Pit deposit. These specimens remain unidentified

not because of any peculiarities but because of the confusing picture presented by the great overlap of sexual and specific size differences. As a result these fragmentary specimens of unknown sex may represent *M. erminea* or *M. frenata*

TABLE 23

Measurements in mm, *Mustela* sp., Armadillo Pit, Robinson Cave, Tennessee.

	length			width		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
M^1	4.7	4.7-4.7	2	2.1	1.9-2.2	2
M^2	4.9	4.5-5.2	2	2.3	2.2-2.3	2
M_1	3.8	3.2-4.0	5	1.3	1.0-1.4	5
P_4	1.8	1.7-2.0	2	1.1	1.0-1.2	2

Family **Felidae**

Lynx cf. *rufus* (SCHREBER) — Bobcat

Material : CM 8047, 8378. 1 partial skeleton; right maxilla with P^3-P^4; 1 right, 1 left P^4; fragment of right mandible with P_3-P_4; 14 second phalanges, 2 os magnum, 1 cuneiform, 1 astragalus, 4 canines.

Remarks : The animal from the Sloth Pit was mineralized, the carbonates apparently replaced by silica. This was the only instance of mineral replacement noted in any of the Robinson Cave fauna. The skeleton was found beneath the unmineralized skeletons of two *Megalonyx* and separated from them by a thin layer of flowtone at the bottom of the Sloth Pit. Despite its obvious antiquity, no characters appear that can differentiate the skeleton from that of *Lynx rufus* (SCHREBER).

TABLE 24

Measurements in mm, *Lynx* cf. *rufus*, Robinson Cave, Tennessee.

	length			width		
	$\bar{X}$	O.R.	N	$\bar{X}$	O.R.	N
P^3	11.3	–	1	5.8	–	1
P^4	14.5	14.0-15.1	2	8.2	7.7-8.7	2
M_1	11.5	11.0-12.0	2	5.2	4.7-5.7	2
P_4	9.8	9.6-10.0	2	5.7	5.1-6.3	2

Order **ARTIODACTYLA**

Family **Cervidae**

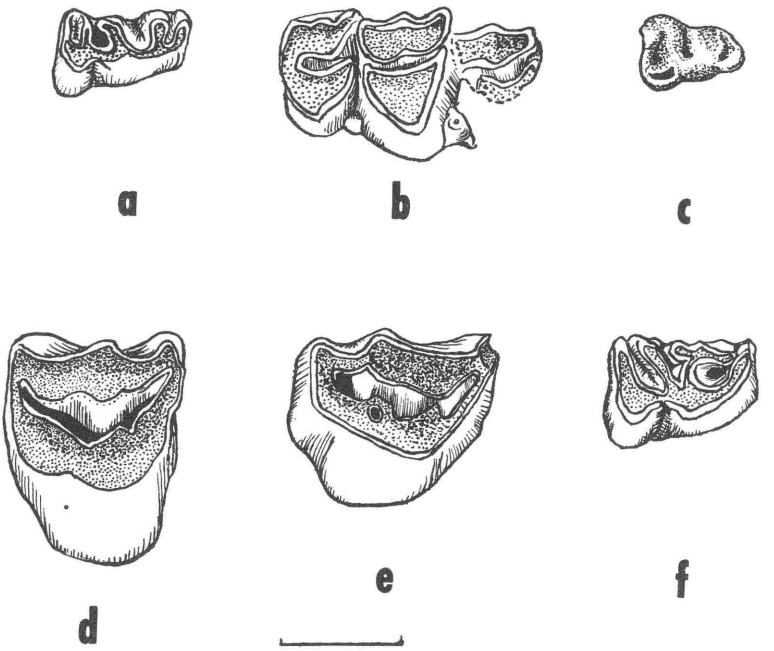

FIG. 12. *Odocoileus* cf. *virginianus* (ZIMMERMANN), Robinson Cave, Overton County, Tennesse. a) CM 8376*a*, right P_3. c) CM 8376*b*, right P_2.
Sangamona cf. *furtiva* HAY, Robinson Cave, Overton County, Tennessee. b) CM 8375, left dP_4. d) CM 8372, right P^4. e) CM 8374, left P^2. f) CM 8377, right P_3. Bar = 10 mm.

Sangamona cf. ***furtiva*** HAY — Extinct Pleistocene Deer

Material : CM 8372-8375, 8377. 2 right P^4's; 1 left P^2; 1 left dP_4; 1 right P_3; (fig. 12 b, d, e, f).

Remarks : Originally identified by Guilday as caribou, *Rangifer tarandus*, the specimens were re-examined by Clayton Ray and Guilday and proved to be referable to *Sangamona*. In the process a partial skeleton from Frankstown Cave, Pa. identified as mule deer, *Odocoileus hemionus* (Peterson, 1926), was found to be that of *Sangamona*. At the outset it was assumed that cervid teeth intermediate in size between *Cervus canadensis* and *Odocoileus virginianus* from a fauna showing boreal affinities were *Rangifer*. In fact, it was strongly suspected that *Sangamona* was indeed *Rangifer*. This does not appear

to be the case. A critical study of this little known, but geographically widely spread, Pleistocene deer is badly needed. Length and width of P^2 = 17.5 × 13.7; P^4 = 14.5 × 18.5 and 13.2 × 18.4; P_3 = 13.1 × 9.1; dP_4 = 22.5 × 11.1.

Odocoileus cf. ***virginianus*** (ZIMMERMANN) — White-tailed Deer

Material : CM 8376. 1 right P_3; 1 right P_2. (fig. 12 a & c).

Remarks : The white-tailed deer inhabits all of the central and eastern portions of the continent north to and including parts of the Canadian Life Zone. Length and width of P_3 = 9.4 × 5.4 mm. Length and width of P_2 = 11.5 × 7.2 mm.

Order **EDENTATA**

Family **Dasypodidae**

Dasypus cf. ***bellus*** (SIMPSON) — Armadillo

Material : CM 8048. Fragmentary carapace scutes. (illustrated in Guilday & McCrady, 1966, fig. 1C).

Remarks : *Dasypus* remains are known from as far north as St. Louis, Missouri (Simpson, 1949) and Pocahontas County, West Virginia (Guilday and McCrady, 1966) in Pleistocene cave deposits. *Dasypus bellus* has, by analogy with the modern *Dasypus novemcinctus*, been referred to as a climatic indicator, intolerant of subfreezing conditions (Slaughter, 1961). It may well be that the *Dasypus* remains from the Armadillo Pit predate the boreal fauna; the fluorine analysis would seem to bear this out and may be attributed to a former, warmer period. Or it may be possible that this large extinct armadillo was more cold-tolerant than its modern counterpart.

Family **Megalonychidae**

Megalonyx jeffersonii (DESMAREST) — Jefferson's Ground Sloth

Material : CM 12527-12528. 1 partial skull, mandible, rib, radius, atlas. Cast of upper and lower dentitions of a second individual.

FIG. 13. *Megalonyx jeffersonii* (DESMAREST), Robinson Cave, Overton County, Tennessee. Lateral view right side of skull, anterior end to the right. Tennessee State Museum collection. See text for measurements.
Photo by W. G. Barton.

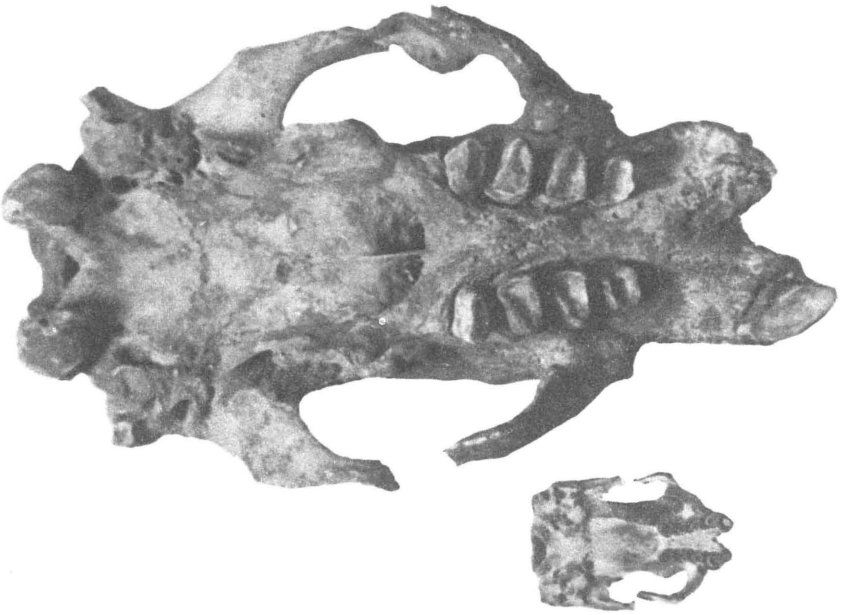

FIG. 14. Bottom view, large skull, *Megalonyx jeffersonii* (DESMAREST), Robinson Cave, Overton County, Tennessee; small skull, modern three-toed tree sloth, *Bradypus tridactylus* LINNAEUS, CM 1987, anterior to the right.
Photo by W. G. Barton.

FIG. 15. Left : lower jaw of *Megalonyx jeffersonii* (DESMAREST), Robinson Cave, Overton County, Tennessee. Same individual as Figs. 14 and 15, see text for measurements. Right : lower jaw of modern three-toed ground sloth, *Bradypus tridactylus* LINNAEUS, CM 1987, anterior end down.

Remarks : Both sloths were found in the Sloth Pit (map, fig. 3). The discovery of the cranium now in the Tennessee State Museum (figs. 13, 14, 15) led to all further excavations. Although some bones appeared to be in a rough

TABLE 25
Measurements in mm, *Megalonyx jeffersonii*, Robinson Cave, Tennessee.

	original (TSM)	cast (CM 12527)	CM 12528
C^1 width, length occlusal surface	34 x 19	31 x 16	-
M^1	-	18 x 14	19 x 16
M^2	-	22 x 17	26 x 17
M^3	-	22 x 16	26 x 18
M^4	-	18 x 10	-
diastema	-	47	39
C_1 width, length occlusal surface	35 x 16	34 x 17	40 x 17
M_1	-	22 x 16	24 x 17
M_2	-	22 x 17	25 x 16
M_3	-	21 x 18	23 x 18
diastema	-	39	-
depth of mandible at M_1	-	-	91

semblance of articulation, the majority were not. All bones were soft, wet and crumbling. The more complete of the two animals was sent to the Tennessee State Museum. Its skull was prepared at Carnegie Museum at which time photographs and casts of the dentition were made before it was returned to Tennessee. Other skeletal elements were not prepared but stored in plaster jackets in the Tennessee State Museum. The second individual, represented by the elements listed above, CM 12508, was retained by Carnegie Museum.

Order **PROBOSCIDEA**

Family **Mammutidae**

Mammut americanus (KERR) — Mastodon

Material : CM 8053. 3 fragments of molar enamel.

DISCUSSION

Almost 85 % of the fauna recovered from the Armadillo Pit consists of remains of small mammals that habitually inhabit caves (bats, 1,826 individuals, 80 %; woodrats, 130 individuals, 4 %). The remaining 15 % (representing 87 % of the 47 species of mammals recovered, however) were apparently trapped in a sink-type pit, wandered into the cave losing their way, or were victims of predation. If bats are left out of consideration, relative percentages of individual small mammals at Robinson Cave are similar to those at Natural Chimneys, Va. The Natural Chimneys deposit is believed to have been primarily a Pleistocene owl roost. At Robinson Cave the high numbers of shrew remains and the high incidence of nocturnal flying squirrels, compared with the low numbers of diurnal ground squirrels, likewise suggests a nocturnal predator such as an owl. Compare the Robinson Cave percents (table 26) with the low relative numbers of shrews and the high incidence of diurnal ground squirrels as opposed to nocturnal flying squirrels at New Paris No. 4, a well-trap sinkhole.

If these cave faunas are broken down into internal size classes regardless of taxa, however, there is no correlation between relative size of entrapped animal and mode of capture (table 27). This is due to the overwhelming relative abundance of small mammals making them the predominant size class captured in any natural trap situation. While it is true that a barn owl silo deposit will produce all small vertebrates, and a "buffalo jump" all large,

TABLE 26
Relative percentages of small mammals from various late Pleistocene cave deposits (troglobitic forms, bats, woodrats, omitted).

	Robinson Cave, Tennessee	Natural Chimneys, Virginia	New Paris No. 4, Pennsylvania	Conard Fissure, Arkansas
number of individuals	768	687	1919	698
	%	%	%	%
Talpidae	0.4	2.0	0.1	0
Soricidae	30.3	19.3	5.6	35.1
Sciuridae	5.1 (46% nocturnal)	6.4 (64% nocturnal)	4.3 (20% nocturnal)	2.6 (0% nocturnal)
Cricetinae	10.0	19.3	12.5	50.6
Microtinae	51.9	47.3	73.5	8.6
Zapodidae	1.7	3.2	1.0	0
Leporidae	0.4	2.5	2.8	3.1

both are cases of selection by predators. Most cave bone deposits accumulate as a result of varying degrees of natural entrapment and predation and, usually spared the winnowing effect of water-sorting, are characterized by an overwhelming abundance of small mammals. The low percentage of large versus small mammals from Cumberland Cave, Md. and Port Kennedy, Pa. are undoubtedly due to collecting bias. Subsequent excavations by Carnegie Museum field parties have revealed a rich and varied small mammal fauna at Cumberland Cave.

TABLE 27
Size classes, mammals, various Appalachian cave deposits.

Site	N*	small %	medium %	large %
Robinson Cave, Tennessee	799	96.8	2.0	1.2
Natural Chimneys, Virginia	713	96.9	1.8	1.3
New Paris No. 4, Pennsylvania	1928	99.0	0.8	0.2
Conard Fissure, Arkansas	794	90.6	6.4	3.0
Cumberland Cave, Maryland	150	25.0	25.0	50.0
Port Kennedy, Pennsylvania	380	5.0	34.0	61.0

* N = total individuals minus bats and woodrats

There are 54 living and 6 extinct species of vertebrates known from the Robinson Cave deposit. Of these 57 % are still to be found in the area, 33 % have either shifted their ranges north or west or retreated to the higher peaks of the southern Appalachians, and 10 % are extinct. The presence of the extinct armadillo in a primarily temperate/boreal fauna may seem incongruous. The modern nine-banded armadillo (*Dasypus novemcinctus*), however, occurs north

to Kansas and Missouri in the Midwest, about five degrees north of the cave site. Perhaps the increased size of the extinct *D. bellus* conferred a greater ability to withstand cold, and its occurrence in Pleistocene deposits at St. Louis, Mo. (Simpson, 1949) and West Virginia (Guilday and McCrady, 1966) with no trace of other southern forms, may be less unusual than it seems. Forty-nine, or 91 %, of those species from the Armadillo Pit that are not extinct can be found in the Minnesota-Wisconsin area today.

Eight species of shrews occurred in the Robinson Cave local fauna, a minimum of 216 individuals. Only four modern species have been reported from central Tennessee, *Cryptotis parva, Blarina brevicauda, Sorex longirostris,* and *Sorex fumeus. S. longirostris* apparently did not occur in the deposit. *Blarina brevicauda* was represented by a large form more characteristic of the Minnesota region than of modern Tennessee. *Cryptotis,* a field form, was rare, 2 % of the identified shrews. The four species of shrews which do not occur in central Tennessee today are of northern affinities. Their presence clearly calls for cooler, moister climatic conditions at the time of deposition.

TABLE 28

Shrews from late Pleistocene cave deposits, eastern North America. Minimum number of individuals and percent of total Soricidae.

Species	Robinson Cave, Tenn.	%	New Paris No. 4, Pa.	%	Natural Chimneys, Va.	%	Bootlegger Sink, Pa.	%
Blarina brevicauda	72	33.3	37	38.9	56	44.1	2	-
Sorex cinereus	72	33.3	35	36.8	45	35.4	1	-
Sorex fumeus	29	13.4	1	0.9	10	7.9	-	-
Microsorex hoyi	17	7.9	11	11.2	1	1.3	7	-
Sorex arcticus	10	4.6	6	6.3	6	3.1	1	-
Sorex dispar	9	4.2	4	4.2	-		-	-
Cryptotis parva	5	2.3	-	-	5	3.9	1	-
Sorex palustris	2	0.9	1	0.9	4	3.1	-	-

Six of the above species (*Blarina brevicauda, Sorex cinereus, Sorex arcticus, Sorex palustris, Microsorex hoyi* and *Cryptotis parva*) may all be found in Wisconsin and Minnesota today. Each has different ecological preferences, but the remains of all might occur in owl pellets of a suitably situated owl roost. The other two, *Sorex fumeus* and *S. dispar,* although they occur as far north as Maine and New Brunswick, apparently do not range as far west as the Wisconsin area. *Sorex fumeus* does range west along the north shore of Lake Superior and has been reported from Racine, Wisconsin, a record which has been questioned (Jackson, 1928, p. 65). *Sorex dispar,* an Appalachian form adapted for, and closely confined to, areas of mountain talus, may be limited more by lack of suitable talus habitat than by climatic factors. Perhaps if suitable contiguous habitat were available between the Appalachians and the Wisconsin area, *S. dispar* might have been able to

spread that far to the west. Central Wisconsin or Minnesota appears to be the closest modern equivalent to a suitable habitat that would accommodate all of the soricids of the Robinson Cave local fauna. This area is approximately 10 degrees north of the cave. A parallel situation is that of the New Paris No. 4 local fauna in Pennsylvania. Here the area of maximum range overlap falls in central Canada, again approximately 10 degrees north of the site. Robinson Cave is some 5 degrees south of New Paris. Its modern climatic equivalent, central Wisconsin, is correspondingly about 5 degrees south of that of the New Paris No. 4 fauna (central Canada, see map, Guilday *et al.*, 1964) indicating a climatic adjustment of approximately the same magnitude.

Seven species of sciurids were represented in the deposit, three ground squirrels (*Marmota monax, Tamias striatus, Citellus tridecemlineatus*) and four arboreal squirrels. Three (*Citellus tridecemlineatus, Tamiasciurus hudsonicus, Glaucomys sabrinus*) do not live in the area today but are found farther north or west. Although each has distinctive habitat preferences, the only area where their ranges all overlap is again the Wisconsin-Minnesota region, as in the case of the Soricidae.

Nine species of cricetids are known from the Robinson Cave local fauna. Four of them (*Synaptomys cooperi, Synaptomys borealis, Clethrionomys gapperi, Microtus pennsylvanicus*) no longer occur as far south as Robinson Cave. All but one, the woodrat, *Neotoma floridana,* occur in the Minnesota/-Wisconsin area today. The absence of the woodrat from that region may be due to factors other than climatic (see discussion under *Neotoma floridana*). High numbers of meadow vole (*Microtus pennsylvanicus*) would necessitate grassland in the vicinity of the cave. Equally high numbers of red-backed voles, *Clethrionomys gapperi,* indicate woodland. A boreal-temperate parkland would probably support all of the species. The absence of such forms as the cotton mouse, *Peromyscus gossypinus,* the golden mouse, *Ochrotomys nuttalii,* the cotton rat, *Sigmodon hispidus,* and the rice rat, *Oryzomys palustris,* animals which reach their northern range limits in Tennessee or Kentucky, is considered indicative of cooler times. The Mexican freetailed bat, *Tadarida brasiliensis,* a species at present found no closer than 90 miles south of the site, has been reported in deposits C-14 dated at more than 38,000 years from Mammoth Cave, Edmonson County, Kentucky, 100 miles northwest of Robinson Cave and presumably Sangamon in age (Jegla and Hall, 1962). With the possible exception of the armadillo, all of the Robinson Cave fauna is believed to postdate this interglacial episode. Several boreal microtines known from Appalachian late Pleistocene cave deposits were not recovered from the numerically large Robinson Cave local fauna, including the collared lemming, *Dicrostonyx hudsonius,* the spruce vole, *Phenacomys ungava,* and the yellow-cheeked vole, *Microtus xanthognathus. M. xanthognathus,* however, has recently been recovered from Welsh Cave, Woodford County, Kentucky (CM collections), about 125 mi north of Robinson Cave. This may mean that these tundra and taiga forms did not range as far south as Tennessee, or that the deposit was not building at the time of maximum small mammal range adjustments. More studies of Pleistocene cave faunas are needed before questions such as this can be resolved.

One reptile and one amphibian from the deposit do not occur in the Wisconsin-Minnesota region today. The worm snake, *Carphophis,* a burrowing form, hence a possible modern contaminant, ranges north as far as southern Iowa. The spadefooted toad, *Scaphiopus,* a burrower in light, friable, sandy soils, reaches southern Alberta in the Great Plains but does not occur in the forested Wisconsin-Minnesota region.

Although the fauna is predominantly a woodland one, the presence of the 13-lined ground squirrel and high numbers of meadow voles and bog lemmings suggests a parkland situation that may well have sustained *Scaphiopus.*

In summary, although fluorine analysis suggests a rather long period of accumulation for the Armadillo Pit fauna, the massive flowstone and brecciated roof of the Armadillo Pit (fig. 8) suggests that, with a few exceptions, the pit had ceased to function as an ossuary trap many thousands of years ago. The fauna as a whole indicates a temperate/boreal, probably open, woodland, finding its closest modern parallel about 10 degrees farther north in the western Lake Superior region.

Exact dating is not possible, but the small percentage of extinct mammals suggests a Wisconsin age or later. Whether the fauna dated from a period before, coincident with, or following the Wisconsin glacial maximum c. 20,000 B.P., cannot be established at present.

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LITERATURE CITED

ARATA A. A. and HUTCHISON J. H. — The racoon (*Procyon*) in the Pleistocene of North America. *Tulane Studies in geology,* **2** (2) : 21-27.

BEER J. R., 1955. — Survival and movements of banded big brown bats. *Jour. Mamm.* **36** (2) : 242-248.

BEER J. R. and RICHARDS A. G., 1956. — Hibernation of the big brown bat. *Jour. Mamm.* **37** (1) : 31-41

BINFORD L. R., 1965. — Radiometric analysis of bone and soil material From Lloyd's Rock Hole, Bedford County, Pennsylvania. *Anthrop. Papers,* Museum Anthrop. Univ. Mich., **25** : 32-40.

BOLE B. P. Jr. and MOULTHROP P. N., 1942. — The Ohio Recent mammal collection in the Cleveland Museum of Natural History. *Scient. Publ. Cleveland Mus. Nat. Hist.,* **5** (6) : 83-181.

BOOTH E. S. 1965. — A bat die off in Mexico. *Jour. Mamm.,* **46** (2) : 333-334.

BROWN B., 1908. — The Conard Fissure, a Pleistocene bone deposit in northern Arkansas; with descriptions of two new genera and twenty new species of mammals. *Memoir. Amer. Mus. of Nat. Hist.,* **9** (4) : 155-204

CHRISTIAN J. J., 1953. — The natural history of a summer aggregation of *Eptesicus fuscus fuscus. Naval Medical Research inst.,* Memorandum Report 53-16 : 161-193.

CONAWAY C. H. and PFITZER D. W., 1952. — *Sorex palustris* and *Sorex dispar* from the Great Smoky Moutains National Park. *Jour. Mammal.,* **33** (1) : 106-108.

DAVIS W. H. and HITCHCOCK H. B., 1964. — Notes on sex ratio of hibernating bats. *Jour. Mammal.,* **45** (3) : 475-476.

ENGELS W. L., 1936. — Distribution of races of the brown bat (*Eptesicus*) in western North America. *Amer. Midland Naturalist.* **17** : 653-660.

GIDLEY J. W. and GAZIN C. L., 1938. — The Pleistocene Vertebrate Fauna From Cumberland Cave. Maryland. *U. S. Nat. Mus. Bull.,* **117** : 1-99.

GOIN O.B., 1943. — A study of individual variation in *Microtus pensylvanicus pennsylvanicus. Jour. Mammal.,* **24** (2) : 212-223.

GRIFFIN D. R., 1953. — Deluge underground. *Bull. Nat. Speleological Soc.,* **15** : 34-37.

GUILDAY J.E. 1962. — The Pleistocene local Fauna of the Natural Chimneys, Augusta County, Virginia. *Annals Carnegie Mus.,* **36** (9) : 87-122.

GUILDAY J. E. 1967. — Notes on the Pleistocene big brown bat (*Eptesicus grandis* (Brown)). *Annals Carnegie Mus.,* **39** (7) : 105-114.

GUILDAY J. E. MS (unpublished). — Vertebrate remains From Banshee Hole. Cumberland County, Tennessee. On file, Section of Vertebrate Fossils, Carnegie Museum, Pittsburgh, Pa.

GUILDAY J. E., HAMILTON H. and MCCRADY A. D., 1966. — The bone breccia of Bootleger Sink, York County, Pa. *Annals Carnegie Mus.,* **38** (8) : 145-163.

GUILDAY J. E., MARTIN P. S. and MCCRADY A. D., 1964. — New Paris No. 4 : A Pleistocene cave deposit in Bedford County, Pennsylvania. *Bull. Nat. Speleological Soc.* **26** (4) : 121-194.

GUILDAY J. E. and MCCRADY A. D., 1966. — Armadillo remains From Tennessee and West Virginia caves. *Bull. Nat. Speleological Soc.,* **28** (4) : 183-184.

HALL J. S. and BLEWETT C. H., 1964. — Bat remains in owl pellets from Missouri. *Jour. Mamm.,* **45** (2) : 303-304.

HAMILTON W. J. Jr., 1943. — The mammals of eastern United States. 432 p. Comstock Publishing Co., Ithaca. N. Y.

HANDLEY C. O. Jr. 1953. — A new flying squirrel from the Southern Appalachian Mountains. *Proc. Biol. Soc. Wash.,* **66** : 191-194.

HANDLEY C. O. Jr. 1956. — Bones of mammals from West Virginia Caves. *Amer. Midland Naturalist.,* **56** (1) : 250-256.

HAY O. P., 1920. — Description of some Pleistocene vertebrates found in the United States. *Proc. U.S. Nat. Mus.,* **58** (2328) : 83-146.

HAY O. P., 1923. — The Pleistocene of North America and its vertebrated animals from the states east of the Mississipi River and from the Canadian provinces east of longitude 95°. Carnegie Institution of Washington. 499 p.

HIBBARD C. W., 1963. — A late Illinoian fauna from Kansas and its climatic significance. *Papers of Mich. Acad. Sci. Arts and letters,* **48** : 187-221.

HOWELL A. H., 1918. — Revision of the American Flying Squirrels. *N. Amer. Fauna* No. 44 : 64 p. U.S. Dept. Agriculture, Washington, D.C.

JACKSON H. H. T., 1928. — A taxonomic review of the American long-tailed shrews. *N. Amer. Fauna* No. 51 : 238 p. U.S. Dept. Agriculture, Washington, D. C.

JEGLA T. C. and HALL J. S., 1962. — A Pleistocene deposit of the free-tailed bat in Mammoth Cave, Kentucky. *Jour. Mamm.,* **43** (4) : 477-481.

KELLOGG R., 1939. — Annoted list of Tennessee mammals. *Proc. U.S. Nat. Mus.,* **86** (3051) : 245-303.

KURTÉN B., 1963. — Fossil Bears from Texas. *The Pearce-Sellards series,* Texas Memorial Museum, **1** : p. 15.

LYNCH J. D., 1966. — Additional tree frogs (*Hylidae*) from the North American Pleistocene. *Annals Carnegie Mus.,* **38** (11) : 265-271.

MCCRADY A. D., 1962. — Preliminary report on vertebrate fossils of Robinson Cave, Tennessee. *The Netherworld News,* Pittsburgh Grotto, Nat. Speleological Soc., **10** (9) : 155-160.

MCCRADY A. D. and SCHMIDT V., 1963. — Second interim report — late Pleistocene fossils from Robinson Cave, Tennessee. *The Netherworld News,* Pittsburgh Grotto, Nat. Speleological Soc., **11** (2) : 19-27.

MILLER G. S., Jr. and ALLEN G. M., 1928. — The American bats of the genera *Myotis* and *Pisonyx. Bull. U.S. Nat. Mus.,* **144** : 1-218.

OESCH R. D., 1967. — A preliminary investigation of a Pleistocene vertebrate fauna from Crankshaft Pit, Jefferson County, Missouri. *Bull. Nat. Speleological Soc.,* **29** (4) : 163-185.

PARMALEE P. W., 1967. — A recent cave bone deposit in south western Illinois. *Bull. Nat. Speleological Soc.*, **29** (4) : 119-147.

PARMALEE P. W. and GUILDAY J.E., 1966. — A recent record of porcupine from Tennessee. *Jour. Tenn. Acad. Sc.* **41** (3) : 81-82.

PETERSON O. A., 1926. — The Fossils of the Frankstown Cave, Blair County, Pensylvania. *Annals Carnegie Mus.*, **16** (2) : 249-315.

RAUN G. G., 1960. — A mass die off of the Mexican Brown Bat, *Myotis velifer,* in Texas. *The Southwestern Naturalist.* **5** (2) : 104.

RAY C. E., 1965. — A new chipmunk, *Tamias aristus,* from the Pleistocene of Georgia. *Jour. Paleontology,* **39** (5) : 1016-1022.

RYSGAARD G. N., 1942. — A study of the cave bats of Minnesota with special reference to the large brown bat, *Eptesicus fuscus fuscus* (de Beauvois). *Amer. Midland Naturalist,* **28** : 245-267.

SCHWARTZ A., 1956. — A new subspecies of the longtail shrew (*Sorex dispar* BATCHELDER) from the southern Appalachian Mountains. *Jour. Elisha Mitchell Sci., Soc.,* **72** : 24-30.

SIMPSON G. G., 1949. — A Fossil deposit in the cave in St.-Louis. *Amer. Mus. Novitates,* **1408** : 46 p.

SLAUGHTER B. H., 1961. — The significance of *Dasypus bellus* (Simpson) in Pleistocene local faunas. *Texas Jour. Sci.,* **13** (3) : 311-315.

STEWART T. D. ,1952. — The fluorine content of associated human and extinct animal bones from the Conkling cavern, New Mexico. *Science,* **116** : 457.

TAYLOR J., 1964. — Noteworthy predation on the guano bat. *Jour. Mamm.,* **45** (2) : 300-310.

TUTTLE M. D., 1968. — First Tennessee record of *Mustela nivalis. Jour. Mamm.,* **49** (1) : 113.