BULLETIN
of CARNEGIE MUSEUM OF NATURAL HISTORY

THE BAKER BLUFF CAVE DEPOSIT, TENNESSEE, AND THE LATE PLEISTOCENE FAUNAL GRADIENT

JOHN E. GUILDAY
Associate Curator, Section of Vertebrate Fossils

HAROLD W. HAMILTON
Research Associate, Section of Vertebrate Fossils

ELAINE ANDERSON
730 Magnolia Street, Denver, Colorado 80220

PAUL W. PARMALEE
Department of Anthropology, University of Tennessee, Knoxville, 37916

with contributions by

CHARLES H. FAULKNER
Department of Anthropology, University of Tennessee, Knoxville 37916 (Archaeology)

FREDERICK C. HILL
Department of Biology, Bloomsburg State College, Bloomsburg, Pennsylvania 17815 (Fish)

GEORGE H. VAN DAM
The Museum, Michigan State University, East Lansing, Michigan 48823 (Amphibians and Reptiles)

NUMBER 11 PITTSBURGH, 1978

BULLETIN OF CARNEGIE MUSEUM OF NATURAL HISTORY
Number 11, pages 1–67, figures 1–16, tables 1–17

Issued 27 December 1978

Price: $5.00 a copy

CARNEGIE MUSEUM OF NATURAL HISTORY, 4400 FORBES AVENUE
PITTSBURGH, PENNSYLVANIA 15213

CONTENTS

Abstract 5
Introduction 5
The Site 5
Excavation 5
Procedure 8
Acknowledgments 8
Prehistoric Cultural Material 9
Faunal List 11
Biotic Discussions
Flora 18
Fish Remains 18
Amphibians and Reptiles 19
Birds 25
Mammals 25
Faunal Summary 50
Faunal Analysis—Stratigraphic Change 51
Dating and Correlations 53
The Ridge and Valley Province Faunal Gradient 55
Family Composition of Three Ridge and Valley Mammalian Paleofaunas 63
Literature Cited 65

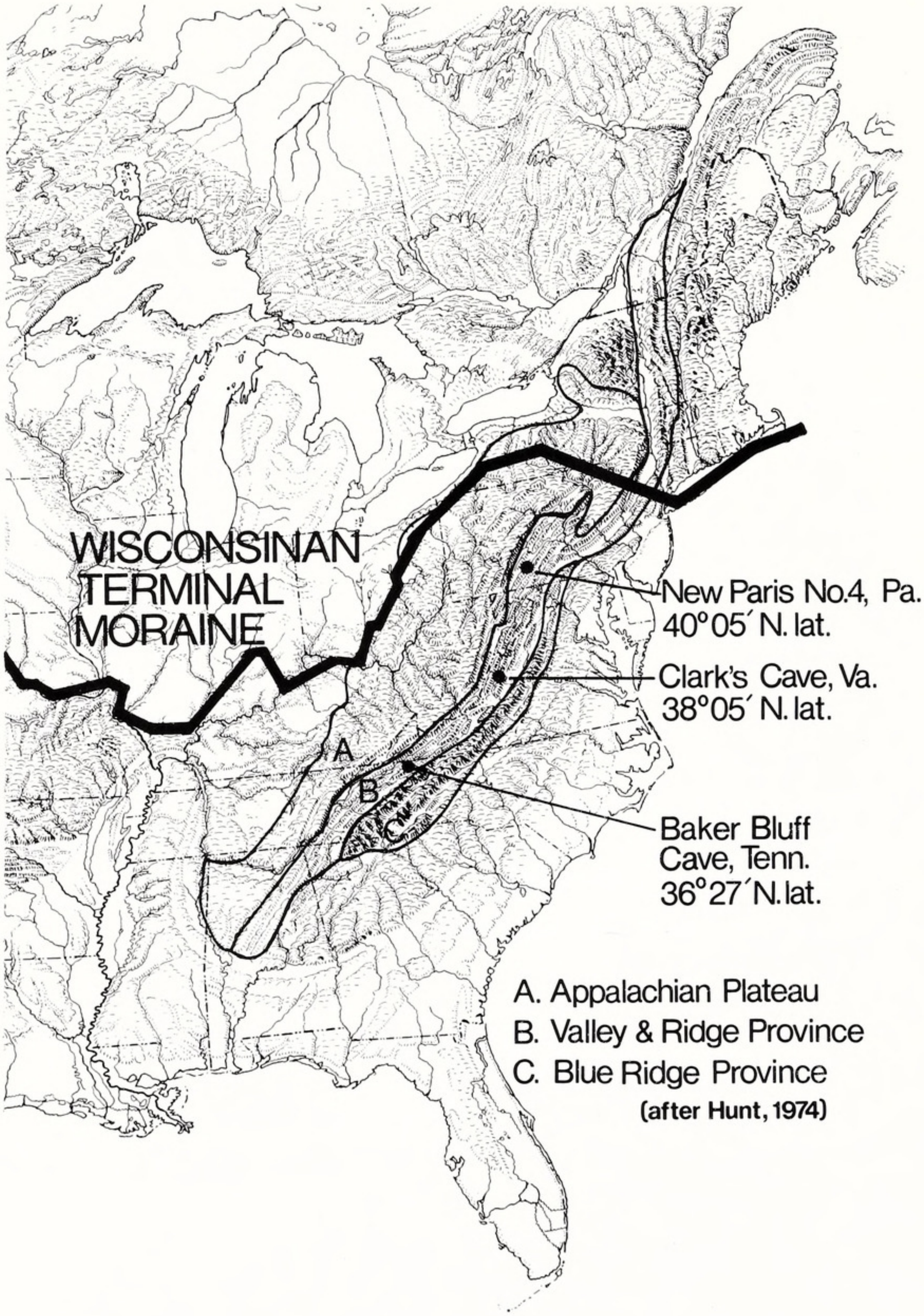

Fig. 1.—Location of three late Pleistocene cave paleofaunas, eastern USA (Base map Erwin Raisz, 1954).

ABSTRACT

Late Pleistocene remains of 180 taxa of vertebrates and invertebrates are reported from a 3 m (10 ft) column of fissure-fill, Baker Bluff Cave, Sullivan County, Tennessee, USA. Radiocarbon dates suggest deposition began about 19,100 years ago. Accompanying faunal sequence indicates a transition from cool-temperate in the lower levels to boreal open woodland in the upper levels. The Pleistocene/Holocene transition was not recorded. Evidence of human occupation from Early Archaic, 8,000 to 9,000 years BP, to the Historic period was present in the top 90 cm (3 ft) of the deposit. Pollen analysis was negative.

Six mammalian taxa are extinct—*Dasypus bellus, Castoroides ohioensis, Felis onca* cf. *augusta, Sangamona fugitiva, Platygonus compressus,* and *Tapirus* cf. *veroensis*; 16.6% of mammalian taxa are found only north or west of the site today; 15% have retreated to higher elevations. Evidence for the contemporaneity of two size classes of *Blarina brevicauda* is presented. One bird, cf. *Pica pica,* no longer occurs in the eastern U.S. The fauna is composed of eastern temperate, midwestern grassland, and boreal forest species, many now allopatric in distribution. No mammals of southerly distribution were present.

A 500 km north-south transect of the Ridge and Valley province comparing late Pleistocene and Recent mammal faunas indicates a steeper faunal gradient under current environmental conditions, but the late Pleistocene mammalian fauna was more boreal in character and richer in species, suggesting cooler but more equable conditions.

INTRODUCTION

The Site

Baker Bluff Cave, 13 km southeast of Kingsport, Sullivan County, is in northeastern Tennessee, 64 km west of the North Carolina border and 11 km south of the Virginia border (Fig. 1). It is perched high on a precipitous bluff overlooking the South Fork Holston River, a tributary of the Tennessee River, 5 km northwest, downstream from the junction of the South Fork Holston and Watauga Rivers, latitude 36°27′30″N, longitude 82°28′W, Boone Dam quadrangle U.S.G.S. 7½′ topographic map.

The cave is 90 m above the west bank of the river on the eastern face of Ayers Ridge, locally known as Baker Bluff, at an altitude of 450 m (Fig. 2). The cave is little more than a single large chamber approximately 10 m long and 3.6 m wide in vertically-bedded Cambrian dolomite. Prior to all excavations the cave floor was within 130 cm of the ceiling and the cave was little more than a crawlway (Figs. 3–4).

The regional landscape today is one of timbered ridges and rolling farmlands. The site lies near the southern end of the Ridge and Valley physiographic province (Atwood, 1940) and is in the Carolinian biotic province (Dice, 1943). At the time of European colonization an oak/chestnut (*Quercus/Castanea*) dominant, mixed mesophytic, closed-canopy woodland covered the land, interspersed with river meadows and sometimes extensive Indian clearings and fields in the major river valleys. Annual precipitation at Knoxville, 140 km SW of the site, is 119 cm (46.85 in); average temperature ranges from 4.6°C (40.3°F) in January to 25.5°C (77.9°F) in July; average last frost 30 March; average first frost 2 November, with a growing season of 217 days. Rainfall is prevalent throughout the year with a slight increase during spring and summer. Snow cover is light and rarely lingers (USDA Yearbook, 1941).

Excavation

The top 3 ft of cave deposit was excavated by private collectors S. D. Dean, Jr., Robert Wilson, and Larry Gardner in 1968, while searching for Indian artifacts. They guided Hamilton to the site 1 September 1969, and on the basis of a caribou *Rangifer tarandus* premolar from the original excavation it was decided to sample the site to a depth beyond that of their excavations. Excavation was recorded in feet and inches.

Dean, Wilson, and Gardner divided the cave floor into six 3 ft squares and excavated to a depth of 3 ft, in 6-inch levels. They saved Indian artifacts, large bone fragments, and the larger land snails. We were able to examine color slides of the archaeological material. Bones and snails were donated by Dean to Carnegie Museum of Natural History. Between 15–23 August 1970, Hamilton and party excavated an irregular shaft 4 ft by 3 ft by 7 ft deep. It began at the base of the Dean excavation 3 ft below the original floor of the cave and extended to the limits of fossiliferous matrix approximately 10 ft below the original cave floor.

A description of the surficial deposits is not now possible. A rim-fire .22 cartridge case, a scorched opossum vertebra indicating at least one fire, and Indian cultural material to a depth of 3 ft suggested considerable disturbance. This disturbed material was described to us as "dark organic to dark brownish-red at the 3-foot level." Below the level of the Dean excavation the matrix changed abruptly in character. Directly in the present entrance and slightly behind it, was a plug of dry, coarsely indurated, light yellow-tan "cave clay," possibly the back-slope of a former entrance cone built by slope-wash at a time when the entrance was more extended. No inclusions other than modern tree roots were noted. Directly behind this non-fossiliferous deposit and extending down 10 ft from the original cave floor was a dark red-brown to yellow partially indurated matrix rich in bone fragments, snails, and hackberry seeds. Frost-spalled dolomite fragments and an occasional broken speleothem occurred at all levels but increased slightly in number with depth. There were no obvious stratigraphic changes in color or texture. No evidence of water action or river

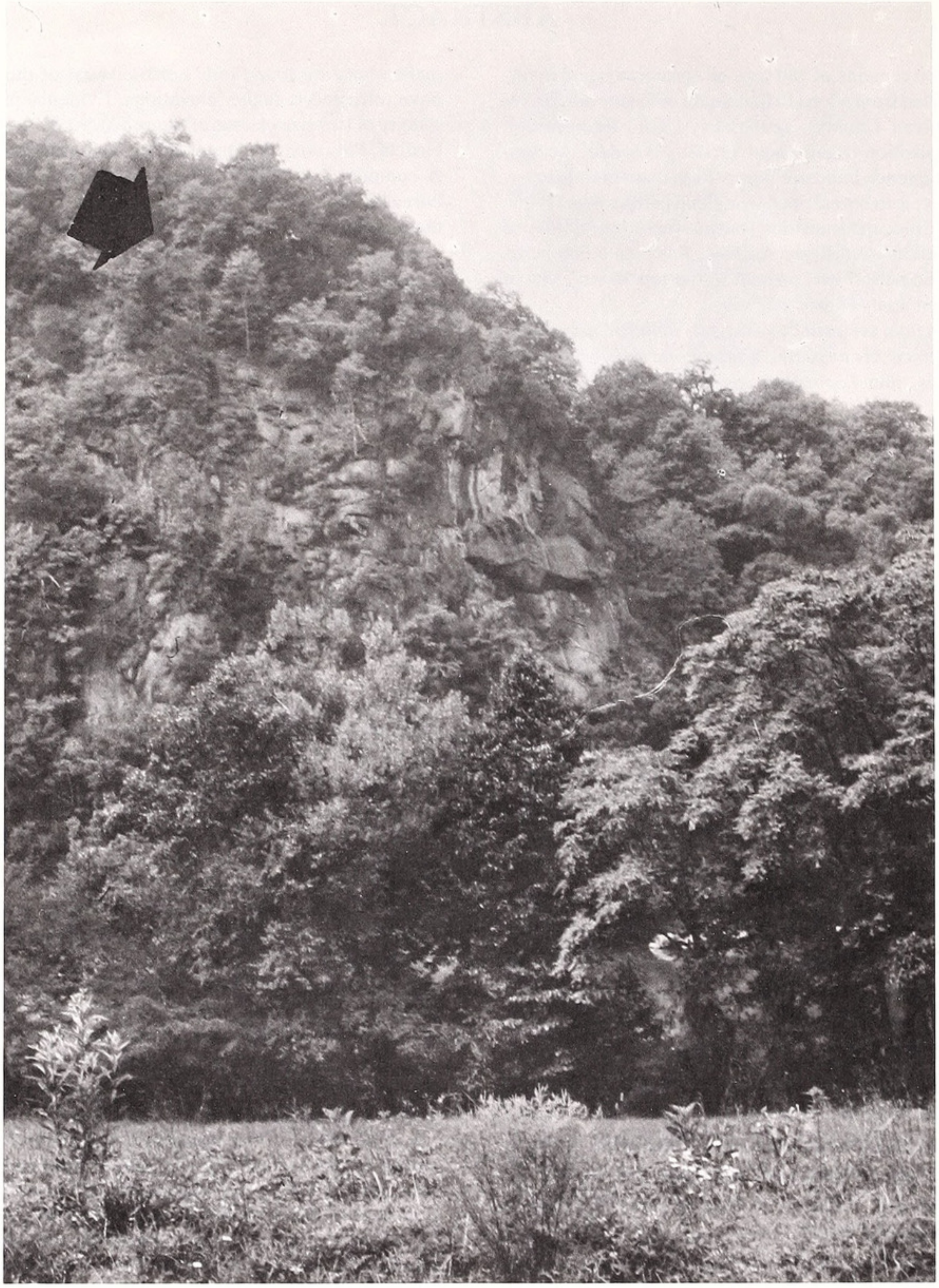

Fig. 2.—Baker Bluff (Ayers Ridge), 13 km SE Kingsport, Sullivan County, Tennessee. South Fork Holston River, flowing to the right, in middle foreground. Arrow points to concealed entrance of Baker Bluff Cave. Hamilton photograph.

pebbles was noted. As the excavation proceeded sterile cave fill encroached from the cave side of the deposit and at 10 ft the fossiliferous material pinched out. Little, if any, is believed to be left *in situ* at the site.

Preservation at all levels was chemically good but mechanically poor. Large mammals were represented by isolated teeth or heavily rodent-gnawed bone fragments. Thousands of complete or fragmentary small vertebrate bones were recovered, but no skeletons were found in articulation. Skulls of woodrats (*Neotoma*) were occasionally complete. Mammal identifications are based mostly upon isolated teeth or mandible fragments containing teeth. All bird remains were fragmentary. Snake vertebrae survived better than most bone because of their small size and compact structure. Gastropod remains were often complete at all levels and probably represented individuals that died *in situ*.

The site throughout its history was a nesting area for rodents,

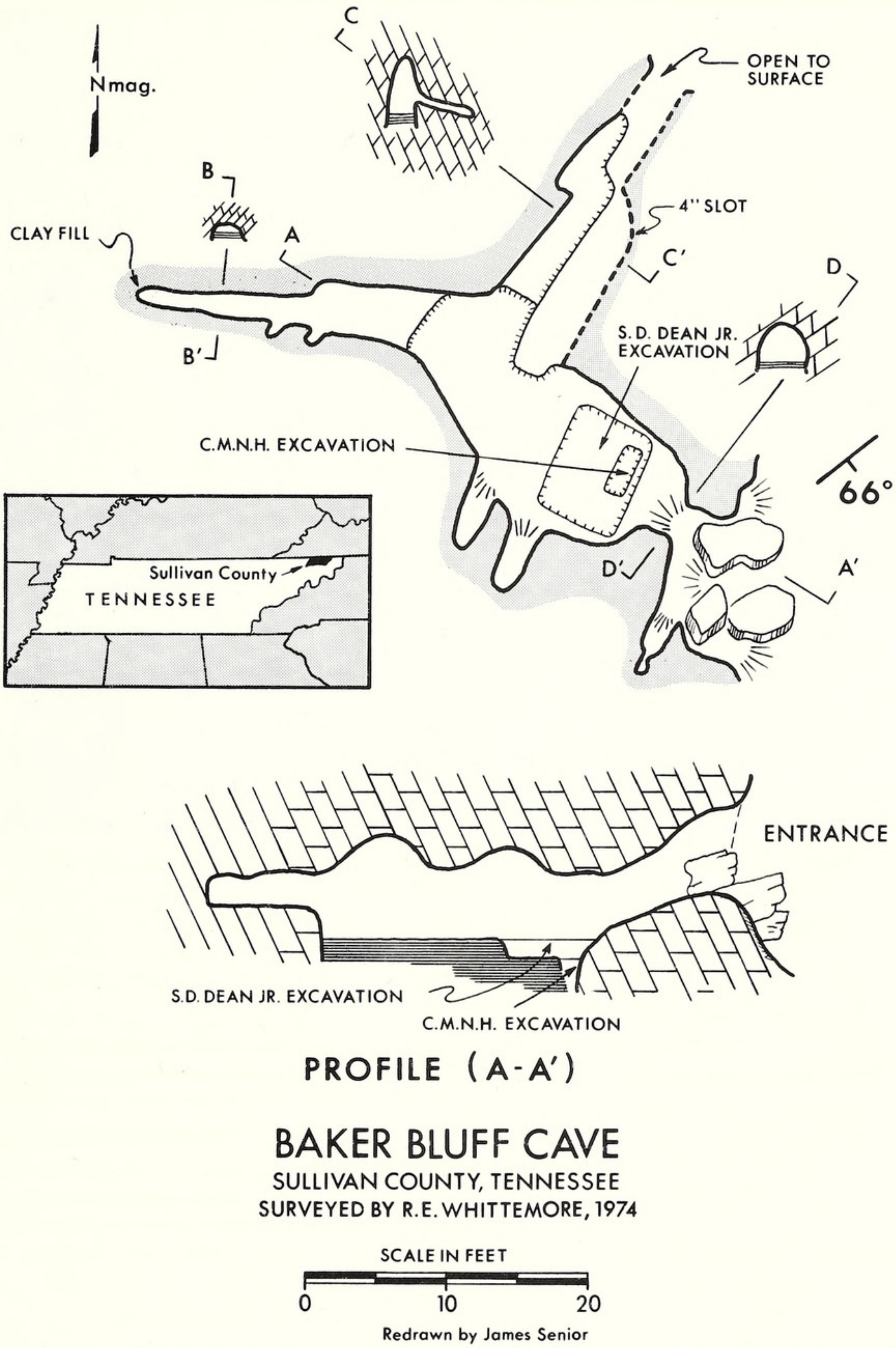

Fig. 3.—Survey plan of Baker Bluff Cave, Sullivan County, Tennessee, showing location of excavations.

primarily *Neotoma* and *Peromyscus*. Unlike rodent middens in the arid West (Wells, 1976; King and Van Devender, 1977) where plants remains are well preserved, most plant tissues and pollen had decayed in this humid eastern environment, leaving a lag deposit of bones, teeth, snails, and hackberry (*Celtis*) seeds. Woodrats were probably responsible for the large mammal remains—isolated teeth and heavily-gnawed bone fragments. Raptors, primarily owls, were responsible for the bulk of the small vertebrates in the deposit. All gastropods and some *Neotoma* probably died *in situ*, and the site may have served as a hibernaculum or shelter

Fig. 4.—Allen Hamilton sitting on original cave floor level, view facing NW taken from entrance of Baker Bluff Cave, Sullivan County, Tennessee. Note edge of CMNH excavation at his feet. Hamilton photograph.

for snakes. Bones of a variety of Recent mammals from the upper 3 ft of the deposit were, in part, introduced by Indians as aboriginal food items.

Procedure

Matrix from each 1 ft level was dry-screened through a ¼ in. (5 mm) grid, and water-screened at the New Paris, Pennsylvania, field laboratory through 1 mm window screening to recover the finer fraction. It is felt that recovery of all fossil materials greater than 1 mm in diameter was total. Specimens are catalogued by stratigraphic levels in the Section of Vertebrate Fossils, Carnegie Museum of Natural History. Minimum number of individuals (MNI) was estimated for each level by counting the commonest replicable element for a given species, usually, but not always, teeth. Summing MNI by stratigraphic levels often results in a larger site total than if specimens from all levels were pooled before calculating MNI. This is true of large mammals represented by widely scattered identifiable elements, deer teeth, for instance, but not necessarily true of small vertebrates and invertebrates, which are either not as highly fragmented or whose MNI is based upon one specific element, such as the M_1, in the case of the small rodents.

Measurements less than 1 cm were taken with a Spencer Cycloptic stereoscopic microscope using an ocular grid at 10×. Larger measurements were taken with a dial micrometer calibrated to 0.1 mm.

Abbreviations in this paper are: BP—before present; CM and CMNH—Carnegie Museum of Natural History; MNI—minimum number of individuals. Dental abbreviations are: I—incisor; C—canine; P—premolar; M—molar; d preceding tooth—deciduous. Tooth position indicated by super- and subscripts. Sites repeatedly referred to throughout the text are: Natural Chimneys, Virginia (Guilday, 1962); New Paris No. 4, Pennsylvania (Guilday et al., 1964); Robinson Cave, Tennessee (Guilday et al., 1969); Welsh Cave, Kentucky (Guilday et al., 1971); and Clark's Cave, Virginia (Guilday et al., 1977).

ACKNOWLEDGMENTS

We thank S. D. Dean, Jr., Robert Wilson, and Larry Gardner for calling attention to the site and allowing us to examine their excavation notes and collections. For field assistance during CMNH excavations we gratefully acknowledge the help of Lee

Ambrose; Alan, Janet, Mary, and Melinda Bailey; Rita and Allen Hamilton; Paul, Helen and Mimi Imblum; Robert and Ann New, and Jay Smith. Site survey and mapping (Fig. 3) was done by Robert E. Whittemore. We thank Allen D. McCrady, codirector of the New Paris Field Laboratory, and the many volunteers through the years who assisted in the processing of the Baker Bluff Cave matrix.

For professional assistance we thank: Charles H. Faulkner, University of Tennessee, Knoxville, archaeology; Robert Thompson and Paul S. Martin, University of Arizona, pollen; Frederick H. Utech, CMNH, botany; Juan Parodiz, CMNH, and Leslie Hubricht, Meridian, Mississippi, molluscs; George H. Van Dam and J. Alan Holman, Michigan State University, amphibians and reptiles; Frederick C. Hill, Bloomsburg State College, Pennsylvania, fish; Mary R. Dawson, the late J. K. Doutt, Caroline A. Heppenstall, Hugh H. Genoways, Duane A. Schlitter, CMNH, and Jerry W. Nagel, East Tennessee State University, mammals. We thank Arthur E. Bogan, University of Tennessee, Knoxville, Helen McGinnis and Ronald C. Wilson, CMNH, for curatorial and technical assistance. Graphs and line drawings are by Erica Hansen, Idaho State Museum (Figs. 5, 8, and 10), and Nancy J. Perkins, James R. Senior, and Kemon N. Lardas, CMNH. Finally, there are the two people most responsible for putting this paper together, Alice M. Guilday and Elizabeth A. Hill.

Research was completed with funds from NSF Grant DEB 76-07329 awarded to the senior author.

For reading over preliminary drafts of this paper and for their helpful comments and assistance we thank: J. Alan Holman, Michigan State University; Mary R. Dawson, Hugh H. Genoways, and Allen D. McCrady, Carnegie Museum of Natural History.

PREHISTORIC CULTURAL MATERIAL

CHARLES H. FAULKNER

Eleven chipped stone artifacts were found in the top 3 ft of the cave fill by Dean, Wilson, and Gardner. Whether this represents the total lithic assemblage is not known, because no chipping debris from tool manufacturing was included in this collection. It is likely that some debitage was present but was not saved by the excavators. The excavators reported no features, pottery or charcoal in the upper fill, which would imply that the cave was occupied for extremely short periods of time. Food bone fragments are discussed elsewhere. One partially charred caudal vertebra of an opossum from the 0–6 in. level suggests at least one fire.

Unfortunately, the chipped stone artifacts were not available for the writer to examine, and their description in this report is based on the examination of color prints and slides of fair quality. The excavators reported that the artifacts were originally typed by James Cambron. The writer concurs with some of Cambron's identifications but disagrees with others. Based on the various limitations of this study, any conclusions should be considered tentative.

The excavated area was laid out in a 3 ft grid. At least six "squares" were excavated, presumably all to the 3 ft level. The earth was removed in arbitrary 0.5 ft cuts and the provenience of the artifacts was given by square number and level.

Two artifacts came from the deepest level (2.5 ft–3.0 ft). These are a side-notched bifurcated base projectile point (Fig. 5c) and a small stemmed biface with an asymmetrical blade (Fig. 5g), the latter being tentatively identified as a knife. Both artifacts are made from a dark gray or black chert. All of the artifacts except one appear to be made from this material. Although it is impossible to positively identify this chert in the photographs, it is probably the so-called "black flint" which occurs as small nodules in the shaley limestones of the eastern Tennessee Valley. This material ranges in color from black to opaque gray (Kellberg, 1963).

The projectile point was identified by Cambron as a *LeCroy* type (Kneberg, 1956). While the bifurcated base of the specimen would certainly seem to place it into the cluster of Early Archaic bifurcated base projectile points that have been reported in the Appalachian uplands from Tennessee to West Virginia, the artifact does not really conform to the classic *LeCroy* type and if anything, might be more like the *St. Albans Side Notched* (Broyles, 1966). However, given the method of analysis, no specific type name should be assigned to this artifact. It can only be identified as an Early Archaic projectile point, probably dating between 6,000–7,000 B.C. in the Eastern Tennessee Valley. The depth of occurrence would seem to substantiate this early placement.

The 2.0 ft–2.5 ft level produced four artifacts from three squares. These include two artifacts identified as projectile points. One of these projectile points (Fig. 5d) had been classified as a *Brewerton Side Notched* (Ritchie, 1961). While this artifact could fall within the range of this Northeastern type, the Brewerton series of projectile points have never been identified in the upper Tennessee Valley. The artifact also appears to resemble the bifurcated base type recovered in the lowest level. While the depth of recovery could indicate it is another Early Archaic artifact, the most prudent conclusion is that it is sim-

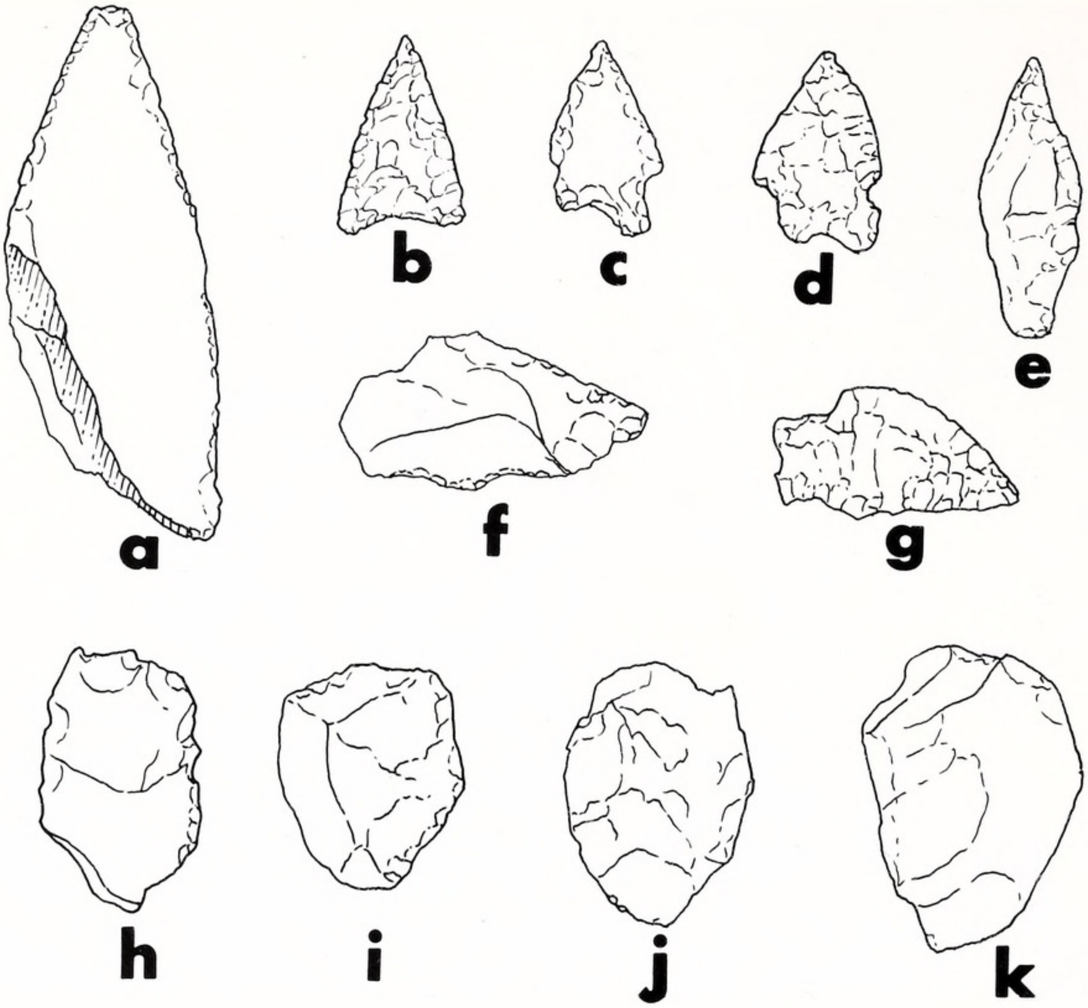

Fig. 5.—Flaked stone artifacts from 0–3 ft level of Baker Bluff Cave, Sullivan County, Tennessee, S. D. Dean, Jr., and R. Wilson private collection. a) Quartzite projectile point "Savannah River type"; b) "Madison" projectile point; c) "LeRoy" projectile point; d) "Brewerton" projectile point; e) "Mt. Fork" projectile point (typology provided by Dean, see Faulkner discussion this paper); f) side-scraper; g) Archaic stemmed curved knife; h) uniface scraper; i–k) oval scrapers. Drawing by E. Hansen from photographs supplied by Dean.

ply an Archaic type. The other projectile point from this level (Fig. 5e) was identified as a *Mountain Fork* which is considered to date from the Middle to Late Woodland periods in Alabama (Cambron and Hulse, 1964). While this spike-shaped artifact may generally conform to the *Mountain Fork* type, the present writer would not place it into any named type and would assign it to an Archaic horizon in the cave. The apparently retouched blade could also indicate this was a specialized tool type such as a perforator.

Two additional implements were recovered in this level. These were previously identified as an "oval" scraper (Fig. 5j) and a uniface scraper (Fig. 5h). The writer will have to assume the latter was actually examined since the lack of retouch on the ventral surface of the flake is not apparent in the photograph. Because the writer did not examine these tools it is impossible to assign a definite function to them although their crude shape suggests they were probably used for generalized scraping or cutting tasks.

No projectile points were found in the 1.5 ft–2.0 ft level. Artifacts from this level have been identified as a side scraper and two oval scrapers. The former (Fig. 5f) appears to be simply a utilized flake, whereas the latter two crude implements (Fig. 5i and Fig. 5k) seem to exhibit bifacial flaking and retouched edges.

Only two additional artifacts were recovered in the top 1.5 ft of the cave floor. Both occurred above the 1 ft level. A stemless triangular projectile point which Cambron identified as a *Madison* type (Scully, 1951) was found in the 0.5 ft–1.0 ft level (Fig. 5b). Although the shape generally conforms to this type, the thickness and incurvate base is more reminiscent of such Early-Middle Woodland types in the upper Tennessee Valley as the *Greenville* and *Nolichucky*

(Kneberg, 1957). In any case, this is certainly a Woodland artifact. The other worked piece is the distal end of a large biface made of quartzite (Fig. 5a). Although it is possible this is a large broken Late Archaic projectile point or knife such as the *Appalachian Stemmed* (Kneberg, 1957) or *Savannah River Stemmed* (Coe, 1964), the fragmentary nature of this artifact precludes such a precise identification. It was found in the 0.0 ft–0.5 ft level of the cave floor.

The 11 artifacts described above indicate Baker Bluff Cave was periodically occupied by several different prehistoric Indian groups. The presence of projectile points, scraping and cutting tools, and food bone fragments indicate they probably used it as a short-term hunting and butchering station. Because the artifacts were not examined by the writer, a precise typology is impossible. It is also probable that they do not represent all of the human derived material deposited there. If this is a representative collection, however, and the tentative typology from the photographs is reasonably accurate, Baker Bluff Cave was first occupied by prehistoric Indians during the Early Archaic period, between 6,000–7,000 B.C. The cave continued to be utilized intermittently through the Late Archaic and Early Woodland periods. There is no evidence that it was occupied by Indians during the late prehistoric or historic periods. Perhaps the change in subsistence and settlement systems during these periods, or more likely the filling of the cave to within 4 ft of the ceiling, finally caused the Indians to abandon it as a temporary camping site.

Table 1.—*Faunal list Baker Bluff Cave, Sullivan County, Tennessee. Superscript*^{1} = *extinct;* ^{2} = *no longer present at site;* ? = *no observation;* * = *present but not tallied; MNI* = *minimum number of individuals.*

Taxon	Depth in feet from surface								MNI
	0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	
Mollusca									
Class Gastropoda (snails)									
(identified by L. Hubricht)									
Helicinidae									
Helicina orbiculata (Say)	?	—	—	—	1	—	—	—	1
Hedersonia occulta (Say)	?	2	1	1	5	4	4	5	22
Cionellidae									
Cionella lubrica (Muller)	?	—	4	4	5	2	6	9	30
Valloniidae									
Vallonia parvula (Sterki)	?	1	—	—	—	—	—	1	2
Pupillidae									
Gastrocopta armifera (Say)	?	1	3	4	3	—	1	2	14
Gastrocopta contracta (Say)	?	—	—	—	—	—	—	1	1
Gastrocopta corticaria (Say)	?	—	2	—	—	—	1	—	3
Strobilopsidae									
Strobilops labyrinthica (Say)	?	2	—	—	7	—	8	6	23
Succineidae									
Succinea ovalis (Say)	?	—	—	—	—	2	2	—	4
Catinella sp.	?	1	—	1	—	—	—	—	2
Endodontidae									
Anguispira alternata (Say)	?	—	—	—	2	—	1	—	3
Anguispira strongylodes (Pfeiffer)	143	37	45	40	25	7	7	11	315
Discus patulus (Lesh.)	?	2	5	8	6	2	5	3	31
Discus bryanti (Harper)	?	—	1	—	8	4	11	3	27
Discus catskillensis (Pilsbry)	?	4	9	13	—	—	—	3	29
Helicodiscus multidens (Hubricht)	?	3	3	13	7	—	5	4	35
Helicodiscus parallelus (Say)	?	3	—	5	—	—	—	1	9
Helicodiscus singleyanus (Pilsbry)	?	13	4	3	13	—	4	8	45
Helicodiscus inermis (H. B. Baker)	?	200	75	75	150	50	200	50	800

Table 1.—*Continued.*

Taxon	Depth in feet from surface 0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	MNI
Zonitidae									
Glyphyalinia wheatleyi (Bland)	?	—	—	5	2	—	1	1	9
Glyphyalinia lewisiana (Clapp)	?	16	19	50	9	2	8	15	119
Glyphyalinia caroliniensis (Ckll.)	?	2	2	3	2	—	—	—	9
Glyphyalinia solida (H. B. Baker)	?	—	—	—	—	—	2	3	5
Mesomphix capnodes (W.G.B.)	6	3	—	1	9	2	1	—	22
Paravitrea multidentata (Binney)	?	—	—	—	—	—	—	2	2
Paravitrea tridens Pilsbry	?	3	10	3	1	—	—	1	18
Paravitrea blarina (Hubricht)	?	1	—	2	—	—	1	—	4
Hawaiia minuscula (Binney)	?	16	14	35	16	—	14	25	120
Euconulus fulvus (Muller)	?	—	—	1	—	—	—	1	2
Gastrodonta interna fonticula (Wurtz)	?	—	—	—	1	—	3	2	6
Ventridens pilsbryi (Hubricht)	?	—	—	—	3	4	6	5	18
Ventridens coelaxis (Pilsbry)	?	—	—	2	2	—	3	2	9
Ventridens demissus (Binney)	?	—	1	—	1	—	—	—	2
Zonitoides arboreus (Say)	?	5	13	7	2	1	2	5	35
Haplotrematidae									
Haplotrema concavum (Say)	?	1	—	2	—	—	1	—	4
Polygyridae									
Polygyra plicata (Say)	?	1	—	12	11	—	1	3	28
Stenotrema spinosum (Lea)	?	—	—	1	2	—	—	1	4
Stenotrema stenotrema (Pfeiffer)	?	—	3	6	1	—	1	2	13
Stenotrema, undescribed species	?	1	—	1	1	1	4	3	11
Stenotrema fraternum fasciatum (Pilsbry)[2]	?	—	—	—	1	—	2	—	3
Mesodon clausus clausus (Say)	?	1	—	1	1	—	—	—	3
Mesodon elevatus (Say)	?	1	—	1	1	—	—	—	3
Mesodon appressus (Say)	422	26	41	33	35	2	9	9	577
Mesodon inflectus (Say)	20	1	—	3	1	3	—	1	29
Mesodon rugeli (Shutt.) small	?	1	—	9	6	1	—	3	20
Mesodon rugeli large	?	—	1	—	2	—	—	—	3
Triodopsis tridentata (Say)	3	—	—	4	17	2	3	1	30
Triodopsis tridentata tenneseensis (Walker)	3	—	—	—	—	—	—	—	3
Triodopsis vulgata (Pilsbry)	?	1	1	1	—	1	—	—	4
Triodopsis denotata (Fer.)	1	—	—	1	1	—	—	—	3
Triodopsis albolabris (Say)	48	3	1	4	2	2	—	3	63
Allogona profunda (Say)	?	3	—	2	2	—	—	1	8
Amnicolidae									
Pomatiopsis lapidaria (Say)	?	—	1	—	—	1	7	1	10
Pomatiopsis cincinnatiensis (Lea)	?	—	—	—	1	—	—	—	1
Pleroceridae									
Io fluviatilus	1	—	—	—	—	—	—	—	1
Class Bivalvia (freshwater mussels)									
Unionidae, sp.	3	—	—	—	—	—	—	—	3
Vertebrata Class Pisces (identified by F. Hill) Order Semionotiformes									
Lepisosteidae									
Lepisosteus sp.—gar	?	—	—	*	—	—	—	—	*
Order Salmoniformes									
Esocidae									
Esox sp.—pike or pickerel	?	*	—	*	—	—	—	—	*

Table 1.—*Continued.*

Taxon	Depth in feet from surface 0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	MNI
					Order Cypriniformes				
Cyprinidae—Cyprinids, unidentified minnows	*	*	*	*	*	*	—	*	*
Catostomidae									
Catostomus commersoni—white sucker	?	—	—	*	*	—	—	—	*
Hypentelium nigricans—northern hog sucker	?	—	—	*	—	—	—	—	*
Moxostoma carinatum—river redhorse	?	—	—	—	*	—	—	—	*
Moxostoma cf. *duquesnei*—black redhorse	?	—	—	*	—	—	—	—	*
Moxostoma erythrurum—golden redhorse	?	*	*	*	—	—	—	—	*
Moxostoma sp.—redhorse, unidentified	?	*	*	*	*	*	*	*	*
					Order Siluriformes				
Ictaluridae									
Ictalurus punctatus—channel catfish	?	—	—	*	*	—	—	—	*
Ictalurus sp.—catfish, unidentified	?	—	*	—	—	—	—	—	*
Noturus sp.—madtom or stonecat	?	—	*	—	—	—	—	*	*
					Order Perciformes				
Centrarchidae									
Ambloplites rupestris—rock bass	?	*	*	—	—	—	*	—	*
Micropterus dolomieui—smallmouth bass	?	—	—	*	—	—	—	—	*
Micropterus sp.—bass, unidentified	?	—	*	—	—	—	—	—	*
Percidae									
Stizostedion canadense—sauger	?	*	—	—	—	—	—	—	*
Stizostedion sp.	?	*	*	*	*	—	*	—	*
Sciaenidae									
Aplodinotus grunniens—freshwater drum	?	*	*	*	*	*	*	*	*
					Class Amphibia (identified by G. Van Dam) Order Anura				
Bufonidae									
Bufo americanus—American toad	?	12	24	10	7	2	2	3	60
Bufo w. fowleri—Fowler's toad	?	3	3	1	—	—	—	—	7
Bufo sp.—toad	?	4	15	4	1	1	2	—	27
Hylidae									
Hyla sp.—tree frog	?	1	—	—	—	—	—	—	1
Ranidae									
Rana sylvatica—wood frog	?	5	6	8	3	—	—	2	24
Rana catesbeiana—bullfrog	?	—	1	—	—	—	—	—	1
Rana sp.	?	3	2	2	1	—	1	—	9
					Order Urodela				
Ambystomatidae									
Ambystoma opacum—marbled salamander	?	—	1	1	1	—	1	—	4
Ambystoma maculatum—spotted salamander	?	—	1	1	1	—	—	—	3
Ambystoma sp.	?	1	1	1	1	1	1	1	7
Proteidae									
Necturus maculosus—mudpuppy	?	1	1	1	1	1	1	—	6
Cryptobranchidae									
Cryptobranchus alleganiensis—hellbender	?	1	1	1	1	1	—	1	6
Plethodontidae									
Desmognathus sp.—dusky salamander	?	1	1	1	1	1	1	—	6

Table 1.—*Continued.*

Taxon	Depth in feet from surface								MNI
	0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	
Class Reptilia (identified by G. Van Dam) Order Testudines									
Emydidae									
Graptemys geographica—map turtle	?	—	1	—	—	—	—	—	1
Order Squamata									
Scincidae									
Eumeces fasciatus—five-lined skink	?	1	1	—	1	—	—	—	3
Viperidae									
Crotalus horridus—timber rattlesnake	1	1	1	1	1	1	1	1	8
Colubridae									
Heterodon platyrhinos—eastern hognose snake	?	—	—	1	1	—	1	—	3
Diadophis punctatus—ringneck snake	?	1	1	1	—	—	—	—	3
Carphophus amoenus—worm snake	?	1	1	—	—	—	—	—	2
Coluber or *Masticophis* sp.—racer or coachwhip	?	—	1	1	1	1	1	—	5
Lampropeltis triangulum—eastern milksnake	?	1	1	1	1	1	1	—	6
Lampropeltis getulus—kingsnake	?	1	1	1	—	—	1	—	4
Elaphe sp.—rat snake	?	—	—	—	1	—	—	—	1
Natrix sipedon—water snake	?	1	1	1	—	—	—	—	3
Natrix sp.	?	—	—	—	1	—	—	—	1
Thamnophis sirtalus—garter snake	?	1	1	1	1	—	—	—	4
Thamnophis sauritus—ribbon snake	?	1	1	—	—	—	1	—	3
Thamnophis sp.	?	1	1	1	1	—	1	1	6
Class Aves (identified by P. Parmalee) Order Podicipediformes									
Podicipedidae sp.—grebes	?	—	1	—	—	—	—	—	1
Order Anseriformes									
Anatidae									
cf. *Anas crecca*—green-winged teal	?	1	—	—	—	—	—	—	1
Anas sp.—duck	?	1	1	1	—	—	—	—	3
Mergus sp.—merganser	?	—	1	—	—	—	—	—	1
Lophodytes cucullatus—hooded merganser	?	1	1	1	—	—	—	1	4
Order Falconiformes									
Accipitridae									
Accipiter gentilus—goshawk	?	—	—	—	—	1	—	—	1
Accipitridae sp.—hawk	?	—	2	1	—	—	—	—	3
Falconidae									
Falco sparverius—kestrel	?	1	1	1	—	—	—	—	3
Order Galliformes									
Tetraonidae									
cf. *Bonasa umbellus*—ruffed grouse	4	3	2	2	—	—	—	—	11
Tetraonidae sp.—grouse	?	1	6	—	1	—	1	1	9
Meleagrididae									
Meleagris gallopavo—turkey	1	—	—	1	—	—	—	—	2
Phasianidae									
Gallus gallus—chicken	1	—	—	—	—	—	—	—	1

Table 1.—*Continued.*

Taxon	Depth in feet from surface								MNI
	0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	
Order Charadriiformes									
Charadriidae									
cf. *Arenaria interpres*—ruddy turnstone	?	—	—	—	1	—	—	—	1
Scolopacidae									
Philohela minor—woodcock	?	2	1	—	—	—	—	—	3
Capella gallinago—common snipe	?	1	—	—	—	—	—	—	1
cf. *Actitis macularia*—spotted sandpiper	?	—	1	—	—	—	—	—	1
Scolopacidae spp.	?	—	6	6	1	—	—	—	13
Laridae									
Larus sp.—gull	?	1	—	—	—	—	—	—	1
Order Columbiformes									
Columbidae									
Ectopistes migratorius—passenger pigeon	8	10	23	11	5	1	1	1	60
Order Strigiformes									
Strigidae									
Bubo virginianus—great horned owl	?	—	1	—	—	—	—	—	1
Otus asio—screech owl	*	—	—	—	—	—	—	—	1
Order Caprimulgiformes									
Caprimulgidae									
cf. *Chordeiles minor*—common nighthawk	?	1	—	—	—	—	—	—	1
Order Apodiformes									
Apodidae									
Chaetura pelagica—chimney swift	?	—	—	—	—	—	—	1	1
Order Coraciiformes									
Alcedinidae									
Megaceryle alcyon—kingfisher	?	1	1	2	—	—	—	—	4
Order Piciformes									
Picidae									
Colaptes auratus—common flicker	?	1	1	1	2	—	—	—	5
Picidae sp.	?	2	1	—	—	1	—	—	4
Order Passeriformes									
Tyrannidae									
Empidonax sp.—flycatcher	?	1	—	—	—	—	—	—	1
Hirundinidae									
Petrochelidon pyrrhonota—cliff swallow	?	—	—	—	—	1	—	—	1
Corvidae									
Cyanocitta cristata—blue jay	?	1	—	—	1	—	—	—	2
cf. *Pica pica*—black-billed magpie	?	—	—	—	1	—	—	—	1
Turdidae									
cf. *Turdus migratorius*—robin	?	—	1	—	—	—	—	—	1
Parulidae sp.—warblers	?	—	—	—	1	—	—	—	1
Icteridae									
cf. *Agelaius phoeniceus*—red-winged blackbird	?	1	—	—	—	—	—	—	1
Fringillidae sp.—sparrow	?	—	1	—	—	—	—	—	1
Passeriformes sp.	?	6	4	4	3	—	1	3	21

Table 1.—*Continued.*

Taxon	Depth in feet from surface 0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	MNI
Class Mammalia (identified by J. Guilday and E. Anderson)									
Order Marsupialia									
Didelphidae									
Didelphis virginiana—Virginia opossum	1	—	—	—	—	—	—	—	1
Order Insectivora									
Soricidae									
Blarina brevicauda—short-tailed shrew	?	15	20	40	31	6	24	13	149
Cryptotis parva—least shrew	?	1	2	—	—	—	—	—	3
Microsorex hoyi[2]—pygmy shrew	?	2	5	2	—	—	—	—	9
Sorex arcticus[2]—arctic shrew	?	1	1	1	—	—	—	—	3
Sorex cinereus—masked shrew	?	9	19	16	5	—	2	2	53
Sorex dispar[2]—rock shrew	?	4	3	2	—	—	—	—	9
Sorex fumeus—smoky shrew	?	2	6	6	6	1	—	1	22
Sorex fumeus or *arcticus*	?	—	4	5	3	—	—	—	12
Sorex cinereus or *dispar*	?	—	11	5	2	—	—	—	18
Talpidae									
Condylura cristata—star-nosed mole	?	1	2	—	—	—	—	—	3
Scalopus aquaticus—eastern mole	1	1	1	3	1	2	2	1	12
Parascalops breweri—hairy-tailed mole	1	2	2	4	3	1	3	1	17
Order Chiroptera									
Vespertilionidae									
Myotis sp.—little brown bats	?	3	4	6	3	—	1	1	18
Pipistrellus subflavus—eastern pipistrelle	?	—	2	1	1	—	1	2	7
Eptesicus fuscus—big brown bat	?	2	3	9	2	1	1	1	19
Nycticeius humeralis—evening bat	?	—	—	—	—	—	1	—	1
Plecotus sp.—big-eared bats	?	—	—	1	—	—	—	—	1
Order Edentata									
Dasypodidae									
Dasypus bellus[1]—"beautiful" armadillo	?	*	*	*	*	—	*	—	1
Order Lagomorpha									
Leporidae									
Sylviagus or *Lepus*—rabbits or hares	*	11	20	22	17	7	10	8	95
Order Rodentia									
Sciuridae									
Tamias striatus—eastern chipmunk	?	3	2	9	4	1	5	3	27
Eutamias minimus[2]—least chipmunk	?	1	2	—	—	—	—	—	3
Marmota monax—woodchuck	1	3	6	5	2	1	3	2	23
Spermophilus tridecemlineatus[2]—thirteen-lined ground squirrel	1	4	10	8	2	1	1	1	28
Sciurus carolinensis—gray squirrel	1	—	2	4	3	1	3	3	17
Tamiasciurus hudsonicus—red squirrel	1	3	6	3	2	1	1	1	18
Glaucomys volans—southern flying squirrel	1	—	1	1	—	—	2	2	7
Glaucomys sabrinus[2]—northern flying squirrel	?	3	5	3	1	1	—	—	13
Castoridae									
Castor canadensis—beaver	—	—	1	—	1	—	1	—	3
Castoroides ohioensis[1]—giant beaver	1	—	—	—	—	—	—	—	1
Cricetidae									
Peromyscus maniculatus or *P. leucopus*—white-footed mice	?	8	26	24	18	2	8	8	94
Neotoma floridana—eastern woodrat	*	23	62	52	46	13	31	33	260

Table 1.—*Continued.*

Taxon	Depth in feet from surface 0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	MNI
Arvicolidae									
Clethrionomys gapperi[2]—southern red-backed vole	?	32	70	43	7	—	1	6	159
Phenacomys intermedius[2]—heather vole	?	12	31	15	5	—	—	1	64
Microtus chrotorrhinus[2]—rock vole	?	7	18	7	4	—	1	—	37
Microtus pennsylvanicus—meadow vole	?	18	35	22	3	1	1	4	84
M. chrotorrhinus or *pennsylvanicus* (total figure includes identified *M. chrotorrhinus* and *M. pennsylvanicus*)	?	58	62	42	10	2	4	8	186
Microtus xanthognathus[2]—yellow-cheeked vole	?	1	1	1	1	—	—	—	4
Microtus pinetorum and/or *M. ochrogaster*—woodland vole and/or prairie vole	?	28	81	93	37	5	17	21	282
Ondatra zibethicus—muskrat	*	2	1	—	1	—	—	—	4
Synaptomys cooperi—southern bog lemming	?	27	71	43	15	3	17	15	191
Synaptomys borealis[2]—northern bog lemming	?	2	3	3	3	—	1	—	12
Zapodidae									
Zapus hudsonius—meadow jumping mouse	?	—	1	1	—	—	—	—	2
Napaeozapus insignis[2]—woodland jumping mouse	?	1	1	1	1	—	—	—	4
Erethizontidae									
Erethizon dorsatum[2]—porcupine	?	1	1	1	—	—	—	—	3
Order Carnivora									
Canidae									
Vulpes vulpes—red fox	?	—	—	1	1	—	—	1	3
Urocyon cinereoargenteus—gray fox	*	—	—	—	—	—	—	—	1
Ursidae									
Ursus americanus—black bear	*	1	1	—	—	—	—	1	4
Procyonidae									
Procyon lotor—raccoon	*	—	—	1	1	—	1	1	5
Mustelidae									
Martes americana[2]—marten	?	2	1	—	—	—	—	1	4
Martes pennanti[2]—fisher	?	(1)		—	—	—	—	—	1
Mustela nivalis—least weasel	?	1	2	1	—	—	—	—	4
Mustela frenata—long-tailed weasel	?	—	1	2	—	—	2	1	6
Taxidea taxus[2]—badger	—	—	—	depth unknown		—	—	—	1
Spilogale putorius—eastern spotted skunk	?	1	—	—	1	—	1	1	4
Mephitis mephitis—striped skunk	*	—	—	—	—	—	—	—	1
Felidae									
Felis onca—jaguar	?	—	—	—	—	—	—	1	1
Order Artiodactyla									
Tayassuidae									
Platygonus compressus[1]—flat-headed peccary	?	—	—	—	1	—	—	1	2
Cervidae									
Cervus elaphus[2]—elk	*	—	—	1	—	—	—	—	2
Odocoileus virginianus—white-tailed deer	*	*	*	*	*	*	*	*	10
cf. *Sangamona fugitiva*[1]—"fugitive" deer	*	—	1	—	—	—	—	—	1
Rangifer tarandus[2]—caribou	*	—	1	—	1	—	—	—	2
Order Perissodactyla									
Tapiridae									
Tapirus cf. *veroensis*[1]—tapir	?	—	1	—	—	—	—	—	1

FLORA

Botanical specimens were not saved from the upper 0–3 ft levels of the deposit, but two fragmentary hickory nuts (*Carya* sp.) were present in the Dean/Wilson collection from the top few inches of the cave floor and are undoubtedly Recent.

A total of 1,071 hackberry seeds (*Celtis* sp.) were identified from the deposit. Many more were originally present but so pulverized that they could not be counted. Thirty-two percent were puncture-gnawed by small rodents, probably *Peromyscus*. Seed counts by stratigraphic level, beginning at the 3–4 ft level, were 31, 73, 320, 359, 73, 94, and 121 at the 9–10 ft level. A stratigraphic increase in abundance is suggested by the relative numbers of hackberry seeds compared to small rodents (Arvicolidae). Applying the formula, *Celtis* seeds ÷ by Arvicolidae MNI × 100, a change in frequency with depth is noted: 3–4 ft level = .19; 4–5 ft level = .23; 5–6 ft level = 1.33; 6–7 ft level = 4.60; 7–10 ft level = 2.82. Hackberry seeds increased in relative abundance in the lower levels of the deposit. There are two possible explanations for this. The greater relative abundance of hackberry in the lower levels may be due to the climatic shift indicated by the small mammals of the deposit, a shift from relatively temperate in the lower levels, favoring *Celtis*, to more boreal conditions in the upper levels. Or the reason may simply be due to a change in the activity level of the raptors responsible for the small mammals in the deposit. It is possible that rodent midden activity, and its accompanying seed caching predominated in the lower levels of the deposit while rodent activity decreased and raptor activity increased in the upper levels of the deposit, which may have been either a secondary effect of climatic change or due simply to the configuration of the deposit.

Pollen analysis was attempted, with negative results, on seven samples from various stratigraphic levels, by Robert Thompson, Laboratory of Paleoenvironmental Studies, Department of Geosciences, University of Arizona, Tucson; four samples utilizing zinc bromide density separation, three samples using hydrofluoric acid. The lack of fossil pollen in this indurated, yellow-brown, basic (pH—7.6–7.7) cave sediment was not unexpected and is unfortunately consistent with results of other Appalachian cave or talus deposits, such as the Meadowcroft Rockshelter, Pennsylvania, and Trout Cave, West Virginia. Apparently, unless pollen is deposited in a subaqueous or other oxygen deficient environment it is soon destroyed in the humid East. Pollen was well-preserved in the late Pleistocene fissure fill of New Paris No. 4, Pennsylvania, due to a rapid rate of deposition in a water-saturated colloidal clay matrix, which served as an impervious shield effectively sealing all accumulating organic inclusions from the atmosphere.

FISH REMAINS

FREDERICK C. HILL

Seventeen taxa of fishes represented by 147 identifiable bones and at least 13 species were identified from the Baker Bluff Cave faunal sequence (Tables 1 and 2). Numerous pharyngeal arches of Cyprinidae have not been studied. Fish are catalogued under CM 30228.

The species recovered from the seven levels at Baker Bluff could be found coexisting in a moderate gradient, medium order river. Only *Catostomus commersoni* is characteristically found in intermittent streams, but it also occurs in larger streams or rivers. Most of these species, including *Aplodinotus grunniens, Moxostoma erythrurum, M. carinatum, Micropterus dolomieui, Ambloplites rupestris, Esox* sp., and *Lepisosteus* sp. are typically found in pools. The presence of riffles between pools is evidenced by young *Ictalurus punctatus,* none of which exceed 16 cm total length (Table 3), and *Micropterus dolomieui*. Nearly all species prefer water with a moderate to swift current although some, such as *Lepisosteus* sp., *Aplodinotus grunniens, Moxostoma erythrurum,* and possibly the *Noturus* sp. are better adapted to slower currents. Six of the species, including *Hypentelium nigricans, Catostomus commersoni, Moxostoma* cf. *duquesnei, M. carinatum, Ambloplites rupestris,* and *Micropterus dolomieui* are best adapted to clear streams, whereas *Moxostoma erythrurum, Aplodinotus grunniens, Ictalurus punctatus,* and *Stizostedion canadense* tolerate varying degrees of turbidity. Thus, one

Table 2.—*Total number of fish bones identified from levels 3–4 ft through 9–10 ft, Baker Bluff Cave, Tennessee. ? = no observation; * = present, not tallied.*

Taxon	Stratigraphic levels							
	0–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10
Hypentelium nigricans (Lesueur)	?	—	—	2	—	—	—	—
Catostomus commersoni (Lacepede)	?	—	—	1	1	—	—	—
Moxostoma cf. *duquesnei* (Lesueur)	?	—	—	1	—	—	—	—
Moxostoma erythrurum (Rafinesque)	?	1	2	1	—	—	—	—
Moxostoma carinatum (Cope)	?	—	—	—	1	—	—	—
Catostomidae sp.	*	—	—	—	—	—	—	—
Aplodinotus grunniens Rafinesque	?	3	5	9	10	8	30	16
Ictalurus punctatus (Rafinesque)	?	—	—	5	1	—	—	—
Noturus sp. Rafinesque	?	1	—	—	—	—	—	3
Stizostedion canadense (Smith)	?	1	—	—	—	—	—	—
Ambloplites rupestris (Rafinesque)	?	2	2	—	—	—	1	—
Micropterus dolomieui Lacepede	?	—	—	1	—	—	—	—
Lepisosteus sp. Lacepede	?	—	—	3	—	—	—	—
Moxostoma sp. Rafinesque	*	9	6	3	1	—	1	—
Stizostedion sp. Rafinesque	?	1	6	1	2	—	1	—
Ictalurus sp. Rafinesque	*	—	1	—	—	—	—	—
Micropterus sp. Lacepede	?	—	1	—	—	—	—	—
Cyprinidae sp.	?	17	46	25	6	2	—	4
Esox sp. Linnaeus	?	1	—	1	—	—	—	—
Total		36	69	53	22	10	33	23

would expect to find these species coexisting in various habitats within a small section of a stream near Baker Bluff.

The estimated sizes (Table 3) of the various fishes suggests that, for the most part, small predators were responsible for their presence in the cave. *Stizostedion canadense* was the largest fish recorded, 50 cm T.L. A single *Ictalurus punctatus* was the smallest fish, only 4 cm T.L. *Moxostoma* identifications were based upon either dentaries or pharyngeal arch teeth. All of the elements from small *Moxostoma* were assigned only to the generic level because of the difficulty encountered in making species identifications. No fish of unusual size were recorded.

The small sample size precludes the recognition of any subtle changes in this ichthyofauna. The greatest number of individuals and taxa appear in the upper 6 ft of the deposit.

AMPHIBIANS AND REPTILES

GEORGE HENRY VAN DAM

The Baker Bluff Cave faunal sequence includes at least five species of urodeles, five species of anurans, one species of turtle, one species of lizard, and 11 species of snakes.

Class Amphibia—Amphibians
Order Urodela—Salamanders
Family Ambystomatidae—mole salamanders

Vertebral centrum amphicoelous, weakly constricted ventrally, without spine produced from its posteroventral surface; neural spine obsolete and single throughout (Holman, 1962).

Ambystoma opacum (Gravenhorst)—marbled salamander

Material.—CM 29754–29757. 2 precaudal vertebrae (4–5 ft); 1 precaudal vertebra (5–6 ft); 5 precaudal vertebrae (6–7 ft); 1 pre-caudal vertebra (8–9 ft).

Remarks.—The Ambystomatidae can be divided into major groups using vertebral ratios—(1) the length of the centrum divided by its width at the anterior end, and (2) the combined zygapophyseal width divided by the zygapophyseal length (Tihen, 1958). Tihen noted that in the *A. maculatum* group and in the subgenus *Linguaelapsus* (at least in the

Table 3.—*Estimated live total length (in cm) of Baker Bluff fish.*

	Total length in centimeters																							
Taxon	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
Ictalurus punctatus	2	2	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ictalurus sp.	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Moxostoma sp.	—	—	—	2	1	—	1	1	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
Ambloplites rupestris	—	—	—	1	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Noturus sp.	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Catostomus commersoni	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Stizostedion sp.	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
Micropterus dolomieui	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Micropterus sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
Hypentelium nigricans	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
Moxostoma erythrurum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	2	—	—	—
Stizostedion canadense	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1

posterior part of the trunk) the postzygapophyses extends as far, usually farther posteriorly, than does the neural arch.

In my examination of the material, I used the length of the centrum divided by its width at the anterior end for species determination.

Ambystoma maculatum (Shaw)—spotted salamander

Material.—CM 29758–29760. 6 precaudal vertebrae (4–5 ft); 3 precaudal vertebrae (5–6 ft); 4 precaudal vertebrae (6–7 ft).

Remarks.—Material was assigned to *A. maculatum* based on criteria discussed under *A. opacum*.

Ambystoma sp. indet.

Material.—CM 29761–29767. 3 precaudal vertebrae (3–4 ft); 15 precaudal vertebrae (4–5 ft); 7 precaudal vertebrae (5–6 ft); 7 precaudal vertebrae (6–7 ft); 3 precaudal vertebrae (7–8 ft); 7 precaudal vertebrae (8–9 ft); 1 precaudal vertebra (9–10 ft).

Remarks.—Material which was too fragmentary for measurement or those whose ratios fell within the ranges of both *A. maculatum* and *A. opacum* were assigned to genus only.

Some specimens referred to *Ambystoma* species exhibited the back-swept neural arch characteristic of *A. tigrinum* as pointed out by Holman (1969), but these could not be assigned to species because anterior thoracic vertebrae of *A. maculatum* and *A. opacum* have this characteristic. Conant (1975) states that *Ambystoma opacum* occurs in a variety of habitats, ranging from moist, sandy areas to dry hillsides. *A. maculatum* is occasionally found (from spring to autumn) beneath stones or boards.

Family Proteidae—Mudpuppies

Specimens were assigned to the Proteidae by comparison with Recent specimens and using criteria of Holman (1968) who noted that their vertebrae are amphicoelous and the transverse processes are undivided.

Necturus maculosus (Rafinesque)—mudpuppy

Material.—CM 29768–29773. 15 precaudal vertebrae (3–4 ft); 22 precaudal and 2 caudal vertebrae (4–5 ft); 5 precaudal vertebrae (5–6 ft); 3 precaudal vertebrae (6–7 ft); 5 precaudal vertebrae (7–8 ft); 3 precaudal vertebrae (8–9 ft).

Remarks.—The fossils were indistinguishable from Recent *N. maculosus. Necturus maculosus* habitats include lakes, ponds, rivers, streams, and other permanent bodies of water (Conant, 1975).

Family Cryptobranchidae—Hellbenders

Cryptobranchus alleganiensis (Daudin)—hellbender

Material.—CM 29774–29779. 30 precaudal, 3 caudal vertebrae, and 1 right dentary (3–4 ft); 73 precaudal vertebrae and 2 vomers (4–5 ft); 33 precaudal vertebrae (5–6 ft); 9 precaudal vertebrae (6–7 ft); 1 precaudal vertebra (7–8 ft); 4 precaudal vertebrae (9–10 ft).

Remarks.—Meszoely (1967) gave characteristics for the identification of *Cryptobranchus*—deeply amphicoelous cotyles, circular in outline; centrum relatively short in respect to the diameter of the cotyle; ventral surface of the centrum rounded without keel or processes; large lateral fossa anteriad to the base of the transverse process; very large size. In addition, Holman (1968) notes that the transverse processes are undivided.

Due to the fragmentary nature of much of the material I found it sometimes difficult to separate vertebrae of *Cryptobranchus alleganiensis* and *Necturus maculosus*. I have found the following criteria useful in differentiating these two: in *C. alleganiensis* the sides of the centrum are more sculptured than in *N. maculosus*; in *C. alleganiensis* the upper transverse process is heavy and cylindrical in shape (*N. maculosus* has a very wing-like upper transverse process); *C. alleganiensis* has the articular facets of the transverse processes exhibiting a single opening, whereas in *N. maculosus* there are usually two distinct openings. *C. alleganiensis* is always found in rivers and larger streams where water is running and ample shelter is available in the form of large rocks, snags, or debris (Conant, 1975).

Family Plethodontidae—Plethodontid Salamanders

Desmognathus sp. indet.—dusky salamanders

Material.—CM 29780–29785. 22 vertebrae (3–4 ft); 158 vertebrae (4–5 ft); 95 vertebrae (5–6 ft); 81 vertebrae (6–7 ft); 19 vertebrae (7–8 ft); 21 vertebrae (8–9 ft).

Remarks.—These specimens have been assigned to *Desmognathus* based on descriptions by Soler (1950) who states that their vertebrae are opisthocoelous and have pointed processes arising from the dorsal surfaces of the postzygapophyses. I am unable to carry the identification any further due to lack of Recent comparative material.

Desmognathus fuscus, D. quadramaculatus, D. monticola, and *D. wrighti* are all present in northeastern Tennessee today and it is not unlikely that all four are present in the collection. *Desmognathus fuscus* occurs in brooks, near springs, and in seepage areas along edges of small woodland streams where stones, chunks of wood, and miscellaneous debris provide ample shelter both for the salamanders and for their food. *D. quadramaculatus* is abundant in boulder-strewn brooks and also found near waterfalls or other places where cold water drips or flows. *D. monticola* prefers a habitat of cool, well-shaded ravines and banks of mountain brooks. *D. wrighti* is today a resident chiefly of high spruce-fir forests and lives under moss and bark on rotting logs or beneath rotting wood or litter on the forest floor near seepage areas (Conant, 1975).

Order Anura—Frogs and Toads

Family Bufonidae—Bufonid Toads

Fossil *Bufo* may be identified by the following characteristics (Holman, 1962): ilium with dorsal blade absent; dorsal prominence produced dorsally, well developed, grooved or irregular in shape; sacral vertebrae procoelus, with one anterior and two posterior condyles; sacrum free from urostyle, its diapophyses moderately expanded.

Bufo americanus Holbrook—American toad

Material.—CM 29786–29792. 12 right, 7 left ilia (3–4 ft); 17 right, 24 left ilia (4–5 ft); 10 right, 10 left ilia (5–6 ft); 3 right, 7 left ilia (6–7 ft); 2 right ilia (7–8 ft); 2 right ilia (8–9 ft); 3 left ilia (9–10 ft).

Remarks.—The ilium of *Bufo woodhousei fowleri* has the base of the dorsal protuberance narrower than in equal-sized *B. americanus* (Holman, 1967). Habitats include shallow bodies of water in which to breed (temporary pools or ditches or shallow portions of streams, for example), possess shelter in the form of hiding places where there is some moisture, and harbor an abundant food supply of insects and other invertebrates (Conant, 1975).

Bufo woodhousei fowleri Girard—Fowler's toad

Material.—CM 29793–29795. 3 right ilia (3–4 ft); 2 right, 3 left ilia (4–5 ft); 1 left ilium (5–6 ft).

Remarks.—Assignment of material to *Bufo w. fowleri* was based on criteria given in the discussion of *B. americanus*. *Bufo w. fowleri* occurs chiefly in sandy areas, along shores of lakes or in river valleys (Conant, 1975).

Bufo sp. indet.

Material.—CM 29796–29801. 2 left ilia, 4 sacral vertebrae (3–4 ft); 3 right, 2 left ilia, 15 sacral vertebrae, 10 frontoparietals (4–5 ft); 4 sacral vertebrae, 6 frontoparietals (5–6 ft); 2 frontoparietals (6–7 ft); 1 sacral vertebra, 1 frontoparietal (7–8 ft); 2 sacral vertebrae, 2 frontoparietals (8–9 ft).

Remarks.—Ilia were assigned to *Bufo* sp. when the anterior or posterior portions of the prominence were missing, thus making it impossible to examine the prominence-protuberance relationship, or when the boundaries of the dorsal protuberance were not clearly defined within the prominence. Tihen (1962) pointed out that the frontoparietal is the most reliable single element for identification of the greatest number of New World *Bufo*. I could not find any distinct differences between the frontoparietals of *B. americanus* and *B. w. fowleri*.

Family Hylidae—Hylid Frogs

Hyla sp. indet.—tree frog

Material.—CM 29802. 1 left ilium (3–4 ft).

Remarks.—Specimen is assigned to the genus *Hyla* based on characters given by Holman (1962)—ilium with dorsal blade absent; dorsal prominence produced dorsolaterally, well developed, usually round and smooth.

The bone is too fragmentary for specific identification, but in comparison with Recent material, it most closely resembles *Hyla chrysoscelis* and *H. versicolor* in the shape of the dorsal prominence.

Family Ranidae—Ranid Frogs

Ilium with dorsal blade well developed and arising anterior to dorsal prominence, without lateral deflection, and with a deep notch between it and dorsal acetabular expansion (Holman, 1962).

Rana sylvatica LeConte—wood frog

Material.—CM 29803–29807. 5 right, 4 left ilia (3–4 ft); 6 right, 6 left ilia (4–5 ft); 8 right, 3 left ilia (5–6 ft); 1 right, 3 left ilia (6–7 ft); 2 left ilia (9–10 ft).

Remarks.—Assignment to *Rana sylvatica* is based on Holman (1967) who noted that *Rana palustris, R. pipiens,* and *R. sylvatica* may be distinguished from *R. catesbeiana* and *R. clamitans* in that the posterodorsal border of the ilial shaft slopes more gently into the dorsal acetabular expansion in the former group than in the latter. The prominence for the origin of the vastus externus head of the triceps femoris muscles is larger, less produced, and less roughened in *R. pipiens* and *R. palustris* than it is in *R. sylvatica*. Based on these criteria, the specimens are assigned to *R. sylvatica*.

In examination of nine Recent specimens of *R. sylvatica* and two of *R. palustris*, the above characteristics hold in separating the two species. *Rana sylvatica* is usually encountered in or near moist wooded areas, but it often wanders considerable distances from water (Conant, 1975).

Rana catesbeiana Shaw—bullfrog

Material.—CM 29808. 1 left ilium (4–5 ft).

Remarks.—This specimen is assigned to *Rana catesbeiana* on the basis of characters discussed above and the observation of Tihen (1954) that *R. catesbeiana* ilia appear to be highly sculptured. *R. catesbeiana* is an aquatic frog that prefers larger bodies of water than most other frogs. It is a resident of lakes, ponds, bogs, and sluggish portions of streams (Conant, 1975).

Rana sp. indet.

Material.—CM 29809–29813. 3 sacral vertebrae (3–4 ft); 2 sacral vertebrae (4–5 ft); 2 sacral vertebrae (5–6 ft); 1 sacral vertebrae (6–7 ft); 1 sacral vertebra (8–9 ft).

Remarks.—These vertebrae have the diplasiocoelous condition with cylindrical rather than expanded diapophyses (Holman, 1962) and more closely resemble those of *R. sylvatica* in the shape of the neural canal and in their small size.

Class Reptilia—Reptiles
Order Testudines—Turtles
Family Emydidae—Pond Turtles
Graptemys geographica (Le Sueur)—map turtle

Material.—CM 29814. 1 proneural bone (4–5 ft).

Remarks.—Material is assigned to *G. geographica* based on the shape, location of shield impressions, and surface sculpturing compared to Recent material. *Graptemys geographica* occurs in large bodies of water, prefering rivers to creeks, and lakes rather than ponds (Conant, 1975).

Order Squamata—Snakes and Lizards
Suborder Sauria—Lizards
Family Scincidae—Skinks
Eumeces fasciatus (Linnaeus)—
five-lined skink

Material.—CM 29815–29817. 1 precaudal vertebra (3–4 ft); 3 precaudal vertebrae (4–5 ft); 1 precaudal vertebra (6–7 ft).

Remarks.—*E. fasciatus* has a more backswept neural spine than *E. laticeps*. *Eumeces fasciatus* lives in rock piles and decaying debris in or near woods. The habitat is usually damp (Conant, 1975).

Suborder Serpentes—Snakes
Family Viperidae—Vipers
Crotalus horridus Linnaeus—timber rattlesnake

Material.—CM 29818–29824. 27 vertebrae (3–4 ft); 50 vertebrae (4–5 ft); 27 vertebrae (5–6 ft); 9 vertebrae (6–7 ft); 4 vertebrae (7–8 ft); 2 vertebrae (8–9 ft); 2 vertebrae (9–10 ft).

Remarks.—Holman (1963) provides characters, which can be used to differentiate *Crotalus* from *Agkistrodon*. In *Agkistrodon* a distinct pit usually occurs on either side of the cotyle of the centrum. Each of these pits contains one moderately large fossa. In *Crotalus* the distinct pits are usually absent and the one or more fossae that occur on either side of the cotyle of the centrum are minute. In addition, *Crotalus horridus* has a lower neural spine than either *C. adamanteus* or *Agkistrodon piscivorus* (Holman, 1967). The material most closely resembles *Crotalus horridus* in these characters. *Crotalus horridus* lives in timbered terrain; usually it is common in second-growth timber where rodents abound (Conant, 1975).

Family Colubridae—Colubrid Snakes
Subfamily Xenodontinae

Members of this subfamily lack hypapophyses on their lumbar vertebrae and have depressed vertebral neural arches and wide vertebral hemal keels (Holman, 1973*b*).

Heterodon platyrhinos Latreille—eastern hognose snake

Material.—CM 29825–29827. 1 precaudal vertebra (5–6 ft); 1 precaudal vertebra (6–7 ft); 1 precaudal vertebra (8–9 ft).

Remarks.—The genus *Heterodon* Latreille may be diagnosed by the following strong characters: hypapophyses absent; vertebrae wider than long through zygapophyses; neural arch flat; neural spine longer than high, usually thickened dorsally with its anterior and posterior borders concave; prezygapophyseal processes large, pointed or truncated; epizygapophyseal spines absent; hemal keel very broad and indistinct on many thoracic vertebrae (Holman, 1962).

In addition, Holman (1963) was able to differentiate between *H. platyrhinos* and *H. nasicus* in that in the former, the anterior zygapophyseal faces are more elongate, and in dorsal view, their anterior margins are much flatter than in the latter species. This material compares closest to the characteristics of *H. platyrhinos*. The eastern hognose snake is usually found in sandy areas (Conant, 1975).

Subfamily Colubrinae

Colubrinae never bear lumbar hypapophyses as do species in the subfamily Natricine, and they lack the combination of the depressed neural arch and the very wide hemal keel of the Xenodontinae (Holman, 1973*b*).

Diadophis punctatus (Linnaeus)—ringneck snake

Material.—CM 29828–29830. 26 precaudal vertebrae (3–4 ft); 19 precaudal vertebrae (4–5 ft); 6 precaudal vertebrae (5–6 ft).

Remarks.—Holman (1967) provides the following characters by which to distinguish the vertebrae of *Diadophis punctatus* from *Carphophis amoenus*: the neural spine is higher, thicker, and usually with more of a posterior overhang in the former than in the latter species. The Baker Bluff Cave fossils more closely resemble those of *D. punctatus*.

Diadophis punctatus is a woodland snake, usually most common in cutover areas that include an abundance of hiding places such as under stones, logs, bark slabs, or in rotting wood. Rocky, wooded hillsides are also favored (Conant, 1975).

Carphophis amoenus (Say)—worm snake

Material.—CM 29831–29832. 16 precaudal vertebrae (3–4 ft); 7 precaudal vertebrae (4–5 ft).

Remarks.—Fossils are assigned to *C. amoenus* based on criteria discussed under *Diadophis punctatus*. *Carphophis amoenus* is partial to moist earth and disappears deep underground in dry weather (Conant, 1975).

Coluber or **Masticophis** Linnaeus—racer or coachwhip

Material.—CM 29833–29837. 1 precaudal vertebra (4–5 ft); 3 precaudal vertebrae (5–6 ft); 7 precaudal vertebrae (6–7 ft); 1 precaudal vertebra (7–8 ft); 3 precaudal vertebrae (8–9 ft).

Remarks.—Holman (1962) characterizes the lumbar vertebrae for the genus *Coluber* as follows: hypapophyses absent; vertebrae longer than wide through zygapophyses; neural arch vaulted; neural spine about as high as long, thin, and delicate, not beveled anteriorly; epizygapophyseal spines usually well developed; hemal keel narrow throughout.

The vertebrae of *Coluber, Masticophis,* and *Opheodrys* are elongate and the neural spine is thin and delicate. But vertebrae of the former two genera are larger, the neural spine is higher, and a well-developed epizygapophyseal spine is almost always present. The fossils resemble the characters of the former two genera in this respect. Based on the present geographic ranges of *Masticophis* and *Coluber* it would appear that the fossils represent *Coluber,* but I am unable to separate the two genera on vertebral remains.

Lampropeltis Fitzinger

Remarks.—The vertebrae of *Pituophis, Elaphe,* and *Lampropeltis* are very similar but have been separated on the basis of characters described by Holman (1965). *Pituophis* is distinct from the other two genera in having a higher neural spine with an indented edge. The genera *Elaphe* and *Lampropeltis* can be separated by the more depressed neural arch of the latter.

Lampropeltis triangulum (Lacepede)—eastern milksnake

Material.—CM 29838–29843. 8 precaudal vertebrae (3–4 ft); 33 precaudal vertebrae (4–5 ft); 11 precaudal vertebrae (5–6 ft); 5 precaudal vertebrae (6–7 ft); 1 precaudal vertebra (7–8 ft); 3 precaudal vertebrae (8–9 ft).

Remarks.—Fossils are assigned to *L. triangulum* because the vertebrae possess lower neural spines than those of *L. getulus*. Also, *L. getulus* vertebrae are quite robust with thick neural spines and neural arches; the hemal keels and subcentral ridges are usually quite strong with the valleys between them quite deep (Holman, 1965).

Lampropeltis getulus (Linnaeus)—kingsnake

Material.—CM 29844–29848. 1 precaudal vertebra (3–4 ft); 2 precaudal vertebrae (4–5 ft); 6 precaudal vertebrae (5–6 ft); 2 precaudal vertebrae (8–9 ft); 2 precaudal vertebrae (9–10 ft).

Remarks.—The fossils have been assigned to *L. getulus* based on criteria discussed under *L. triangulum. L. getulus* occurs regionally but has not been recorded in the immediate area. It is possible that Recent *L. getulus* may be collected in the area in the future.

Elaphe sp. indet.—rat snake

Material.—CM 29849. 3 precaudal vertebrae (6–7 ft).

Remarks.—These specimens are assigned to the genus *Elaphe* sp. indet. because they have a more vaulted neural arch than *Lampropeltis* but a less vaulted arch than *Pituophis* (Holman, 1973*a*). In addition, *Pituophis* exhibits strongly developed epizygapophyseal spines, which are lacking in the fossils (Auffenberg, 1963). The material is too fragmentary to assign to species.

Subfamily Natricine

Material is assigned to the subfamily Natricine on characters given by Holman (1973*b*)—hypapophyses on their lumbar vertebrae—and by Auffenberg (1965)—epizygapophyseal spines are usually present.

Natrix sipedon (Linnaeus)—water snake

Material.—CM 29850–29852. 2 precaudal vertebrae (3–4 ft); 1 precaudal vertebra (4–5 ft); 3 precaudal vertebrae (5–6 ft).

Remarks.—In general, *Thamnophis* vertebrae are elongate when viewed from above, whereas *Natrix* vertebrae are almost square (Brattstrom, 1967). *Natrix* vertebrae tend to have higher neural spines (Holman, 1962).

Natrix septemvittata and *N. sipedon* occur in the area today. *N. septemvittata* possesses a long, low neural spine and *N. sipedon* possesses a much higher one (Auffenberg, 1963). The fossils resemble the latter species in this respect.

Natrix sp. indet.

Material.—CM 29853. 1 precaudal vertebra (5–6 ft).

Remarks.—The fossil is too fragmentary for specific identification but the genus was determined using criteria discussed under *Natrix sipedon*.

Thamnophis sauritus (Linnaeus)—ribbon snake

Material.—CM 29854–29856. 1 precaudal vertebra (3–4 ft); 5 precaudal vertebrae (4–5 ft); 1 precaudal vertebra (8–9 ft).

Remarks.—Criteria for assignment to *Thamnophis* was discussed under *Natrix sipedon*. In *T. sauritus* the accessory processes are oblique to the longitudinal axis of the centrum; in *T. sirtalis* they are at right angles (Holman, 1962).

Thamnophis sirtalis (Linnaeus)—garter snake

Material.—CM 29857–29860. 11 precaudal vertebrae (3–4 ft); 6 precaudal vertebrae (4–5 ft); 2 precaudal vertebrae (5–6 ft); 1 precaudal vertebra (6–7 ft).

Remarks.—The fossils were assigned to *T. sirtalis* based on criteria discussed under *T. sauritus*.

Thamnophis sp. indet.

Material.—CM 29861–29866. 16 precaudal vertebrae (3–4 ft); 20 precaudal vertebrae (4–5 ft); 3 precaudal vertebrae (5–6 ft); 2 precaudal vertebrae (6–7 ft); 1 precaudal vertebra (8–9 ft); 1 precaudal vertebra (9–10 ft).

Remarks.—The material was too fragmentary for specific identification but could be assigned to genus based on characters discussed under *Natrix sipedon*.

Discussion

All species of reptiles and amphibians from the Baker Bluff Cave local fauna, as far as can be determined, live in the area today. Only *Lampropeltis getulus*, which occurs regionally, is not found in the immediate area.

Perhaps the most striking thing about the herpetofauna is that there is nothing that strongly indicates that the climate or topography was any different then than it is today in northeastern Tennessee. Minimum numbers of individuals from each level (Table 1) show no discernible trends in the herpetofauna to indicate that climatic or ecological conditions changed markedly from approximately 20,000 years BP to approximately 600 years BP (but see Faunal Summary).

The Baker Bluff Cave herpetofauna exhibits many similarities to the late Pleistocene herpetofauna from Ladds Quarry, Georgia (Holman, 1967). At least 10 species, mostly snakes, from the Ladds Quarry site are also present at Baker Bluff Cave.

The Baker Bluff Cave herpetofauna is indicative of four major ecological preferences: a permanent aquatic habitat based on the evidence of *Rana catesbeiana* and *Graptemys geographica*; a marsh-stream border situation indicated by the water snakes *Natrix* and *Thamnophis* and the toad *Bufo. w. fowleri*; an open, sandy area indicated by *Heterodon platyrhinos*; and a moist woodland habitat where the majority of the identified Colubrinae, *Crotalus horridus*, *Ambystoma opacum*, and *A. maculatum* probably occurred.

The diversity of habitats exhibited by the herpetofauna suggests that the fossil remains were probably deposited by raptors.

AVES—BIRDS

Material.—CM 29725, 30176–30181, 30227, 30787–30789. MNI = 169.

Remarks.—The majority of bird remains were fragmentary and represent prey items of raptorial birds. Approximately 30 species were identified (Table 1), 23% of all vertebrate species from the deposit. One hundred sixty-nine individuals were represented, 7% of the combined numbers of individual birds and mammals from the deposit; this figure closely approximates the 5% at the Clark's Cave, Virginia, local fauna, another riverside raptor roost.

The riverbluff location of the site is reflected in the numerous remains of aquatic and semiaquatic species—grebe, ducks, mergansers, sandpipers, turnstone, gull, kingfisher—30% of the recovered avian species, a figure again comparable to the 26% from the Clark's Cave, Virginia, deposit.

Despite the variety of birds, only grouse Tetraonidae and passenger pigeon, *Ectopistes migratorius*, were present in any appreciable numbers. These two taxa accounted for 48% of all individual birds from the site, a figure identical to that of the Clark's Cave deposit avifauna, reflecting the collecting bias of raptors. However the two sites did differ significantly in the relative numbers of grouse (all species) and passenger pigeons. Grouse accounted for 34% of all birds at Clark's Cave, but only 12% at Baker Bluff Cave. Passenger pigeon, on the other hand, accounted for only 14% of all birds at Clark's Cave, but a high 36% at Baker Bluff, almost a direct reversal in relative numbers. Both sites are late Pleistocene in age, lie in a similar physiographic setting, and both contain boreal elements. It is probable that the higher number of passenger pigeon remains at Baker Bluff Cave, 2° south of Clark's Cave, is due to the site's lower latitude and therefore greater relative freedom from boreal periglacial conditions. Spruce grouse (*Canachites*), sharp-tailed grouse (*Pedioecetes*), and ptarmigan (*Lagopus*) were recovered from Clark's Cave in addition to ruffed grouse (*Bonasa*), the only tetraonid there today; only the ruffed grouse is definitely recorded from Baker Bluff Cave. However, the distal end of a left tibiotarsus from the 6–7 ft level (CM 30810) may possibly be sharp-tailed grouse (*Pedioecetes phasianellus*).

One bird of western affinities, the black-billed magpie (*Pica pica* Linnaeus), is tentatively identified from the Baker Bluff Cave deposit. The determination is based on a right scapula from the 6–7 ft level (CM 30181). The black-billed magpie in North America is found from southern Alaska to northern New Mexico and east to Kansas. It occurs east casually to Ontario and western Quebec in the north and to the Mississippi River in the south, with occasional strays reported as far east as South Carolina and Florida (A.O.U. Checklist 1957:376). Assuming that the Baker Bluff Cave specimen was from a resident bird, its presence at the site would complement that of other western or midwestern forms from the deposit such as the thirteened-lined ground squirrel (*Spermophilus tridecemlineatus*) and the badger (*Taxidea taxus*). The magpie has also been reported from the late Pleistocene raptor deposit at Natural Chimneys, Virginia (a complete humerus, Wetmore, 1962). All other species of birds from the site are of wide geographical distribution and are either common migrants or residents of the area today.

Chicken (*Gallus gallus*) remains were found within the upper 2 ft of the deposit by Dean and Wilson and are Recent in origin.

MAMMALIA—MAMMALS

Order Marsupialia—Marsupials
Family Didelphidae—American Opossums
Didelphis virginiana Linnaeus—Virginia opossum

Material.—Dean/Wilson collection: 6 vertebrae, 1 right jugal.

Remarks.—The opossum was not a member of the Pleistocene component at Baker Bluff Cave. The six vertebrae and one skull fragment were recovered from the top 2 ft of the deposit in an archaeological context. Four of the vertebrae were

Table 4.—*Measurements (in mm) of* Sorex cinereus *Kerr.*

Locality	Anteroposterior crown length P_4-M_3				
	Mean	OR	SD	CV	N
Recent					
Pennsylvania*	3.69	3.6–3.9	.07	1.89	20
Late Pleistocene					
New Paris No. 4, Pennsylvania*	3.90	3.7–4.3	.16	4.09	29
Clark's Cave, Virginia*	3.98	3.6–4.4	.13	3.40	35
Robinson Cave, Tennessee**	3.90	3.6–4.5	—	—	18
Baker Bluff Cave, Tennessee	3.97	3.78–4.36	.06	1.51	28

* From Guilday et al., 1977.
** From Guilday et al., 1969.

recovered from a depth of less than 6 in. One of the latter, a caudal vertebra, was charred, the only indication of fire in the cave.

Didelphis is common in the Pleistocene of Florida, from Irvingtonian and Rancholabrean sites (Webb, 1974), and has been reported from the Pleistocene of Georgia (Ray, 1967). It has not been found in Pleistocene sites farther north, but extended its range northward following the Wisconsinan glacial recession. Opossum remains are common in late prehistoric archaeological sites as far north as west-central West Virginia (Guilday, 1971). The spread of *D. virginiana* into Pennsylvania and points north was apparently associated with ecological changes brought on by European settlement of the country (Guilday, 1958).

Order Insectivora—Insectivores
Family Soricidae—Shrews

Sorex arcticus Kerr—Arctic shrew

Material.—CM 29959–29961. 3 partial left mandibles. MNI = 3.

Sorex cinereus Kerr—masked shrew

Material.—CM 29962–29967. 52 left, 41 right mandibles; 4 maxillae. MNI = 53.

Sorex dispar Batchelder—rock shrew

Material.—CM 29968–29970. 7 left, 4 right mandibles. MNI = 9.

Sorex fumeus Miller—smoky shrew

Material.—CM 29971–29976. 10 left, 21 right mandibles; 3 left, 1 right maxillae. MNI = 22.

Sorex sp., large (**S. arcticus** or **S. fumeus**)

Material.—CM 29977–29979. 10 left, 11 right mandibles. MNI = 12.

Sorex sp., small (**S. cinereus** or **S. dispar**)

Material.—CM 29980–29983. 13 left, 20 right mandibles. MNI = 20.

Microsorex hoyi (Baird)—pygmy shrew

Material.—CM 29956–29958. 6 left, 7 right mandibles; 2 partial skulls. MNI = 9.

Cryptotis parva (Say)—least shrew

Material.—CM 29954–29955. 3 right mandibles. MNI = 3.

Blarina brevicauda (Say)—short-tailed shrew

Material.—CM 29746–29753. 130 left, 130 right mandibles; partial skulls, maxillae, isolated teeth. MNI = 149.

Remarks.—Seven species of shrews were identified from the deposit. Three of these live in the area today. *Blarina brevicauda* and *Cryptotis parva* are common; *Sorex fumeus* and *Sorex longirostris* (the latter apparently not represented in the cave fauna) are uncommon (Smith et al., 1974).

The four species of shrews from the deposit not represented in the modern fauna (*Sorex cinereus, S. dispar, S. arcticus, Microsorex hoyi*) are now confined either to higher latitudes or to higher altitudes in the Great Smoky Mountains east of the site.

There is a change in the relative frequency of various soricids at successive stratigraphic levels in the deposit (Fig. 11) which suggests environmental changes during deposition. Those species requiring cooler conditions, *S. arcticus, S. dispar,* and *Microsorex hoyi,* were confined to the upper 2 ft of the undisturbed sequence. Only *Blarina brevicauda, Sorex fumeus,* and *Sorex cinereus* occurred at all levels. *Sorex cinereus* does not occur at the site today but is present at higher elevations in the Great Smoky Mountains at the same latitude.

Table 5.—*Measurements (in mm)* Microsorex hoyi *(Baird), Baker Bluff Cave, Tennessee.*

Measurement	Mean	OR	N
Length of palate	—	5.0–5.2	2
Maxillary width	—	3.7–4.1	2
P^4-M^3	—	3.4–3.6	2
M^1-M^3	2.4	—	1
Total length, mandible with incisor	8.0	7.9–8.2	3
Total length, dentary	6.2	6.1–6.2	3
Height, ascending ramus	2.8	2.7–2.9	7
P_4-M_3	3.5	3.4–3.6	6
M_1-M_3	2.9	2.7–3.0	8

Given the fragmentary nature of the collection the southeastern shrew, *S. longirostris,* may be represented in the referred *S. cinereus* material from the deposit. The entire cave collection is identified as *S.* cf. *cinereus,* however, because the mandibles average larger than Recent Pennsylvania specimens and are comparable in size to late Pleistocene material from New Paris No. 4 and Clark's Cave (Table 4). Mandibular measurements show no stratigraphic size shifts which suggest the absence of the smaller *S. longirostris* in the lower levels of the deposit where boreal conditions were apparently less intense. The third unicuspid was larger than the fourth, a character distinguishing *S. cinereus* from *S. longirostris,* in the one example complete enough for observation (CM 29964, 6 ft level). The presence of *S. cinereus* in the lower more temperate levels of the deposit suggests that climatic conditions at the time of lower-level deposition, although milder than upper-level conditions that supported a larger number of boreal species, was cooler than at present. Remains of *Clethrionomys gapperi* and one *Phenacomys intermedius* from the lowest level support this conclusion.

The presence of *Cryptotis parva,* a temperate species, in the upper levels seems anomalous in the boreal context suggested by the associated fauna. However it has also been reported from the late Wisconsinan Robinson Cave, Tennessee, and Eagle Cave, West Virginia, local faunas, both of which suggest cooler conditions, so it may have persisted in the richer boreal/temperate faunal mix of the late Wisconsinan periglacial environment. The least shrew was not present in either the New Paris No. 4, Pennsylvania, or the Clark's Cave, Virginia, soricid faunas, however, and its late Wisconsinan distribution is yet to be determined. The three mandibles from the upper levels of Baker Bluff Cave may have filtered down from Recent levels through undetected oblique deposition or animal burrowing.

The absence of the water shrew, *Sorex palustris,* a semiaquatic soricine of boreal affinities, was unexpected. Its remains have been recovered from the late Pleistocene Robinson Cave deposit, 256 km west of Baker Bluff. But *S. palustris* remains are rare in eastern late Pleistocene deposits (New Paris No. 4, 0.9%; Clark's Cave, 3%; Robinson Cave, 0.8% of all soricids) and their absence from the Baker Bluff fauna may be a matter of chance.

The *Blarina brevicauda* collection from Baker Bluff Cave (Figs. 6 and 7) presents an interesting picture of the coexistence of two size-forms throughout a portion of the depositional time span, confirming a concept developed by Graham and Semken (1976). *Blarina brevicauda,* the most common shrew in temperate eastern North America today, is also the commonest soricid at all levels in the Baker Bluff deposit. Its remains comprise 41.6% of all shrews from the 3 ft level, increasing relatively (but not actually) to a high of 87.7% at the lowest cave level as a result of the lessening numbers of *Sorex, Microsorex,* and *Cryptotis* (Fig. 11).

There are two forms of *Blarina brevicauda* present in the Baker Bluff Cave deposit (Fig. 6). A small form, comparable in size to the modern mid-Appalachian *B. b. kirtlandi,* occurred at all levels; in the lower 3 ft of the deposit it was the only form represented. However, the upper level sample (3 to 7 ft) is bimodal, with modal values of P_4-M_3 of 5.92 mm (*B. b.* cf. *kirtlandi*) and 6.59 mm. The latter value is comparable to *B. b.* cf. *brevicauda* from the late Pleistocene Clark's Cave deposit (6.56 mm), somewhat larger than that of modern Minnesota specimens of *B. b. brevicauda* (6.29 mm, N = 20, Guilday et al., 1977).

An additional expression of variability is the spread of the observed range expressed as the percent of increase from the smallest to the largest values. That figure, for the upper levels of the deposit, is 21.4%, comparable to the bimodal samples from the New Paris Sinkhole No. 4, Pennsylvania, 20% and Meyer Cave, Illinois, 25%. In the lower levels the figure shrinks to 11.1%, a figure comparable to the unimodal Clark's Cave sample.

A small form of short-tailed shrew, comparable in size to modern mid-Appalachian material, occurred at the earliest level represented at Baker Bluff. At the 6–7 ft level, however, an influx of larger stock took place and both forms apparently

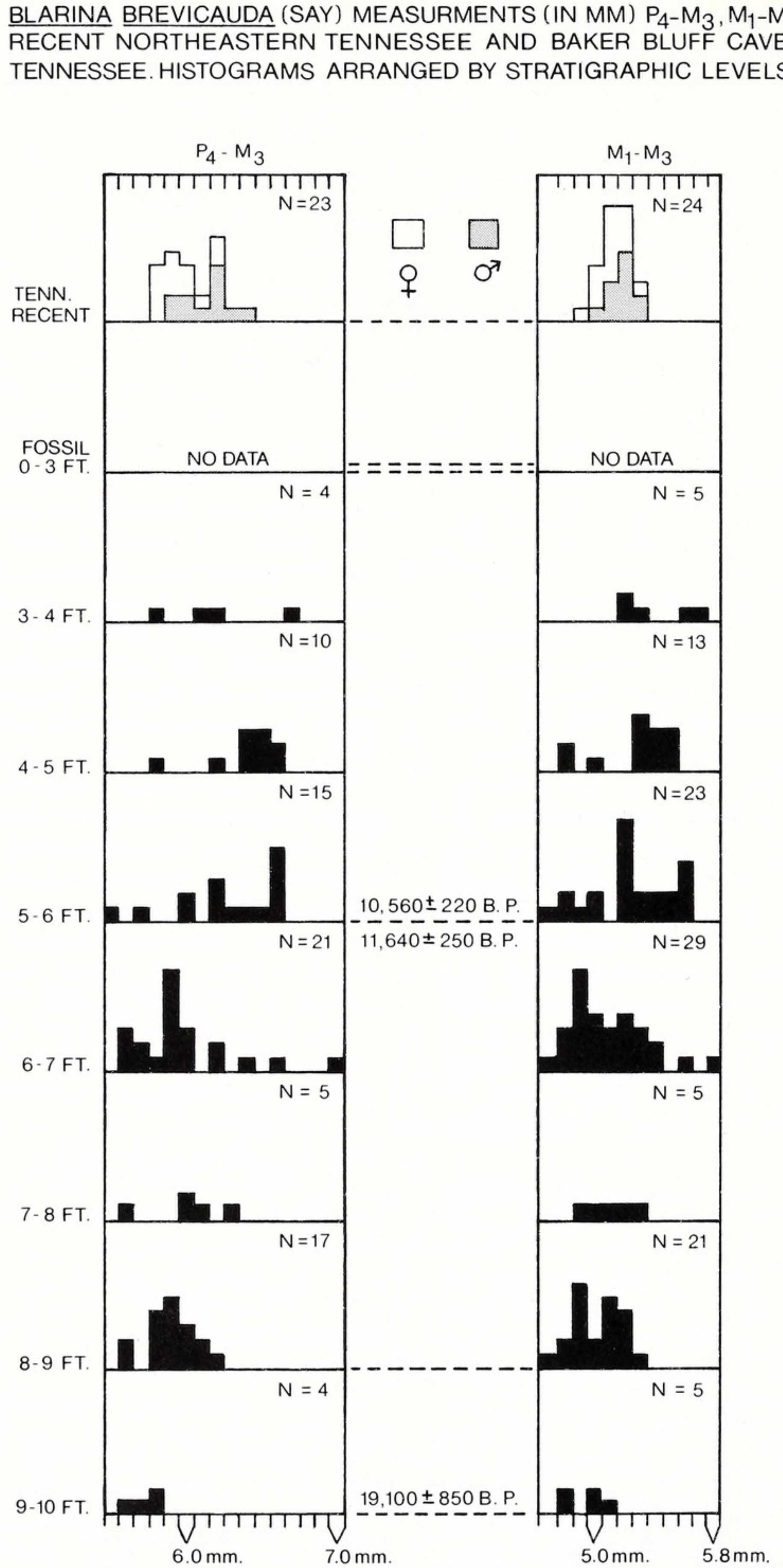

Fig. 6.—Histograms of mandibular measurements, *Blarina brevicauda* (Say), arranged by stratigraphic levels illustrating presence of two size groups, corresponding to Recent *B. b. kirtlandi* (smaller) and *B. b. brevicauda* (larger), Baker Bluff Cave, Sullivan County, Tennessee.

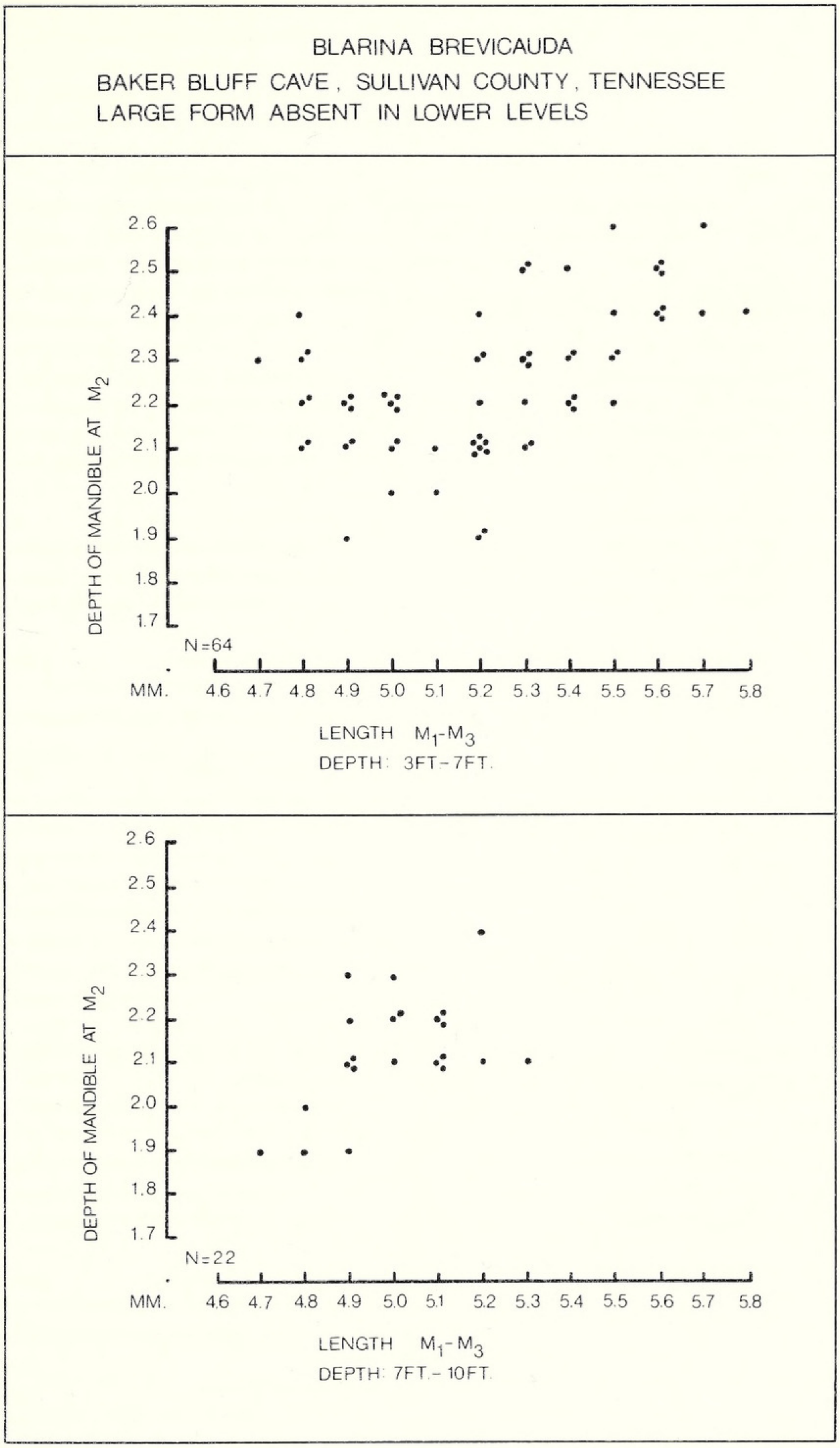

Fig. 7.—Scatter diagrams of mandibular measurements *Blarina brevicauda* (Say), Baker Bluff Cave, Sullivan County, Tennessee. Compare with Fig. 6.

existed in the area during the 3–7 ft depositional period. The top 3 ft of the deposit was destroyed and with it the Pleistocene/Holocene transition. The influx of the larger, presumably northern *B. b.* cf. *brevicauda* at the 6–7 ft level coincides with an increase in relative numbers of boreal voles. Climatic change is inferred at this point and it would appear that both forms of *Blarina* were coexisting in the area during an episode that was cooler than lower level times when only the smaller form existed at the site.

Graham and Semken (1976:443) speculate that "Sympatry of these phena [size-forms] during the Pleistocene suggested a more equable climate existed during glacial times than at present and that sympatric phena of *Blarina* coexisted in partitioned niches that presently are not defined. Post-glacial continental climates subsequently divided the . . . phena into their existing parapatric distributions." They suggest that "Coexistence of these phena in the same deposit without apparent interbreeding suggest a specific rather than a subspecific relationship." This assumes that there were no ecological barriers. *B. b. brevicauda* and *B. b. kirtlandi*, the modern equivalents of two of these late Pleistocene phena, and so identified by Graham and Semken, are currently considered to be subspecies. Current studies underway by J. R. Choate and H. H. Genoways on the evolution of *Blarina* may clarify the situation.

Family Talpidae—Moles
Condylura cristata (Linnaeus)—star-nosed mole

Material.—CM 30149–30150. 3 humeri. MNI = 3.

Scalopus aquaticus (Linnaeus)—eastern mole

Material.—CM 30151–30157. 3 humeri, 5 mandibles, skull fragments and isolated molars. MNI = 12.

Parascalops breweri (Bachman)—hairy-tailed mole

Material.—CM 30158–30165. 14 humeri, 15 mandibles, assorted limb bones, skull fragments and isolated molars. MNI = 17.

Remarks.—The eastern mole, *Scalopus aquaticus*, is common in the area today. The hairy-tailed mole, *Parascalops breweri*, has been reported from Bristol, Sullivan County, 50 km NE of the site in the Ridge and Valley province (Smith et al., 1974), and may occur at or near the site. The star-nosed mole, *Condylura cristata*, does not occur in the Ridge and Valley province at this latitude but does occur east of the site in the Great Smoky Mountains. This species is the most demanding in its ecological requirements, preferring boggy or mucky areas. It is a relatively weak burrower and often semiaquatic in its habits. Remains of the star-nosed mole were confined to the upper 3–5 ft levels.

Moles accounted for 1.6% of all mammals from the site. They were also scarce, 0.9% of the fauna, in the Clark's Cave local fauna, 307 km NE of Baker Bluff. Both accumulations are old raptor roosts, so the selection bias was much the same at both sites. But the relative percentages of the three species of talpids were quite different. The *Condylura/Scalopus/Parascalops* composition of the Baker Bluff Cave mole fauna (all levels combined) was 9%-54%-37%. At Clark's Cave it was 50%-4%-46%. The striking difference between the relative numbers of *Condylura* and *Scalopus* suggests that some factor other than relative availability to raptors was responsible for the discrepancy. The topography of the two sites is much the same but there is some evidence that the Cowpasture River valley, in which Clark's Cave is located, may have been relatively wetter (number and variety of ranids and semiaquatic birds) so that the high number of *Condylura* at that site can be attributed to local ecological factors.

At the latitude of Baker Bluff, *Condylura* and *Parascalops* are at the southern limits of their modern ranges. The fact that *Parascalops* was the commonest of the three species in the deposit is in accordance with the overall boreal aspect of the recovered fauna. *Parascalops breweri* has also been recorded from Robinson Cave, Overton County, Tennessee, 256 km west of Baker Bluff, well south of its present mid-continental range.

Order Chiroptera—Bats
Family Vespertilionidae—Evening Bats
Myotis sp. Kaup—little brown bats

Material.—CM 30143–30148. Partial mandibles and maxillae. MNI = 18.

Pipistrellus subflavus (F. Cuvier)—eastern pipistrelle

Material.—CM 30136. Partial mandibles; maxilla. MNI = 7.

Eptesicus fuscus (Palisot de Beauvois)—big brown bat

Material.—CM 30138–30142. Partial mandibles; maxilla; partial skull; isolated teeth. MNI = 19.

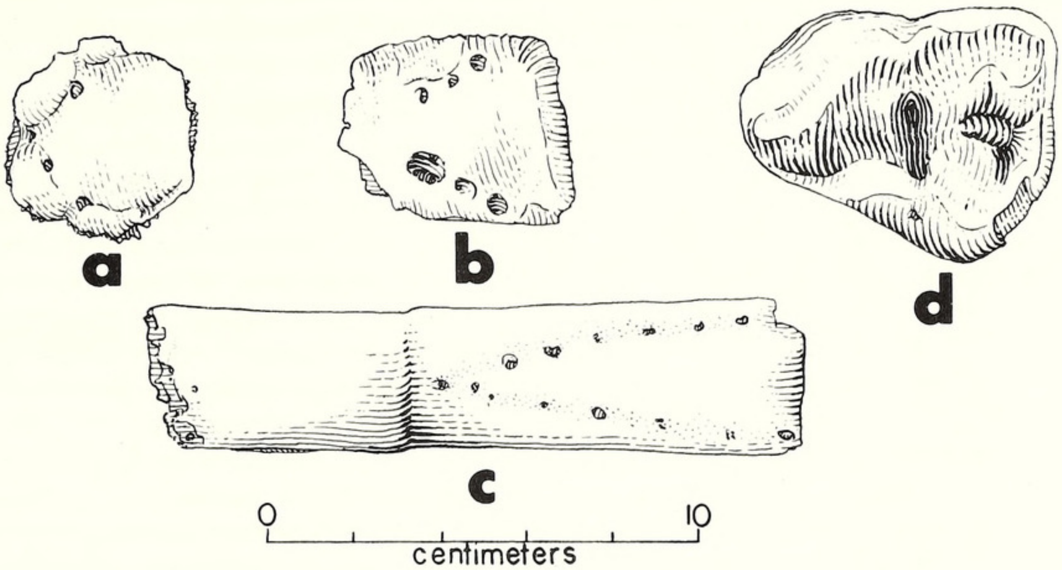

Fig. 8.—*Dasypus bellus* Simpson, dermal scutes: a) CM 29524; b) CM 29536; c) CM 29531. *Tapirus* cf. *veroensis* Sellards: d) CM 29522, left P^1, occlusal view, anterior to left. Baker Bluff Cave, Sullivan County, Tennessee.

cf. **Nycticeius humeralis** (Rafinesque)—evening bat

Material.—CM 30137. Partial mandible. MNI = 1.

Plecotus sp. E. Geoffroy Saint Hilaire—big-eared bat

Material.—CM 30143. Partial mandible. MNI = 1.

Remarks.—Baker Bluff Cave is too small and exposed to support a large bat colony and there is no other cave in the immediate vicinity capable of doing so. Bat remains were relatively uncommon, only 46 individuals, or 2.4%, of the total mammalian assemblage. By way of contrast bats accounted for 36% of the mammalian assemblage from Clark's Cave, Virginia, and 74% from Robinson Cave, Tennessee. The high number of bats from the Clark's Cave local fauna was due to raptor predation on a nearby cave colony; the bulk of the Robinson Cave bat remains (87% *Eptesicus fuscus*) resulted from natural mortality of the resident bat colony.

The big brown bat (*Eptesicus fuscus*) was the commonest bat from the Baker Bluff fossil fauna—19 individuals, 41% of all bats. This is a reflection of the shallowness of the cave, a condition differentially favoring this large hardy species.

Although at least 18 little brown bats (*Myotis* spp.) were present, only 11 mandibles were complete enough to measure. At least two size classes were represented. The alveolar length C-M_3 of two specimens measured 5.3 mm and 5.5 mm. Nine additional mandibles measured C-M_3 as follows: 6.2; 6.3; 6.4; 6.5; 6.5; 6.5; 6.5; 6.7; 6.8 mm. The smaller group lies within the modern *M. leibii/austroriparius/sodalis/lucifugus* size range, the larger series within the modern *M. keenii/grisescens* range (Guilday et al., 1977, Fig. 16).

All species of bats recovered from the site are found in Tennessee today (Graves and Harvey, 1974). Only *Plecotus rafinesquii* has been reported from the state today, although a relict colony of *P. townsendii,* the western big-eared bat, in the central Appalachians northeast of the site (Handley, 1959), implies a former range continuum that may have included eastern Tennessee. The Baker Bluff specimen, a partial mandible, cannot be identified to species.

Order Edentata—Edentates
Family Dasypodidae—Armadillos
Dasypus bellus Simpson—"beautiful" armadillo

Material.—CM 29506, 29515, 29523, 29524, 29531, 29535, 29536. 15 fragmentary scutes (Fig. 8). MNI = 1.

Remarks.—Fifteen fragmentary dermal scutes were recovered, scattered throughout the deposit, but no other skeletal remains of this extinct armadillo were recognized (Fig. 8). This is due to the poor condition of all large bones from the deposit and the characteristic appearance of even fragmentary armadillo scutes. Armadillo remains are found in Appalachian late Pleistocene sites as far north as West Virginia (Guilday and McCrady, 1966). Its presence in such sites is an indication of milder winter extremes despite the presence of so many boreal forms in the deposit. Armadillo remains have also been reported from Robinson Cave, Overton County, Tennessee.

Order Lagomorpha—Rabbits, Hares, and Pikas
Family Leporidae—Rabbits and Hares
Sylvilagus, sp. and/or **Lepus,** sp.—
cottontail rabbit or snowshoe hare

Material.—CM 30007–30013. Isolated teeth, fragmentary maxillae, fragmentary mandibles. MNI = 95.

Remarks.—Leporid remains were common at all stratigraphic levels (Table 1). Preservation was so poor that identification beyond family level was not feasible and minimum number of individuals is based on counts of isolated teeth.

At least three species may be represented—*Sylvilagus floridanus,* the eastern cottontail, *Sylvilagus transitionalis,* the New England cottontail, and *Lepus americanus,* the snowshoe hare. The Baker Bluff leporid sample consists of remains of medium-sized animals, of *S. floridanus/transitionalis* size, too small for the Recent Appalachian subspecies of snowshoe hare, *L. a. virginianus.* But in the light of the presence of other northern forms in the deposit, a small late Pleistocene form of snowshoe hare may be present (see Guilday et al., 1964, for discussion of size relationships). Kellogg (1939) reports hearsay evidence of snowshoe hare from the Great Smokies in eastern Tennessee.

S. floridanus is the only leporid now in the cave area. *S. transitionalis,* a species more characteristic of a northern hardwood forest situation, has been taken as far soutn as northeastern Alabama (Howell, 1921) and its distribution prior to colonial deforestation may have included the cave area. *S. aquaticus,* the swamp rabbit, occurs in swampy situations along the Mississippi and Tennessee river valleys, farther west in the state (Kellogg, 1939), but the fossil remains are too small to be those of *S. aquaticus.*

Minimum number of individuals was based upon upper incisors and upper second premolars per level. Crown width of 138 upper incisors produced a unimodal curve skewed to the left with a high coefficient of variation—16.12. Based upon this measurement a single size-population with a large relative percentage of juvenile animals is most probable.

Order Rodentia—Rodents
Family Sciuridae—Squirrels
Tamias striatus (Linnaeus)—eastern chipmunk

Material.—CM 30083–30096. 3 left, 4 right partial maxillae, 11 left, 9 right partial mandibles: 25 M^1 or M^2, 1 M^3, 2 P^4, 57 M_1 or M_2, 4 M_3. MNI = 27.

Remarks.—Remains of the eastern chipmunk, 19.8% of all sciurids, were exceeded only by those of the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*).

Measurements (Table 6) indicate that the Baker Bluff *T. striatus* were large-sized individuals, with a P_4-M_3 length averaging 10% larger than modern Pennsylvania material and some 6% larger than *T. s. pipilans,* the largest living subspecies. But the Baker Bluff sample averages 11% smaller in length of P_4-M_3 than the one extant mandible of the large extinct *T. aristus* from the Pleistocene of Georgia (USNM 23321, Ray, 1965). The largest of the Baker Bluff measurements, however, is only 2% smaller than that of *T. aristus.* We are dealing with small samples (seven measurements from Baker Bluff, one of *T. aristus*) and additional material may demonstrate a size-continuum. More material is needed to show whether *T. aristus* is a valid species or one based upon very large specimens of a large late Pleistocene form of *T. striatus.* Ray (1965) discusses this possibility and we concur with his opinions.

T. striatus increases in body size with decreasing latitude today, a condition which apparently held in late Pleistocene times as well even though all late Pleistocene *T. striatus* appear to have been larger than modern counterparts in the same latitude. Measurements P_4-M_3 of late Pleistocene material show a size increase from Pennsylvania through Virgina and Tennessee (Table 6).

The eastern chipmunk, a woodland form, and the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), a prairie form, were both common in the Baker Bluff local fauna, suggesting a regional mosaic of prairie and woodland. Numbers of the thirteen-lined ground squirrel diminished with increasing depth in the deposit while those of the eastern chipmunk remained relatively constant. This suggests that woodland was present throughout depositional times, although other evidence from the site suggests that the percent of woodland to grassland varied.

Eutamias cf. **minimus** (Bachman)—least chipmunk

Material.—CM 30114–30115. 2 left M_1 or M_2; CM 30116, partial left mandible with P_4-M_3. MNI = 3.

Table 6.—*Measurements (in mm) of* Tamias striatus *(Linnaeus) and* Tamias aristus *Ray.*

Sample data	Mean	OR	SD	CV	N
	Alveolar length P_4-M_3				
Recent					
Tamias striatus					
Pennsylvania*	6.58	6.20–6.98	.24	3.64	17
New Paris No. 2, Pennsylvania (1,875 years B.P.)	6.28	5.80–6.80	.18	2.86	114
*Tamias striatus pipilans***	6.76	6.30–7.40	.30	4.40	19
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	7.24	6.79–7.95	—	—	7
Robinson Cave, Tennessee	7.50	7.30–7.80	—	—	2
Clark's Cave, Virginia***	6.81	6.50–7.30	.21	3.08	28
Hartman's Cave, Pennsylvania**	6.90	6.20–7.70	.42	6.11	9
New Paris No. 4, Pennsylvania	6.74	6.30–7.10	.20	2.96	30
*Tamias aristus***	8.10	—	—	—	1
	Occlusal length M_1				
Recent					
Tamias striatus					
Pennsylvania*	1.47	1.30–1.50	.05	3.49	16
*Tamias striatus pipilans***	1.58	1.49–1.67	—	—	2
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.61	1.50–1.70	.06	3.88	13
Ladds, Georgia**	1.54	1.49–1.60	—	—	2
Tamias aristus					
Ladds, Georgia**	2.12	—	—	—	1
	Occlusal width M_1				
Recent					
Tamias striatus					
Pennsylvania*	1.61	1.45–1.75	.09	5.33	16
*Tamias striatus pipilans***	1.71	1.70–1.73	—	—	2
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.71	1.50–1.80	.07	4.48	13
Ladds, Georgia**	1.73	1.73–1.74	—	—	2
Tamias aristus					
Ladds, Georgia**	2.29	—	—	—	1
	Occlusal length M_2				
Recent					
Tamias striatus					
Pennsylvania*	1.63	1.45–1.75	.08	4.88	16
*Tamias striatus pipilans***	1.89	1.81–1.91	—	—	2
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.68	1.45–1.84	—	—	16
Ladds, Georgia**	1.86	1.82–1.90	—	—	2
Tamias aristus					
Ladds, Georgia**	2.42	—	—	—	1
	Occlusal width M_2				
Recent					
Tamias striatus					
Pennsylvania*	1.70	1.55–1.75	.07	4.11	16
*Tamias striatus pipilans***	1.89	1.82–1.96	—	—	2

Table 6.—*Continued.*

Sample data	Mean	OR	SD	CV	N
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.86	1.64–1.94	—	—	16
Ladds, Georgia**	1.79	1.78–1.81	—	—	2
Tamias aristus					
Ladds, Georgia**	2.53	—	—	—	1
	Occlusal length M_1 or M_2				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.62′	1.45–1.84	.14	8.66	45
	Occlusal width M_1 or M_2				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.68	1.45–2.03	.13	7.70	46
	Alveolar length P^4-M^3				
Recent					
*Tamias striatus pipilans***	6.55	6.50–6.60	—	—	2
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	6.30	—	—	—	1
*Tamias aristus***	7.25	—	—	—	1
	Occlusal length M^1				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.55	1.40–1.50	—	—	4
	Occlusal width M^1				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.86	1.80–1.90	—	—	4
	Occlusal length M^2				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.50	—	—	—	3
	Occlusal width M^2				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.90	1.80–2.00	—	—	3
	Occlusal length M^1 or M^2				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.66	1.40–1.80	.11	6.36	24
	Occlusal width M^1 or M^2				
Late Pleistocene					
Tamias striatus					
Baker Bluff, Tennessee	1.89	1.60–2.10	.12	6.15	24

* CMNH Recent mammal collection: 25091, 25104, 25105, 25107, 25109–25116, 25118, 25120, 25123, 25124, 25132.
** Ray, 1965.
*** Guilday et al., 1977.

Remarks.—The least chipmunk occurs today in the American West and subarctic western Canada east to Lake Superior, Lake Huron, and southwestern Hudson Bay, where it prefers open to brushy coniferous forest situations (Banfield, 1974). Remains have been reported from two other late Pleistocene cave deposits in the Appalachians, Back Creek Cave No. 2 and Clark's Cave, Virginia. Baker Bluff Cave marks the southernmost record for the least chipmunk in eastern North America.

Rare in the deposit, and confined to the upper 3–6 ft levels, presence of the least chipmunk in conjunction with high numbers of *Spermophilus tridecemlineatus* from those levels suggests an open, predominantly coniferous parkland environment. Measurements of CM 30116 are as follows: P_4-M_3, 5.2 mm; P_4, .97 mm × .97 mm; M_1, 1.3 mm × 1.4 mm; M_2, 1.4 × 1.4 mm; M_3, 1.5 × 1.4 mm.

Marmota monax (Linnaeus)—woodchuck

Material.—CM 30166–30173. 3 skull fragments; 3 left, 1 right mandibles; 15 upper incisors; 8 dP^4; 12 P^3; 16 P^4; 22 M^1 or M^2; 1 M^2; 17 M^3; 14 lower incisors; 7 dP_4; 8 P_4; 26 M_1 or M_2; 1 M_1; 16 M_3. MNI = 23.

Remarks.—Remains of this large hibernating ground squirrel are present in all Holocene and Pleistocene Appalachian cave deposits of any size, and they are common in the Baker Bluff fauna—at least 23 individuals, based upon dentitions, 17% of all sciurids from the site.

Most of the remains may represent individuals who died of natural causes as the deposit is within a few meters of the present entrance. All but juvenile woodchucks are too large for most raptors and their diurnal habits protect them from owls. The extent to which woodchuck remains may build up in cave deposits is dramatically illustrated by the early Holocene fissure, Meyer Cave, Illinois (Parmalee, 1967). At least 597 individuals were present in that deposit, 82% of all sciurids.

Woodchuck burrowing in such a small deposit as Baker Bluff Cave may have affected stratigraphic integrity, but there is no field evidence for this.

Spermophilus tridecemlineatus (Mitchell)—
thirteen-lined ground squirrel

Material.—CM 30073–30082. 1 left, 3 right partial maxillae; 5 left, 2 right partial mandibles; 2 dP^4; 1 P^3; 24 P^4; 2 M^1; 3 M^2; 33 M^1 or M^2; 10 M^3; 7 P_4; 2 M_1; 36 M_1 or M_2; 22 M_3. MNI = 28.

Remarks.—The thirteen-lined ground squirrel, *Spermophilus tridecemlineatus*, was the commonest squirrel, 20% of all sciurids, from the deposit. This is a high figure for an eastern late Pleistocene cave fauna compared with 9.6% New Paris No. 4, Pennsylvania, 4.3% Clark's Cave, Virginia, and 7.6% of the sciurids from Robinson Cave, Tennessee.

The thirteen-lined ground squirrel is a prairie species, occurring in the American Midlands from Wyoming to western Ohio and from Manitoba to Texas (Hall and Kelson, 1959). It does not now live in the forested East. It is not found south of the Ohio River except in those few instances where it has been introduced locally by man (Doutt et al., 1973). However during at least late Wisconsinan times it was distributed throughout the mid-Appalachian region. It has been reported from cave sites in Pennsylvania, West Virginia, Virginia, Kentucky, and Tennessee (Guilday et al., 1977). The presence of thirteen-lined ground squirrels at such sites, in association with boreal woodland mammals, suggests a mixed woodland/grassland ecotype. At Welsh Cave, Kentucky, 268 km NW of Baker Bluff Cave, ^{14}C dated 12,950 ± 950 BP, *S. tridecemlineatus* dominated the small mammal fauna, and, other than a single red squirrel (*Tamiasciurus hudsonicus*), was the only sciurid from the site. It was found with remains of *Taxidea taxus, Ursus arctos, Mammuthus,* and *Equus,* as well as with boreal forest rodents and insectivores, suggesting a prairie parkland periglacial environment in what is now a region of deciduous forest.

The relative percent of thirteen-lined ground squirrel to chipmunk (*Tamias striatus*) is instructive. Both are diurnal, conspicuous ground squirrels of comparable size; both are susceptible to predation by raptors. They occupy separate ecological niches, however. *S. tridecemlineatus* is a prairie form, whereas *T. striatus* inhabits woodland or forest edge. Their changing relative numbers, stratigraphically or geographically, should provide a relative index to the type of ground cover present at the time of deposition.

S. tridecemlineatus comprised 23% of the ground squirrels (*Spermophilus, Tamias*) from New Paris No. 4, Pennsylvania, 17% from Clark's Cave, Virginia, 33% from Robinson Cave, Tennessee, 51% at Baker Bluff Cave, and 100% from Welsh Cave, Kentucky. It is apparent that variation in the *Spermophilus/Tamias* ratio does occur but not enough paleofaunas have been analyzed to recognize any geographic pattern that might reflect paleoenvironmental trends. The data now at hand suggest that *Spermophilus* is relatively more common in south-

Table 7.—*Measurements (in mm) of* Spermophilus tridecemlineatus, *Baker Bluff Cave, Tennessee.*

Mean	OR	SD	CV	N	Mean	OR	SD	CV	N
	Occlusal length M^1					Occlusal width M^1			
1.64	1.40–1.70	—	—	5	2.30	2.10–2.40	—	—	5
	Occlusal length M^2					Occlusal width M^2			
1.69	1.50–1.80	—	—	7	2.30	2.00–2.40	—	—	7
	Occlusal length M^1 or M^2					Occlusal width M^1 or M^2			
1.67	1.40–1.80	.13	7.68	24	2.20	1.70–2.40	.16	7.30	24
	Occlusal length M_1					Occlusal width M_1			
1.55	1.40–1.60	—	—	5	1.92	1.84–1.94	—	—	5
	Occlusal length M_2					Occlusal width M_2			
1.68	1.40–1.80	—	—	3	2.16	1.90–2.30	—	—	3
	Occlusal length M_1 or M_2					Occlusal width M_1 or M_2			
1.60	1.40–1.80	.13	8.69	20	1.98	1.50–2.10	.17	8.57	20
	Alveolar length P_4-M_3								
8.60	—	—	—	1					

ern (Tennessee) and western (Kentucky) late Pleistocene sites.

There is a stratigraphic change in the ground squirrel fauna from Baker Bluff Cave itself (Fig. 12). At levels 0–7 ft *S. tridecemlineatus* was the dominant species—58.1%. In the lower levels, 7–10 ft, the relative numbers of *S. tridecemlineatus* and *Tamias striatus* shifted and *T. striatus* became the dominant species—66%. This suggests a trend toward a denser woodland in the lower levels, an impression heightened by an accompanying shift in the relative numbers of large tree squirrels; the temperate deciduous forest *Sciurus* became common in the lower levels. In the upper levels of the deposit it was partially replaced by the red squirrel (*Tamiasciurus hudsonicus*), a coniferous/northern hardwood species that does not require as dense a forest habitat.

Spermophilus (*Ictomys*) sp. has been reported from Haile XIV A, a Sangamonian/Wisconsinan fissure site in Florida, accompanied by a predominantly xeric fauna. No northern species were noted. It was suggested that either *S. tridecemlineatus* or *S. mexicanus* might be represented and that they represented a western element in this Florida fauna (Martin, 1974). Northern species dominate all of the eastern late Wisconsinan faunas studied so far from the mid-Appalachians. The accompanying *Spermophilus* from these sites is believed to be the northern *S. tridecemlineatus*, which ranges north to Manitoba today, rather than *S. mexicanus*, which ranges only as far north as Texas and northern Mexico. Both species are larger than *S. spilosoma* (Table 7).

Sciurus carolinensis Gmelin—gray squirrel

Material.—CM 30106–30113. 1 right mandible with P_4-M_3; 1 left maxilla with P^3-P^4; 1 right dP^4; 4 left, 2 right P^4; 19 left, 12 right M^1 or M^2; 9 left, 4 right M^3; 3 P_4; 12 left, 9 right M_1 or M_2; 4 left, 2 right M_3. MNI = 17.

Remarks.—The gray squirrel and the larger fox squirrel (*Sciurus niger*) occur in the area at the present time. *S. niger* may have been present in the fossil deposit, but there is no indication of it. A right mandible from the Dean/Wilson collection (CM 30106) agrees in size with *S. carolinensis*, and a maxilla (CM 30107) bears the diagnostic P^3. The remainder of the collection, 81 isolated premolars and molars, are referred to *S. carolinensis* on the basis of their size and the lack of any apparent bimodality (Table 8).

Gray squirrel remains in the deposit became more common relative to those of red squirrel, *Tamiasciurus hudsonicus*, with increasing depth (Fig. 12). In the upper levels, 0–7 ft, the percentage of *Sciurus*

Table 8.—*Length and width of molars (in mm) of* Sciurus *cf.* carolinensis *Gmelin, Baker Bluff Cave, Sullivan Co., Tennessee.*

Measurements	Mean	OR	SD	CV	N
Crown length M^1 or M^2	2.49	2.10–2.70	.15	6.02	26
Crown length M_1 or M_2	2.54	2.30–2.80	.20	7.87	18
Crown width M^1 or M^2	2.81	2.40–3.10	.16	5.69	26
Crown width M_1 or M_2	2.75	2.50–2.90	.13	4.69	16

Table 9.—*Measurements (in mm) of* Tamiasciurus hudsonicus *(Erxleben).*

Age and locality	Mean	OR	SD	CV	N
		Occlusal length P_4-M_3			
Recent					
Pennsylvania*	7.39	6.80–7.80	—	—	33
Natishquan River, Quebec*, and Hamilton River, Labrador*	7.66	7.30–8.00	—	—	20
Hudson Bay, Quebec*	7.84	7.60–8.20	—	—	15
Moorhead, Minnesota*	7.92	7.20–8.50	—	—	11
Aklavik NWT, Seward, Alaska*	8.20	8.00–8.40	—	—	9
Late Pleistocene					
New Paris No. 4, Pennsylvania*	8.20	8.00–8.30	—	—	4
		Alveolar length P_4-M_3			
Late Pleistocene					
Clark's Cave, Virginia*	8.68	8.15–9.20	0.30	3.46	20
Baker Bluff Cave, Tennessee	8.48	8.24–8.73	—	—	4
Robinson Cave, Tennessee**	8.70	8.65–8.70	—	—	2
		Occlusal length M_1 or M_2			
Late Pleistocene					
Baker Bluff Cave, Tennessee	2.01	1.84–2.32	0.12	5.85	30
		Occlusal width M_1 or M_2			
Late Pleistocene					
Baker Bluff Cave, Tennessee	2.21	1.94–2.72	0.21	9.51	29
		Occlusal length M^1 or M^2			
Late Pleistocene					
Baker Bluff Cave, Tennessee	1.95	1.64–2.32	0.14	7.16	31
		Occlusal width M^1 or M^2			
Late Pleistocene					
Baker Bluff Cave, Tenn.	2.36	2.04–2.72	0.16	7.85	30

* Measurements from Guilday et al., 1977.
** Measurements from Guilday et al., 1969.

to *Tamiasciurus* was 40%, but increased to 70% in levels 7–10 ft. The gray squirrel is a more temperate species and its relative increase in numbers with depth suggests a more temperate environment during lower-level depositional times. The presence of gray squirrel throughout the stratigraphic column is a reflection of the low latitude of the cave and its distance from periglacial effects. *S. carolinensis* was scarce at Clark's Cave, Virginia, 2° latitude father north, where the percentage of *S. carolinensis* to *T. hudsonicus* was only 1.1%. Two degrees farther north of Clark's Cave, at New Paris No. 4, Pennsylvania, only *T. hudsonicus* was present.

Martin and Webb (1974) point out that *S. niger* is absent from all but late Pleistocene/early Holocene deposits in Florida. They believe that *S. niger* dates back only 8,000 years in Florida and speculate that it may have been a northern invader. The apparent absence of *S. niger* from Baker Bluff Cave in eastern Tennessee during the late Pleistocene does not bear this out. Undated *S. niger* remains, two complete skulls covered with thin layers of flowstone (CM 8050–8051), were recovered from Robinson Cave in northcentral Tennessee (Guilday et al., 1969).

Tamiasciurus hudsonicus (Erxleben)—red squirrel

Material.—CM 30097–30105. 2 incisors; 4 P^4; 38 M^1 or M^2; 8 M^3; 1 P_4; 34 M_1 or M_2; 10 M_3; 2 left, 4 right partial mandibles; 1 humerus. MNI = 18.

Remarks.—A form of red squirrel larger than *T. h. loquax,* the subspecies now occupying the southern and central Appalachians, but similar in size to red squirrels from other Appalachian cave deposits of late Pleistocene age (New Paris No. 4, Clark's

Cave) is indicated by dental and mandibular measurements (Table 9).

The red squirrel does not occur in the area, nor in the state, outside of the Great Smokies where it occurs in spruce/fir/hemlock situations above 1,000 m (Kellogg, 1939; Smith et al., 1974).

Remains of both gray squirrel (*Sciurus carolinensis*) and red squirrel were present at all levels in the deposit, but red squirrel was relatively more common in the upper levels, reinforcing the ecological shift indicated by the presence of other boreal forms in those same upper levels (Fig. 12).

Only 18 individuals were indicated from the site, 13% of all sciurids. This is one-half of the relative number of red squirrel represented from the Clark's Cave local fauna, 307 km NE. But, if we include numbers of both *Sciurus* and *Tamiasciurus* from Baker Bluff Cave, the aggregate percentage of large diurnal tree squirrels is about the same at both sites.

The percentage of large diurnal tree squirrels (*Sciurus, Tamiasciurus*) relative to small diurnal ground squirrels (*Tamias, Eutamias, Spermophilus*) differs from the two sites (38% arboreal, Baker Bluff Cave, 47% arboreal, Clark's Cave, Virginia). Assuming that the squirrels from both sites were raptor prey, then raptors at Clark's Cave captured a larger proportion of arboreal squirrels, suggesting that forest cover was denser at Clark's Cave during depositional times than it was at Baker Bluff Cave.

At Baker Bluff Cave the percentage of diurnal ground squirrels relative to that of diurnal arboreal squirrels dropped somewhat in the lower levels from 70% in levels 3–7 ft to 55% in levels 7–10 ft, suggesting a denser forest cover in lower level depositional times. The fact that red squirrel also became relatively less common in the lower levels suggests a warmer deciduous woodland situation.

Genus **Glaucomys** Thomas—flying squirrels
Glaucomys sabrinus (Shaw)—northern flying squirrel

Material.—CM 30117–30128. 6 left, 2 right partial mandibles; 2 right maxillae, 67 isolated molars and premolars. MNI = 13.

Glaucomys volans (Linnaeus)—southern flying squirrel

Material.—CM 30130, 30132–30135. 2 left, 1 right partial maxillae; 5 M^1 or M^2; 5 M_1 or M_2. MNI = 7.

Glaucomys, sp. (cf. **sabrinus** or **volans**)

Material.—CM 30129, 30131. 2 partial maxillae; 1 P^4; 2 M^1 or M^2.

Remarks.—Flying squirrels comprised 15% of all sciurids in the Baker Bluff deposit (19% at New Paris No. 4, Pennsylvania, 43% at Clark's Cave, Virginia, 46% at Robinson Cave, Tennessee, 63% at Natural Chimneys, Virginia) a relatively low figure for an Appalachian cave deposit, reflecting the greater relative abundance of remains of the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*).

Glaucomys volans is common throughout the state today. *Glaucomys sabrinus* is a boreal species of the Hudsonian/Canadian Zone coniferous forests whose range extends south in the Appalachian highlands at ever increasing elevations. It is present in the Great Smoky Mountains east and south of the site at elevations over 900 m higher than Baker Bluff in hardwood-coniferous woodlands. *Glaucomys sabrinus* accounted for 65% of the Baker Bluff flying squirrels. Its presence in decreasing relative numbers in the site with depth is in accordance with other internal evidence suggesting a cooling of the environment during mid- and late-depositional times at the site.

Measurements of the fossil material (Table 10) indicate a form of *Glaucomys sabrinus* larger than present day eastern races but comparable in size to modern northern and western material and to late Pleistocene specimens from other Appalachian cave deposits (Guilday et al., 1977). *Glaucomys volans* also averaged larger in dental dimensions during the late Pleistocene in the Appalachians, but the Baker Bluff specimens, referred to *G. volans,* were insufficient for valid size inferences to be drawn. *G. volans* has been reported from numerous Pleistocene sites in Florida extending back to the Sangamonian interglacial (Webb, 1974), but Baker Bluff Cave and Robinson Cave, Tennessee, are the most southern Pleistocene stations for *Glaucomys sabrinus*.

The ratio of remains of nocturnal flying squirrels (*Glaucomys*) to those of the diurnal chipmunk (*Tamias*) in a fossil bone sample give some indication of the relative importance of owls in its formation. The percent of *Glaucomys* to *Tamias* at Baker Bluff Cave was a low 42%, suggesting that nocturnal predators such as owls played a lesser role at Baker Bluff Cave in building the fossil assemblage than at Clark's Cave (66%), Robinson Cave (66%), and Natural Chimneys (82%). The New Paris No. 4 deposit (38%) was a fissure pitfall where no owl activity was involved and the low percent of *Glaucomys* to *Tamias* reflects this. On

Table 10.—*Measurements (in mm) of* Glaucomys *Thomas.*

Age and locality	Mean	OR	SD	CV	N
	Alveolar length P^3-M^3				
Pleistocene, Baker Bluff Cave, Tennessee					
Glaucomys cf. *sabrinus*	8.15	—	—	—	1
Glaucomys cf. *volans*	6.68	—	—	—	1
	Alveolar length P_4-M_3				
Recent, Pennsylvania*					
Glaucomys sabrinus (Shaw)	7.19	6.80–7.60	.17	2.36	18
Pleistocene					
Glaucomys cf. *sabrinus*					
New Paris No. 4, Pennsylvania	7.70	7.60–8.10	—	—	3
Natural Chimneys, Virginia	7.80	7.30–8.40	—	—	14
Clark's Cave, Virginia	8.00	7.60–8.60	.01	1.19	30
Robinson Cave, Tennessee	7.80	7.00–8.70	—	—	8
Baker Bluff, Tennessee	7.90	7.70–8.40	—	—	7
	Anteroposterior crown length M_1 and M_2				
Recent, Pennsylvania					
Glaucomys volans (Linnaeus)**	1.57	1.45–1.75	.10	6.83	34
Glaucomys sabrinus (Shaw)*	1.69	1.45–1.94	.13	7.65	36
Pleistocene, Baker Bluff Cave, Tennessee	1.65	1.45–2.01	—	—	29
	Crown width M_1 and M_2				
Recent, Pennsylvania					
Glaucomys volans (Linnaeus)**	1.71	1.55–1.94	.12	6.99	34
Glaucomys sabrinus (Shaw)*	1.81	1.65–2.13	.15	8.26	36
Pleistocene, Baker Bluff Cave, Tennessee	1.97	1.69–2.42	—	—	29

* CMNH Recent mammal collection: 31603, 31604, 31606, 31607, 31609–31611, 36392, 36394–36402, 37134.
** CMNH Recent mammal collection: 34318–34325, 34327–34329, 34332, 34333, 34335–34337, 34382, 34383.

the face of it, this percentage suggests that owls were of relatively little importance in amassing the fossil deposit at Baker Bluff Cave. But a more likely possibility, strengthened by high numbers of thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) and the presence of badger (*Taxidea taxus*), both open country forms, in the deposit is that the country was not as densely forested, a situation differentially favoring the chipmunk (*Tamias*).

Family Castoridae—Beavers

Castoroides ohioensis Foster—giant beaver

Material.—CM 24680. 1 M^1 or M^2 (illustrated in Parmalee et al., 1976). MNI = 1.

Remarks.—A single molar of the extinct giant beaver was recovered prior to the CMNH excavation by Bob Wilson and S. D. Dean, Jr., 36 to 72 in. inside the entrance, and 36 to 72 in. from the north wall at a depth of 1.5 to 2 ft, in what appears to have been the Holocene level. The molar probably belongs to the underlying late Pleistocene fauna, and the upper levels (0–3 ft) represent a chronological mix due to human disturbance. This tooth may have represented a woodrat hoard-object. *Castoroides* has been reported from an unnamed cave along the Clinch River, near Oak Ridge, Roane County, Tennessee (Parmalee et al., 1976).

Castor canadensis Kuhl—beaver

Material.—CM 30062–30064. 4 isolated molars. MNI = 3.

Remarks.—The stratigraphic distribution of these isolated teeth has no significance. Beaver were probably present throughout the depositional sequence. Lt. Henry Timberlake, in December 1761, specifically noted the abundance of beaver along the Holston River in what is now Sullivan County (Williams, 1927, in Kellogg, 1939). Smith et al. (1974) mention sporadic reports of their presence in the county today.

Family Cricetidae—New World Rats and Mice
Peromyscus, sp.—white-footed mouse
[either **P.** cf. **maniculatus** (Wagner) and/or
P. cf. **leucopus** (Rafinesque)]

Material.—CM 29994–30000. maxillae, mandibles, isolated molars. MNI = 94.

Remarks.—White-footed mouse remains were common in all levels from 3–10 ft in the deposit (Table 1). They were undoubtedly present in the upper 0–3 ft of the deposit, but small vertebrate remains were not recovered by the original excavators. *Peromyscus leucopus* and *P. maniculatus* are common in the cave area at the present time. The golden mouse (*Ochrotomys nuttali*), close to *Peromyscus* in dental morphology, has also been recorded (Phillips and Richmond, 1971; Smith et al., 1974).

M_1 morphologies, typical of *P. maniculatus* and *P. leucopus* (see Guilday et al., 1977:59, for criteria), were noted, but no stratigraphic percents were calculated due to the low frequency of recovered M_1's.

Alveolar length of M_1-M_3 of 90 mandibles averaged 3.59 mm (OR = 3.2 to 4.2 mm). This is 0.19 mm larger than the mean of 48 mandibles of a mixed *P. leucopus-P. maniculatus* sample from the late Pleistocene Clark's Cave, Virginia, deposit (Guilday et al., 1977). Some examples measured 0.5 mm larger than the largest Clark's Cave specimen. This suggests that *Ochrotomys nuttalli* may be present in the Baker Bluff Cave collection, but no molars of *O. nuttalli* morphology were noted.

A bimodal curve of M_1-M_3 alveolar length with modes at 3.4 mm and 3.7 mm suggests that the smaller *P.* cf. *maniculatus* comprised about one-third of the total sample (stratigraphic levels combined) and the larger *P.* cf. *leucopus* about two-thirds of the population sample. Frequencies ran in 0.1 mm increments of increasing size—2, 13, 15, 7, 13, 17, 9, 6, 5, 2, 1.

Neotoma floridana (Ord)—eastern woodrat

Material.—CM 24686–24692. partial crania, mandibles, isolated molars. MNI = 260.

Remarks.—The woodrat was the commonest mammal represented at all stratigraphic levels of the deposit, with the exception of voles of the genus *Microtus*. Most of the remains are, we believe, those of rats that died a "natural" death in this woodrat midden/raptor roost accumulation. This is suggested by the excellent preservation of some of the skulls compared with those of other species of small mammals, and by the high numbers of *Neotoma* remains, 18% of all rodents from the deposit. By way of contrast, woodrats accounted for only 2% of all rodents from the large, late Pleistocene raptor roost deposit at Clark's Cave, Virginia, in a similar physiographic setting.

Woodrats are common in cliff and cave habitats throughout the Ridge and Valley province but do not persist in settled areas, perhaps because they cannot compete with introduced black and/or Norway rats (*Rattus*). Smith et al. (1974) do not record *Neotoma* from Sullivan County, and characterize its distributional status as uncertain. They were probably widespread in suitable habitats at least until European settlement of the area.

Woodrats were responsible for most of the isolated teeth and bones of large mammals in the deposit. Scavenged items are a common constituent of modern woodrat middens, an expression of the animal's well-known gathering and hoarding propensities.

Family Arvicolidae—Voles
Clethrionomys gapperi (Vigors)—
red-backed vole

Material.—CM 24462–24466, 24655–24661. 132 left, 153 right mandibles and/or M_1. MNI = 159.

Remarks.—Red-backed vole remains were common in the deposit at all levels, 17.6% of all voles. However, the relative frequency of *Clethrionomys* remains varied stratigraphically (Fig. 13) from over 25% of all voles in the upper levels to less than 10% in the lower levels.

The species no longer occurs at the site or in the Ridge and Valley province of eastern Tennessee. It does occur as the dominant woodland vole in northern hardwood/coniferous woodlands at that latitude east of the Ridge and Valley province in the higher elevations of the Great Smoky Mountains. Smith et al. (1974) reported it as relatively common above 660 m in Unicoi County, Tennessee. Howell and Conaway (1952) trapped a specimen in the Cumberland Mountains, about 232 km WSW of Baker Bluff Cave, in an "overgrown jumble of rocks in a growth of rhododendron and hemlock." This is the first Recent record of *Clethrionomys* from the Cumberland Plateau of Tennessee, although Barbour and Davis (1974) record it from the Cumberland Plateau of eastern Kentucky (Big Black Mountain) above 680 m elevation in northern hardwood situations. But in the Ridge and Valley province of Tennessee today *Clethrionomys* is replaced by the woodland vole, *Microtus pinetorum*.

Clethrionomys has been reported from at least two other late Pleistocene Tennessee sites situated beyond its present range—Carrier Quarry Cave, Sullivan County, 10% of all voles (CM 30216–30223; vole MNI = 212), and Robinson Cave, Overton County, 14% of all voles (Guilday et al., 1969; vole MNI = 227).

The relative decrease in numbers of *Clethrionomys* with increasing depth at Baker Bluff is in accord with the decrease of all other species of boreal affinities in the lower levels of the deposit and suggests a change from boreal to temperate conditions with depth.

Phenacomys intermedius Merriam—heather vole

Material.—CM 24467–24470, 24662–24666. 45 left, 57 right M_1; 142 additional molars. MNI = 64.

Remarks.—The heather vole occurs throughout the boreal forest of northern North America, but is no longer found in the Appalachians south of the St. Lawrence estuary. Although usually present in mid-Appalachian late Pleistocene vole faunas from Pennsylvania south to Tennessee, and in some midwestern and western deposits of Wisconsinan age (Guilday and Parmalee, 1972) it is usually the rarest species of vole encountered. Comparative percentages relative to all voles are as follows: 3.8%, New Paris No. 4, Pennsylvania; 3.6%, Natural Chimneys, Virginia; 1.6%, Clark's Cave, Virginia; 5.6%, Carrier Quarry Cave, Tennessee; 7.1%, Baker Bluff Cave.

Phenacomys remains were recovered from all levels in the deposit but diminished with depth from a high of 10% of all voles at the 3–4 ft level to a low of 1.1% at the 7–10 ft level (Fig. 13).

The habitat requirements of the heather vole, within the context of boreal forest, vary from "dry, open coniferous forests . . . with an understory of heaths" to "borders of forest and in moist mossy meadows" (Banfield, 1974:193). Their present absence from the closed-canopy northern hardwood/coniferous forests of the northern Appalachians suggests more open woodland during late Wisconsinan times in the periglacial Appalachians.

Phenacomys intermedius and *Clethrionomys gapperi* were present throughout the deposit. Both are woodland voles and their relative numbers in a given Appalachian cave deposit are usually positively correlated. But *Phenacomys* appears to be unusually abundant in two Tennessee paleofaunas studied to date. Percentages of *Phenacomys* relative to *Clethrionomys* at various Appalachian sites are as follows: 15%, New Paris No. 4, Pennsylvania; 17.5%, Natural Chimneys, Virginia; 10%, Clark's Cave, Virginia; 28.7%, Baker Bluff Cave, Tennessee; 35.3%, Carrier Quarry Cave, Tennessee. The comparative abundance of the heather vole in these two Tennessee sites, at what must have been at or near the southern limit of their Wisconsinan range expansion, is puzzling.

Microtus chrotorrhinus (Miller)—rock vole

Material.—CM 24483–24486, 24643–24747. 29 left, 25 right M^3; associated molars and partial palates. MNI = 37. (Adjusted MNI = 57, see *Microtus pennsylvanicus* account for explanation).

Remarks.—The rock vole no longer occurs at the site. This is the rarest Appalachian *Microtus* and occurs sporadically in the mountains to the east. Linzey and Linzey (1971) record the species above 800 m in the Great Smoky Mountain National Park, usually in talus or under mossy logs and rocks in high humid forest, much the same habitat as the red-backed vole *Clethrionomys gapperi*.

The rock vole was present at all levels in the deposit, but it was relatively more abundant in the upper levels (Fig. 13) and accounted for only 6.3% of all voles. Their numbers relative to those of the meadow vole (*Microtus pennsylvanicus*) were high, 30.6%, reinforcing the impression of a cool forest habitat. This percent was virtually identical with that of Clark's Cave, 30.7%, suggesting that conditions for *Microtus chrotorrhinus* were equally favorable at both sites. These figures differ markedly, however, from those of the Carrier Quarry Cave, 24 km east of Baker Bluff (CMNH collections). At that site *Microtus chrotorrhinus* formed 5.2% of the vole fauna but 10% of the *M. chrotorrhinus*/*M. pennsylvanicus* sample, only a third of the figure for Clark's and Baker Bluff caves. The interpretation of such varying percentiles must await the analysis of other paleofaunas.

Microtus pennsylvanicus (Ord)—meadow vole

Material.—CM 24478–24482, 24636–24642. 61 left, 65 right M^2; 72 left, 65 right M^3; isolated molars and fragmentary palates. MNI = 84; adjusted MNI = 129.

Remarks.—The meadow vole is common in suitable moist grassy habitat in the immediate area (Phillips and Richmond, 1971; Smith et al., 1974), but is here at the southwestern edge of its eastern

North American range (Hall and Kelson, 1959). It is absent from west Tennessee (Severinghaus and Beasley, 1973). During late Pleistocene times its range extended much farther south, however. Webb (1974) records the meadow vole from at least four late Pleistocene sites in Florida.

Microtus pennsylvanicus was the commonest vole at Baker Bluff Cave from the 3–4 ft level, but decreased rapidly in relative abundance with depth, from 25% of all voles at the 3–4 ft level to 9.8% at the 7–10 ft level where it ran a poor third in relative numbers of voles, exceeded by three times as many *Synaptomys cooperi* and four times as many *M. pinetorum* and/or *M. ochrogaster* (Fig. 13). The decreasing abundance of *M. pennsylvanicus* with depth suggests drier conditions at the lower cave levels. This species prefers moist grasslands, although they may occur as forest enclaves.

Meadow vole remains accounted for 14.3% of all voles from the site (Fig. 16), a relatively low figure compared with that of Clark's Cave, Virginia, 32%, and New Paris No. 4, Pennsylvania, 30%. But this overall figure of 14.3% of all voles does not take into account the marked stratigraphic change from common in the upper levels of the site to scarce in the lower older levels. Thus it would be misleading to interpret the low relative number of *M. pennsylvanicus* from Baker Bluff Cave as due solely to the more southerly geographic location of the site. The meadow vole accounted for a high 31% of all voles from Robinson Cave, Tennessee (N = 227, Guilday et al., 1969), and an even higher 48% at Carrier Quarry Cave, Tennessee, only 24 km away (N = 212, CMNH collections) and just as far south as Baker Bluff. Both Robinson Cave and Carrier Quarry Cave lack some species of boreal affinity that were recovered at Baker Bluff Cave, *M. xanthognathus* for example, and probably postdate the site.

It is obvious that relative numbers of *M. pennsylvanicus* varied markedly from site to site, as well as stratigraphically, at Baker Bluff. But more data are necessary. We are at that unfortunate stage of too much data for simplistic explanations to suffice and too little to resolve the picture.

The adjusted minimum numbers of *M. pennsylvanicus* and *M. chrotorrhinus* were derived by dividing the minimum numbers of voles identified as either *M. pennsylvanicus* or *M. chrotorrhinus* on the basis of recovered M_1's (the commonest elements recovered) into two groups based on the percentage of the specifically identified M^3. This diagnostic tooth is smaller than the M_1, hence not as often recovered from fossil deposits due to its greater chance of destruction. This resulted in an adjusted increase in the minimum numbers of both species and made their numbers a truer relative approximation to the minimum numbers of other species of voles recovered from the site based on M_1 counts.

Microtus xanthognathus (Leach)—
yellow-cheeked vole

Material.—CM 24487–24490. 4 left, 1 right mandible; partial skull; left maxilla; left M^3. MNI = 4.

Remarks.—The yellow-cheeked vole is now found in the Hudsonian Life Zone of Alaska and northern Canada. Remains at Baker Bluff are confined to the upper levels of the deposit (Table 1, Fig. 13), suggesting at least marginal boreal conditions during the deposition of the upper cave levels.

The former occurrence of the yellow-cheeked vole in North American periglacial sites of Wisconsinan age is well documented (Guilday and Bender, 1960; Hallberg et al., 1974). It was a common vole in sites of this age in the central Ridge and Valley province where its remains were encountered by the hundreds in such sites as Clark's Cave or New Paris No. 4, where it dominated the vole faunas. At Baker Bluff Cave, however, only four individuals were recovered, 0.4% of the minimum number of all voles, and the animal was probably at or near the southern limits of its maximum Wisconsinan range extension (Fig. 16). Two other Sullivan County sites have produced boreal voles, Carrier Quarry Cave and Guy Wilson Cave (CMNH collections), but *Microtus xanthognathus* was not present. These sites may not, however, have been contemporaneous with the Baker Bluff deposit.

Microtus xanthognathus has been recorded slightly farther south in the American Midlands during late Wisconsinan times, 36°N, Peccary Cave, Arkansas (Hallberg et al., 1974). Dental measurements are given in Table 11 and Fig. 9.

Microtus pinetorum (Le Conte)—woodland
vole and/or
Microtus ochrogaster (Wagner)—prairie vole

Material.—CM 24471–24477, 24648–24654. 241 left, 254 right mandibles or M_1. MNI = 282.

Remarks.—The woodland vole (*Microtus pinetorum*) is widely distributed throughout Tennessee and is the commonest vole at the site today (Phillips and Richmond, 1971). *Microtus ochrogaster* does not occur in East Tennessee east of the Cumberland Plateau, but is common in grassy situations in west-

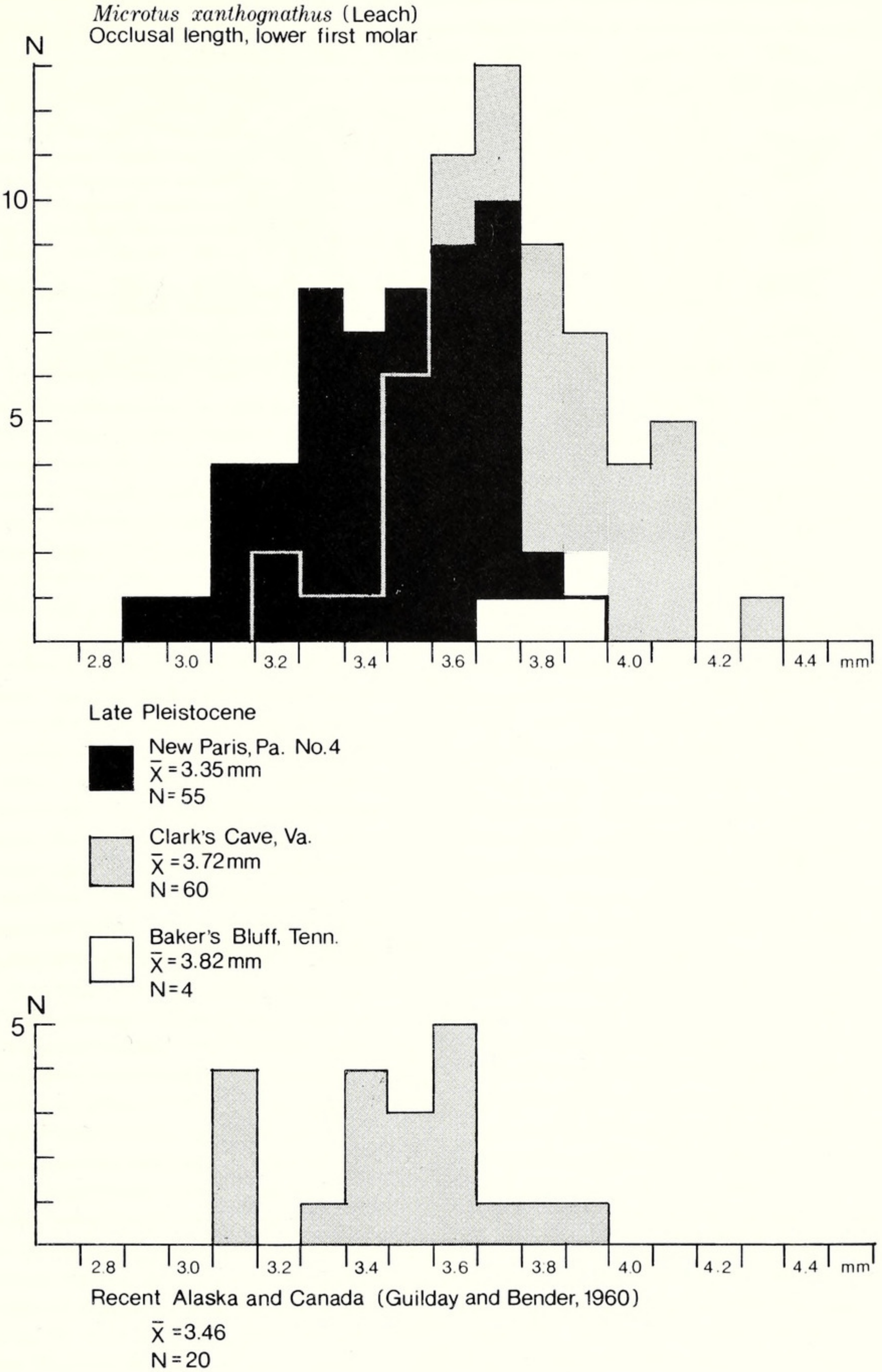

Fig. 9.—Histograms of length M_1 (in mm) *Microtus xanthognathus* (Leach), various localities.

Table 11.—*Measurements (in mm) of* Microtus xanthognathus *(Leach), various Pleistocene localities.*

Locality	Mean	OR	SD	CV	N	CMNH catalog nos.
		Occlusal length M_1				
New Paris No. 4, Pennsylvania	3.35	2.90–3.90	.22	6.34	55	6750, 6845, 6873, 6885,6930, 7150, 7171, 7179, 7185, 7192
Clark's Cave, Virginia	3.72	3.20–4.30	.215	5.78	60	24522
Baker Bluff Cave, Tennessee	3.80	3.70–3.90	—	—	4	24487–24488
		Occlusal width M_1				
New Paris No. 4, Pennsylvania	1.24	0.97–1.45	.11	8.74	56	as above
Clark's Cave, Virginia	1.29	1.07–1.46	.09	7.23	60	as above
Baker Bluff Cave, Tennessee	1.20	1.00–1.36	—	—	5	as above

central Tennessee (Phillips and Richmond, 1971; Barbour and Davis, 1974). In East Tennessee today, the meadow vole *M. pennsylvanicus* occupies the meadow, old-field niche to the exclusion of *M. ochrogaster* (Smith et al., 1974).

We do not trust our ability to differentiate *M. pinetorum* from *M. ochrogaster* on dental characters alone, the only criteria that can be used on the Baker Bluff Cave specimens. The difficulty lies in the amount of variation, individual and geographic, which cannot be satisfactorily assessed without a comprehensive study. Either or both species may be present in the deposit. We suspect both in the light of the presence of such western species as the thirteen-lined ground squirrel, least chipmunk, badger, and probably the black-billed magpie in the deposit.

M. pinetorum and/or *M. ochrogaster* accounted for 31% of the voles from the deposit. The relative numbers varied stratigraphically, increasing from 17.5% at the 3–4 ft level, to 45% at the 6–10 ft level (Fig. 13). Both are temperate species, their modern ranges stopping short of the boreal forest; *M. pinetorum* at 45°N and *M. ochrogaster* at 53°N, in the Central Plains (Hall and Kelson, 1959). No matter which of the two species is present in the Baker Bluff Cave collection, their decreasing relative numbers in the upper cave levels agrees well with the relative decrease of other temperate species from those same levels.

Relative numbers of *M. pinetorum* and/or *M. ochrogaster,* compared with those of other voles, fluctuate in late Pleistocene Ridge and Valley sites—0.9% at New Paris No. 4; 8% at Clark's Cave; 31% at Baker Bluff Cave (Fig. 16). The high figure from Baker Bluff Cave is due to its lower latitude or to an influx of *M. ochrogaster,* or both. Relative numbers of *M. pinetorum* to *M. ochrogaster* from eastern cave sites, and from the various stratigraphic levels at Baker Bluff Cave itself, might supply information about the relative abundance of deciduous woodland (*M. pinetorum*) and grassland (*M. ochrogaster*) during depositional times. Unfortunately "the state of the art" does not permit unequivocal identification from the dentition alone.

Ondatra zibethicus (Linnaeus)—muskrat

Material.—CM 30068–30070. 2 partial palates; partial left mandible; 6 isolated molars. MNI = 4.

Remarks.—Muskrat remains were scarce in the deposit, 0.4% of all arvicolids. They were also uncommon at the extensive Clark's Cave deposit, 0.2%. Both sites are primarily owl-roost deposits located beside rivers, but the low number of muskrats is probably due to predator bias. Adults are too large for many birds of prey and are protected by their semiaquatic habits.

Synaptomys cooperi Baird—southern bog lemming

Material.—CM 24448–24463, 24667–24673. 185 left, 168 right partial mandibles and/or M_1; 1 partial palate. MNI = 191.

Remarks.—Rare and local in the area today and indeed throughout most of its range, the southern bog lemming occurs here at the extreme southern edge of its range. Smith et al. (1974) record a specimen from the South Holston Dam, elevation 485 m within a few km of the site. Recent specimens are also known from Morristown, Hamblen County, 75 km SW of Baker Bluff Cave (University of Tennessee, Knoxville, collections). The southern bog lemming is seldom taken by modern trapping methods throughout the Appalachian area. They accounted for only 5.5% of all voles (N = 1,367) collected from central Pennsylvania (Gifford and Whitebread, 1951; Roslund, 1951). These results may be biased by both trapping methods and modern land usages, but at the Sheep Rockshelter, Pennsylvania, a prehistoric owl-roost deposit in the

Table 12.—*Measurements (in mm) of* Synaptomys cooperi *and* S. australis, *occlusal length* M_1.

Locality	Mean	OR	SD	CV	N
	Synaptomys cooperi Baird				
Pennsylvania, Recent*	2.48 ± .038	2.1–2.7	0.19	7.66	25
New Paris No. Pennsylvania, late Pleistocene	2.41 ± .020	2.3–2.5	0.09	3.73	20
Clark's Cave, Virginia, late Pleistocene	2.40 ± .019	2.2–2.7	0.11	4.75	33
Natural Chimneys, Virginia, late Pleistocene	2.39 ± .013	2.2–2.5	0.05	2.92	14
Robinson Cave, Tennessee, late Pleistocene	2.65 ± .014	2.3–2.9	0.122	4.61	71
Baker Bluff Cave, Tennessee, late Pleistocene	2.53 ± .007	2.2–2.8	0.13	5.21	265
Carrier Quarry Cave, Tennessee, late Pleistocene	2.55 ± .018	2.2–2.8	0.13	5.10	48
	Synaptomys australis Simpson				
Florida, CMNH collection	3.5	3.3–3.9	—	—	7

* Guilday et al., 1977:68.
** Guilday et al., 1969:57.

same area (Guilday and Parmalee, 1965) *S. cooperi* remains comprised only 7% of the voles suggesting that it was a relatively uncommon animal even prior to colonial deforestation. *Synaptomys cooperi* is also uncommon in late Wisconsinan sites from Pennsylvania and Virginia (Fig. 16), where it is usually outnumbered by remains of the northern bog lemming *S. borealis*.

Yet, surprisingly, *Synaptomys cooperi* was one of the commonest small mammals represented in the deposit at all stratigraphic levels, and in three other late Wisconsinan sites from Tennessee—Guy Wilson Cave and Carrier Quarry Cave, Sullivan County; Robinson Cave, Overton County. In the highest undisturbed level at Baker Bluff Cave, *Synaptomys cooperi* accounted for 17% of all vole remains and increased to a high of 34% in the lower 3 ft of the deposit (Fig. 13).

In addition to being more common in the area during late Wisconsinan times, *Synaptomys cooperi* remains are larger than those of modern eastern North American specimens (Table 12). There is a significant size difference between the small late Pleistocene specimens from Pennsylvania and Virginia, which average smaller in dental dimensions than Recent Pennsylvania specimens of *S. c. cooperi*, and M_1's from three Tennessee Pleistocene sites. M_1's from Baker Bluff Cave, Carrier Quarry Cave, and Robinson Cave average larger than both Recent and more northerly late Pleistocene specimens. *Synaptomys cooperi* today becomes larger with decreasing latitude, as does the Pleistocene material. This suggests there may be a yet-undemonstrated size continuum between *S. cooperi* and the large extinct *S. australis* from the Pleistocene of Florida. At present there is a size gap between the two populations, but there is also a geographic gap in Alabama and Georgia between the southern range limits of Pleistocene *S. cooperi* and the northern range limits of *S. australis* from which specimens have yet to be collected.

Synaptomys borealis (Richardson)—northern bog lemming

Material.—CM 24454–24458, 24674–24676. 10 left, 9 right partial mandibles and/or M_1. MNI = 12.

Remarks.—Remains of the northern bog lemming were scarce in the deposit, 1.3% of all voles, and largely confined to the upper stratigraphic levels (Fig. 13). This species no longer occurs in the central or southern Appalachian region. Its present range includes the coniferous forest and taiga of Canada and Alaska south to Minnesota and the White Mountains of New Hampshire, some 1,200 km northeast of Baker Bluff Cave.

The southeastern portion of the range of *S. borealis* overlaps the northern portion of the range of *S. cooperi* (Hall and Kelson, 1959). Both species are usually present in late Wisconsinan cave deposits from Pennsylvania to Tennessee. *S. borealis* is never a common species relative to other voles in such deposits, however, and becomes rarer with decreasing latitude (Fig. 16). Relative numbers of *S. borealis* to *S. cooperi* also change with latitude in late Wisconsinan Appalachian sites (Table 13). Sullivan County, Tennessee, marks the southern limit of its known late Pleistocene range.

Family Zapodidae—Jumping Mice

Zapus hudsonius (Zimmerman)—meadow jumping mouse

Material.—CM 30001–30002. 1 left, 2 right mandibles with M_1. 1 left M_1. MNI = 3.

Remarks.—Sparingly present in the upper levels

Table 13.—*Relative abundance of* Synaptomys cooperi *Baird and* Synaptomys borealis *(Richardson) in various late Wisconsinan Appalachian cave deposits, CMNH collections.*

Site	Latitude	MNI voles	% *Synaptomys cooperi*	% *Synaptomys borealis*	% *S. borealis* to all *Synaptomys*
New Paris No. 4, Pennsylvania	40°05′N.	1,212	1.32	5.8	82.0
Natural Chimneys, Virginia	38°22′N.	323	4.62	1.07	19.0
Clark's Cave, Virginia	38°05′N.	2,060	1.11	3.0	73.0
Carrier Quarry Cave, Tennessee	36°29′N.	212	14.60	—	—
Baker Bluff Cave, Tennessee	36°27′N.	899	21.24	1.3	5.9
Robinson Cave, Tennessee	36°17′N.	227	14.80	0.4	2.0

of the deposit (Table 1), remains of the meadow jumping mouse were not as common as those of the woodland jumping mouse. Both species were absent from the lower levels of the deposit which, in conjunction with other stratigraphic species shifts in the deposit, suggests more mesic conditions in the upper levels.

Zapus hudsonius has not been reported from the Ridge and Valley section of eastern Tennessee today, but it does occur farther east in the Great Smoky Mountains (Smith et al., 1974). It has been reported from low elevations farther west in the state, however (Severinghaus and Beasley, 1973), so it may occur near the cave at the present time. Remains of at least four individuals were recovered from the late Pleistocene deposits of Robinson Cave, Overton County, northcentral Tennessee. Length of M_1-M_3, one mandible, was 3.8 mm. Length of M_1, four specimens, was 1.4, 1.4, 1,4, 1.5 mm. Comparable measurements from the Robinson Cave deposit: M_1-M_3 = 3.5 mm; length M_1 = 1.2, 1.4, 1.55 mm.

Napaeozapus insignis (Miller)—woodland jumping mouse

Material.—CM 30003–30006. 3 maxillae; 2 mandibles; 2 isolated molars. MNI = 4.

Remarks.—Remains of the woodland jumping mouse in the upper levels of the deposits, from 3–7 ft depths, suggest a cooler more mesic environment than that of the lower-level fauna or the Recent local mammal fauna. At the latitude of Baker Bluff Cave the woodland jumping mouse occurs in the Great Smoky Mountains to the east, at altitudes of 760 m or more, in cool Transition or Canadian Zone hardwood/coniferous forests (Smith et al., 1974). Remains of *Napaeozapus insignis,* considerably south of their modern range, have also been reported from the late Pleistocene deposits of Robinson Cave, Tennessee, 256 km west of Baker Bluff, in association with other small mammals. Their presence at these sites suggests a cooler environment.

Dental measurements (Table 14) suggest that late Pleistocene *Napaeozapus insignis* from Robinson and Baker Bluff caves, Tennessee, were somewhat smaller than individuals from more northerly late Pleistocene deposits such as Clark's Cave, Virginia, and New Paris No. 4, Pennsylvania, thus paralleling the present day increase in size with increasing latitude (Wrigley, 1972).

Family Erethizontidae—Porcupines
Erethizon dorsatum (Linnaeus)—porcupine

Material.—CM 30065–30067. 5 isolated molars, 3 isolated premolars. MNI = 3.

Remarks.—Porcupine remains were confined to the upper levels of the deposit (Table 1). The animal

Table 14.—*Crown length (in mm)* M_1, Napaeozapus insignis *(Miller).*

Locality and age	Mean	OR	SD	CV	N
Recent					
Quebec, Ontario (CMNH collections)	1.6	1.6–1.6	—	—	3
Pennsylvania (CMNH collections)	1.6	1.5–1.8	.04	2.5	20
Late Pleistocene					
New Paris No. 4, Pennsylvania	1.8	1.7–2.1	.09	5.0	11
Clark's Cave, Virginia	1.7	1.6–1.9	—	—	27
Robinson Cave, Tennessee	1.7	1.6–1.8	.09	5.01	13
Baker Bluff Cave, Tennessee	1.66	1.6–1.8	—	—	3

is not a member of the Recent fauna of Tennessee, or of the southern Appalachians, but its remains have been recovered from caves and archaeological sites in central Tennessee, northern Alabama, and Georgia. These sites range in age from late Pleistocene to an estimated 3,000 to 5,000 years old (summarized in Corgan, 1976:11). But Bogan (1976) states that no remains of porcupines have been recovered from archaeological sites in East Tennessee. The porcupine has a predilection for rocky situations and may have survived in karst areas later than it might otherwise have during late Pleistocene climatic adjustments. Given the above fossil record its presence at Baker Bluff was expected and may not be of any climatic significance.

Order Carnivora—Carnivores
Family Canidae—Wolves and Foxes
Urocyon cinereoargenteus (Schreber)—gray fox

Material.—Dean/Wilson collection. Square 1, 0–6 in. Left humerus, immature. MNI = 1.

Vulpes vulpes Linnaeus—red fox

Material.—CM 29525, 29534, 29546. C_1; left M^2; right M_1; unassigned premolar. MNI = 3.

Remarks.—Remains of the gray fox were confined to the superficial Recent strata. Red fox remains were found only in the Pleistocene levels (Table 1).

Both red and gray fox are present in East Tennessee today. The red fox is not as common as the gray and prefers less heavily timbered areas (Smith et al., 1974). Kellogg (1939) speculates that the red fox may not have been native to the state. Evidence derived from analysis of mammal bones from pre-Columbian Indian garbage bears this out. Only gray fox remains occur in late prehistoric archaeological sites from Pennsylvania on south in eastern North America. The red fox appears to have been absent from the eastern forests south of New York state during most of Holocene times and extended its range to the south as Colonial deforestation resulted in copse-woodland, more to its liking. Red foxes have also been extensively stocked in the Southeast.

The presence of the red fox in the Pleistocene levels of Baker Bluff Cave does not contradict this picture. The presence of both boreal and steppe forms in the paleofauna suggest a more open, cooler environment compared to present day conditions and the red fox appears to have spread as far south as Florida, during at least the late Pleistocene, under the influence of expanding periglacial conditions. Pleistocene *Vulpes* remains have also been reported from Natural Chimneys, Virginia, and Vero Beach and Melbourne, Florida (Ray, 1958). With the waning of glacial conditions in post-Wisconsinan times the eastern range of the red fox contracted to the north, as far as archaeological evidence shows, to about the Pennsylvania-New York border, only to expand again within historic times under the influence of environmental changes brought on not by climatic shifts but by human land-use practices.

Family Ursidae—Bears
Ursus americanus Pallas—black bear

Material.—CM 29500, 29504–29505, 29512–29513, 29516–29518, 29545. 2 C^1; 1 C_1; 1 P^4; 1 M^2; 1 M_2; 2 M_3; 1 unassigned premolar. MNI = 4.

Remarks.—Black bear was represented by isolated teeth and a partial ulna. Teeth are comparable in size to those of Recent northeastern black bear (Table 15). These isolated elements undoubtedly represent woodrat detritus. Black bear remains are among the commonest of Appalachian cave finds.

Family Procyonidae—Procyonid Carnivores
Procyon lotor (Linnaeus)—raccoon

Material.—CM 29526, 29532, 29537, 29544. Isolated molars and premolars. MNI = 5.

Remarks.—Isolated raccoon teeth occurred at five different levels of the deposit, ranging from the surface material to the deepest 9–10 ft level. It is common in the area today and was probably so throughout the depositional history of the deposit.

Family Mustelidae—Mustelid Carnivores
Martes americana (Turton)—pine marten

Material.—CM 29509–29510, 29519, 29542. Right mandible with P_3-P_4, 2 M_1, 2 M_2, 1 M^1. MNI = 4.

Martes pennanti (Erxleben)—fisher

Material.—CM 29514. Right mandible with P_2; M_1. MNI = 1.

Mustela nivalis Linnaeus—least weasel

Material.—CM 29508, 29521, 29529. Right mandible with M_1M_2; left mandible with M_1; left M_1; 2 C; 2 P^4. MNI = 4.

Mustela frenata Lichtenstein—long-tailed weasel

Material.—CM 29507, 29520, 29527–29528, 29538–29539, 29541. Partial mandibles, isolated molars. MNI = 6.

Table 15.—Ursus americanus *Pallas, crown length and width (in mm)* M_2.

Locality	Age	OR length	OR width	N
East Tennessee, males Parmalee et al., in press	Recent	20.5–22.7	11.9–14.1	6
West Virginia archaeological sites, 46Pu31 and 46Fa7	Recent (1600 A.D.)	17.7–31.1	10.7–13.3	17
Baker Bluff Cave, Tennessee, CM 29517	Rancholabrean	18.7	11.5	1
Baker Bluff Cave, Tennessee, CM 29518	Rancholabrean	17.3	12.7	1

Mephitis mephitis (Schreber)—striped skunk

Material.—CM 29503. Right maxilla with P^3-P^4. MNI = 1.

Spilogale putorius (Linnaeus)—eastern spotted skunk

Material.—CM 29511, 29533, 29540, 29543. Partial mandible, isolated molars. MNI = 3.

Taxidea taxus (Schreber)—badger

Material.—CM 29549. I^3. MNI = 1.

Remarks.—Seven species of mustelids have been reported from East Tennessee within Recent times—fisher; striped skunk; spotted skunk; least weasel; long-tailed weasel; mink (*Mustela vison*); otter (*Lutra canadensis*) (Kellogg, 1939; Howell and Conaway, 1952; Smith et al., 1974). With the exception of the mink and the otter, both semi-aquatic, all Recent species were also present in the Baker Bluff Cave local fauna. Carnivore remains are scarce in raptor deposits, their numbers, usually in inverse proportion to their size, reflecting not their relative abundance during life but the inability of raptors to handle such aggressive animals. Isolated teeth or bones of the larger species may have been introduced into the deposit piecemeal by woodrats.

Striped skunk remains were confined to the disturbed top strata and spotted skunk remains to the lower late Pleistocene levels, but this distribution may be fortuitous.

The pine marten (*Martes americana*) is no longer found as far south nor the badger (*Taxidea taxus*) as far east as Tennessee. Within historic times the pine marten occurred only as far south as central Pennsylvania, 5° north of Baker Bluff Cave and its presence complements the large boreal element present in the paleofauna. Pine marten remains have also been reported from Robinson Cave, Overton County, Tennessee, and it is frequently found in mid-Appalachian late Pleistocene cave faunas (Guilday et al., 1977).

This is the first record of badger from the Pleistocene of Tennessee. Unfortunately its site provenience is unknown. Badger remains are known from late Pleistocene sites east and south of their present prairie range at Welsh Cave, Kentucky, Bootlegger Sink, Pennsylvania, and Baker Bluff Cave, Tennessee (CMNH collections). At all three sites the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), another western to midwestern grassland species, was also present, indicating an eastern spread of the modified steppe biota, at least in early post-Wisconsinan times. Pre-Wisconsinan, perhaps late Kansan, badgers have also been reported from two eastern cave deposits, Fort Kennedy Cave, Pennsylvania (Cope, 1899), and Cumberland Cave, Maryland (Gidley and Gazin, 1938).

Family Felidae—Cats

Felis onca Linnaeus—jaguar

Material.—CM 29547. P_4. MNI = 1.

Remarks.—Jaguar remains are common in Tennessee caves. Guilday and McGinnis (1972) list specimens from five cave sites in the state. There are no historic records and the Baker Bluff tooth from the lowest cave level is referred to *F. o. augusta*, the extinct late Pleistocene subspecies.

Order Artiodactyla—Even-toed Ungulates

Family Tayassuidae—Peccaries

Platygonus compressus Le Conte—flat-headed peccary

Material.—CM 29548, partial upper molar. CM 30229, LdP_2. MNI = 2.

Remarks.—These two molars, from an adult and a piglet, may have been introduced by rodents. Corgan (1976) records *Platygonus* from four Tennessee sites, two of them, Worley Cave and Guy Wilson Cave, in Sullivan County. Remains of at least 16 animals with a ^{14}C date of 19,700 ± 700 yr BP (I-4163) were recovered from Guy Wilson Cave (CM 20042, 20043, 20083–20101). This extinct species is common in late Pleistocene Appalachian sites.

Table 16.—*Anteroposterior length (in mm) teeth of* Odocoileus virginianus *(Zimmerman), Baker Bluff Cave, Tennessee, late Pleistocene; Eschelman Site, Pennsylvania (36 La 12), early historic; and Chota Site, Tennessee (40 Mr 2), early historic.*

Tooth	Locality	Mean	OR	SD	CV	N
dP^3	Baker Bluff Cave	14.0	—	—	—	1
dP^4	Baker Bluff Cave	11.5	11.0–12.0	—	—	2
dP_2	Baker Bluff Cave	7.8	7.0–9.0	—	—	5
dP_3	Baker Bluff Cave	9.7	9.0–11.0	—	—	8
dP_4	Baker Bluff Cave	15.7	15.0–17.0	—	—	4
P^2	Baker Bluff Cave	11.4	10.0–12.0	—	—	5
	Eschelman Site	11.9	11.0–13.0	—	—	25
P^3	Baker Bluff Cave	9.0	8.0–10.0	—	—	3
	Eschelman Site	10.5	9.0–12.0	—	—	29
$M^{1,2,3}$	Baker Bluff Cave	13.9	12.0–15.0	—	—	15
	Eschelman Site	14.6	12.0–16.0	—	—	80
P_2	Baker Bluff Cave	8.2	7.0–9.0	—	—	9
	Eschelman Site	9.1	7.0–10.0	—	—	20
P_3	Baker Bluff Cave	10.8	10.0–12.0	—	—	5
	Eschelman Site	11.4	10.0–13.0	—	—	23
P_4	Baker Bluff Cave	11.0	10.0–13.0	—	—	10
	Eschelman Site	11.7	10.0–13.0	—	—	25
M_1 or M_2	Baker Bluff Cave	13.4	12.0–16.0	—	—	22
	Eschelman Site	14.5	12.0–17.0	—	—	53
M_3	Baker Bluff Cave	19.1	18.0–23.0	—	—	8
	Eschelman Site	20.7	19.0–24.0	—	—	26
	Chota Site	19.4	17.0–22.3	1.18	6.06	49

Family Cervidae—Deer
cf. **Cervus elaphus** Erxleben—elk

Material.—CM 29530, unerupted right M_3; CM 30226, left dP^3 (0–3 ft, Dean collection). MNI = 1.

Remarks.—Identification of CM 29530 is based primarily on size and is tentative because the tooth appears to be congenitally deformed. A normal cervid M_3 is trilobed. The posterior lobe is reduced in *Rangifer* but is prominent in other cervids. It may rarely be absent in *Odocoileus* (Guilday, 1961). The third lobe is reduced to a low cingulum in CM 29530. The external valley between the anterior and central lobe appears cramped compared with *Rangifer* or normal *Cervus elaphus* specimens. The ectostylid is absent. Size as in *Cervus elaphus.*

Elk are not present in Tennessee today, but in pre-Colonial times were common and their remains occur in Holocene archaeofaunas as far south as North Alabama (Barkalow, 1972).

Odocoileus virginianus (Zimmerman)—white-tailed deer

Material.—CM 30051–30057. 1 dP^3, 2 dP^4, 5 dp_2, 8 dP_3, 4 dP_4, 5 P^2, 1 P^2 or P^3, 3 P^3, 2 P^3 or P^4, 9 M^1, 2 M^1 or M^2, 2 M^2, 2 M^3, 2 M^1, M^2 or M^3, 10 P_2, 6 P_3, 9 P_4, 13 M_1, 11 M_2, 1 M_1 or M_2, 8 M_3, 3 incisors. MNI = see discussion below.

Remarks.—The Baker Bluff Cave white-tailed deer, at all levels, were the same size as their Recent Tennessee counterparts. Molar teeth agreed in size with historic archaeological specimens from a Cherokee Indian village site (Chota Site, 40 MR 2, Monroe County, Tennessee, Table 16). This is interesting and somewhat surprising considering the presence of boreal small mammals in the upper levels of the deposit. Modern deer become larger with increasing latitude (Doutt, no date) and one might have expected the Baker Bluff deer to have been larger than Recent local deer as a reflection of more boreal conditions. But compared with archaeological deer dentitions from only as far north as Pennsylvania (Eschelman Site, 36 LA 12), Guilday et al., 1962), Baker Bluff Cave deer are smaller in all dental dimensions by 4.8% in the upper molars and 7.6% in the lower molars (Table 16). This is also true of Pennsylvania versus Tennessee archaeological material and points up the necessity for using local comparative material if valid comparisons are to be made between Pleistocene and Recent *Odocoileus.*

If the size of northern white-tailed deer today is correlated with environment, then the size of the Baker Bluff Cave specimens do not suggest boreal conditions at the site. Although the deposit extends throughout the late Pleistocene and early Holocene and environmental change during that period is evident throughout the stratigraphic column there was no correlation between dental dimensions of deer and depth in the deposit.

Some measure of the stratigraphic dispersal of large mammal elements in the deposit may be gained from the fact that by lumping isolated teeth from all levels, a minimum of only five adult deer and five fawns could be accounted for, but if analyzed by stratigraphic level with no reference to levels above or below, 14 adults and seven fawns were represented when levels were totaled. A broken premolar from the 8–9 ft level fit a similar fragment from the 9–10 ft level. As with all large mammals remains in the deposit, deer bones and teeth probably accumulated by sporadic woodrat caching with a greater loss of stratigraphic integrity compared to the small vertebrate, owl-deposited, debris.

cf. **Sangamona fugitiva** Hay—"fugitive" deer

Material.—CM 29501, P^4; CM 30060, left P_3. MNI = 1.

Remarks.—The P^4 was compared with the referred dentition from Frankstown Cave, Pennsylvania (CM 11044). Upper premolars of *Sangamona* are much larger relative to the molars than are those of *Odocoileus,* and there is little likelihood of confusing them with white-tailed deer on size alone. They are, however, about the size of premolars of the large *Rangifer* from the deposit. As noted by Hay (1920) the weak buccal ribbing of *Sangamona* cheek teeth appears to be definitive. The P_3, identical in cusp conformation with *Cervus* or *Odocoileus,* was referred to *Sangamona* because of its intermediate size. It differs from a P_3 of *Rangifer* in cusp conformation.

Remains of this deer have been reported from two other Tennessee localities—the type locality, Whitesburg, Hamblen County (Hay, 1920), and Robinson Cave in Overton County (Guilday et al., 1969).

Measurements of P^4 are (CM 29501), length 14.0, width 15.8 mm; P_3 (CM 30060), width 9.6 mm.

Rangifer tarandus Linnaeus—caribou

Material.—CM 24588. Left P_4 (Fig 10). CM 24681, 29502, 30058, 30061. Left P^3 or P^4; right P_2, P_4, M_2. CM 30274. Partial left humerus. MNI = 2.

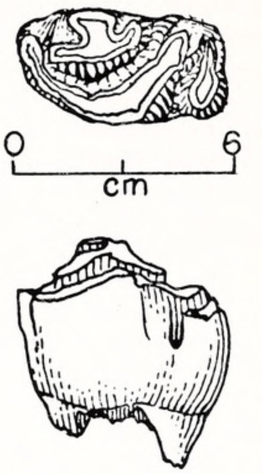

Fig. 10.—*Rangifer tarandus* Linnaeus, CM 24588, left P_4, occlusal and labial views, anterior to left, Baker Bluff Cave, Sullivan County, Tennessee.

Remarks.—One P_4, CM 24681, was found by S. D. Dean, Jr., in the upper 1 ft of the Baker Bluff Cave deposit mixed with Indian cultural refuse, but was probably displaced from the underlying Pleistocene levels by human activity. The occurrence of caribou from this and two other Tennessee cave deposits, Beartown Cave and Guy Wilson Cave, also in Sullivan County, is discussed and specimens figured in Guilday et al. (1975). This marks the southernmost North American extension of the genus *Rangifer*.

Order Perissodactyla—Odd-toed Ungulates
Family Tapiridae—Tapirs
Tapirus cf. **veroensis** Sellards—Vero tapir

Material.—CM 29522. Left P^1 (Fig. 8). MNI = 1.

Remarks.—The crown length of 18.7 mm and crown width of 15.5 mm of this isolated premolar lie within the range of *T. veroensis* Sellards, smaller than the mid-Pleistocene *T. copei* Simpson, as presented by Lundelius and Slaughter (1976). Tapirs are common Pleistocene fossils in eastern cave deposits from Pennsylvania south to Florida. Corgan (1976) records remains from nine other East Tennessee caves.

FAUNAL SUMMARY

The Baker Bluff Cave faunal sequence consists of at least 180 species of vertebrates and invertebrates—3 freshwater snails, 50 land snails, 1 mussel, 14 fish, 10 amphibians, 13 reptiles, 29 birds, and 60 species of mammals. About 2,600 individual molluscs and 2,305 vertebrates were present.

Mammals accounted for 82.8% of all individual vertebrates, birds 7.2%, amphibians 6.9%, reptiles

2.3%, and fish .67%. Fish are underestimated because of the difficulty of estimating minimum numbers of individuals from fragmentary material.

Forty-six of the 50 species of land snails still occur in the area. According to Leslie Hubricht, one species of *Stenotrema* is undescribed and has not yet been found alive. Three other land snails do not occur at the site today—*Hendersonia occulta*, present in central Tennessee; *Discus catskillensis*, a montane form reaching its southern limits in Highland County, Virginia; and *Stenotrema fraternum fasciatum*, a montane form. All other invertebrates are present in the area today.

All identified species of fish, amphibians, and reptiles still occur regionally.

Two birds, cf. *Pica pica* and *Ectopistes migratorius*, and 10 species of mammals no longer occur in the southern Appalachian area—*Sorex arcticus*, *Eutamias minimus*, *Spermophilus tridecemlineatus*, *Phenacomys intermedius*, *Microtus xanthognathus*, *Synaptomys borealis*, *Erethizon dorsatum*, *Martes americana*, *Taxidea taxus*, and *Rangifer tarandus*. Nine species of mammals occur today only at higher elevations in the southern Appalachians—*Microsorex hoyi*, *Sorex cinereus*, *Sorex dispar*, *Condylura cristata*, *Tamiasciurus hudsonicus*, *Glaucomys sabrinus*, *Clethrionomys gapperi*, *Microtus chrotorrhinus*, and *Napaeozapus insignis*. Four species were represented by forms larger than those now inhabiting the area—*Blarina brevicauda*, *Tamias striatus*, *Glaucomys volans*, and *Synaptomys cooperi*. Six taxa are extinct—*Dasypus bellus*, *Castoroides ohioensis*, *Felis onca* cf. *augusta*, *Sangamona fugitiva*, *Platygonus compressus*, and *Tapirus* cf. *veroensis*.

In summary, 29 taxa of mammals, 48% of the 60 mammalian taxa from the site, differed in some fashion from the modern mammalian fauna. Ten percent are extinct; 16.6% are found only north or west of the site in either a boreal forest or a temperate grassland habitat today; 15% have retreated to higher elevations in the southern Appalachians; and an additional 6.6% have decreased in bodily size at least locally since depositional times. No taxa of southern distribution such as *Sigmodon*, *Ochrotomys*, *Reithrodontomys*, or *Oryzomys* were present in the deposit, although each of these four rodent genera occur at or near the site today (Smith et al., 1974).

Faunal Analysis—Stratigraphic Change

There is a marked change in faunal composition between the upper and lower levels of the site (Figs. 11, 12, and 13). Those species of small mammals found in cooler regions today, either at higher latitudes in Canadian/Hudsonian zone situations or at higher altitudes in the southern Appalachians, were relatively more abundant in the upper levels of the deposit.

Stratigraphic analysis begins at the 3 ft level (3 ft from the original cave floor surface prior to the Dean excavation). All stratigraphic levels are arbitrary. Natural stratigraphic levels were either not present or were not noticed under the awkward excavating conditions. Remains of large mammals were not considered. They are present in such small numbers that statistical comparison is not feasible and their presence in the deposit is probably due to capricious woodrat scavenging.

Remains of small mammals were numerous at every level. These animals were probably collected by raptors hunting the local countryside with regularity and, unlike the sparse large mammal material, their presence, absence, or relative abundance up and down the stratigraphic column takes on interpretative significance. Minimum numbers used for stratigraphic analysis were, in the case of shrews and voles, based upon minimum numbers of individuals derived from tooth or mandible counts. In the case of the squirrels (*Marmota* omitted), numbers of M^1's and M^2's of each species were combined per level in order to increase sample sizes and lessen the effect of random fluctuations.

Results of the analysis of shrew, squirrel, and vole remains tell a consistent complementary story.

There were seven species of shrews recovered from the deposit. Only three, *Blarina brevicauda*, *Sorex cinereus*, and *Sorex fumeus*, occurred at all stratigraphic levels (Fig. 11). Two additional species of *Sorex* occurred sparingly in the upper 3–5 ft levels, *S. arcticus*, a boreal woodland species no longer found in the Appalachians, and *S. dispar*, a woodland rock-talus species found at higher elevations in the mountains east of the site. Two other shrews were also present sparingly in the upper levels, *Microsorex hoyi*, of boreal affinities and not a member of the Recent fauna of the state, and *Cryptotis parva*, a temperate grassland/old-field species. Long-tailed shrews, genus *Sorex*, were commonest in the upper stratigraphic levels, 63% of all shrews, twice as prevalent as *Blarina brevicauda*, the common temperate/woodland shrew of the Baker Bluff area today.

Blarina brevicauda increased in numbers with depth while shrews of the genera *Sorex*, *Microsorex*, and *Cryptotis* became relatively scarce or dis-

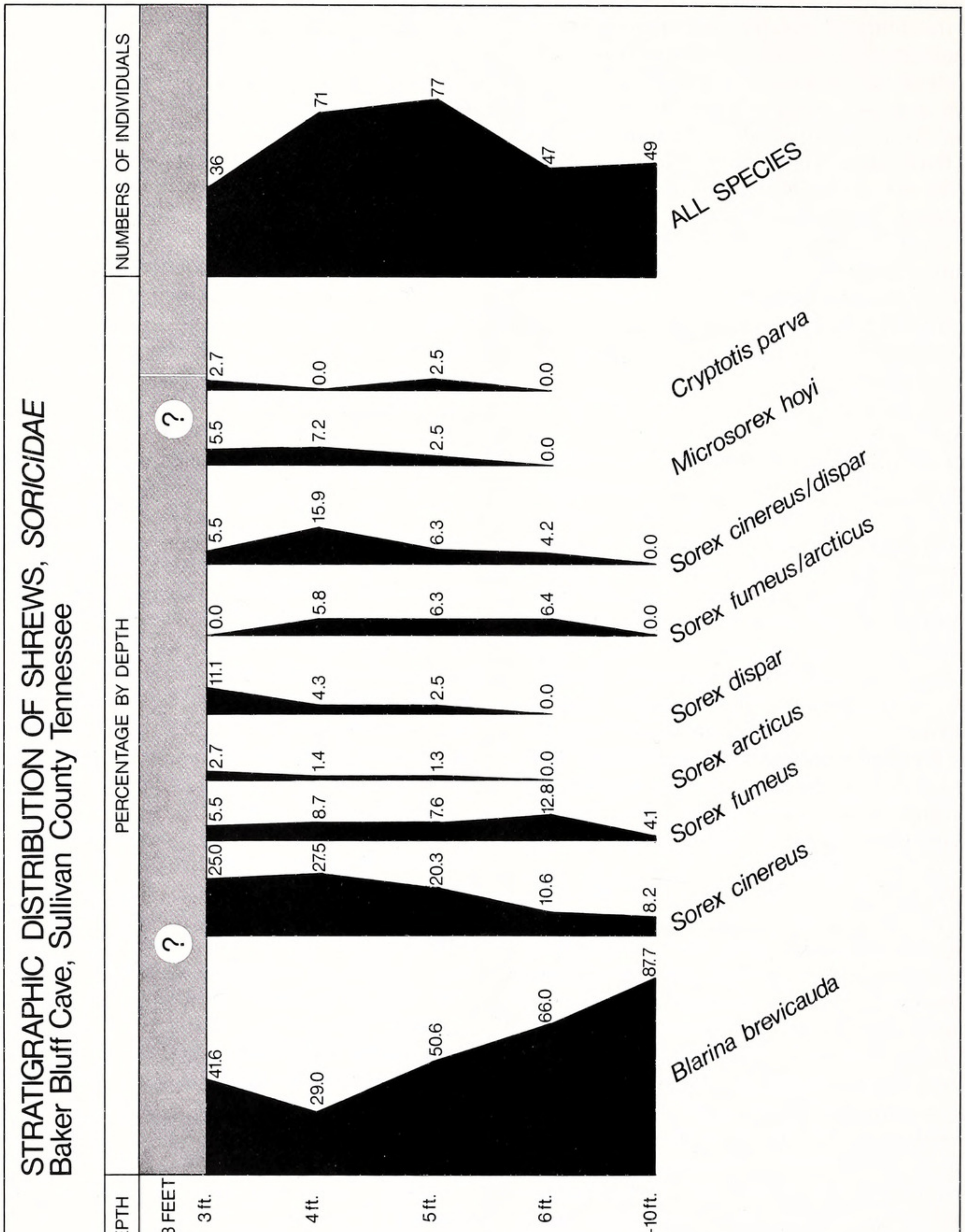

Fig. 11.—Shrews, Family Soricidae. Stratigraphic distribution, Baker Bluff Cave, Sullivan County, Tennessee.

appeared from the stratigraphic column. An interesting infraspecific situation occurs in *Blarina brevicauda* from the deposit. The upper cave levels contained two distinct sizes, a smaller form similar to *B. b. kirtlandi,* the subspecies currently found in the area, and a larger form similar to the large northern race, *B. b. brevicauda* of the Minnesota/Wisconsin area and also to the large *Blarina* from late Pleistocene sites farther north in the Ridge and Valley province, New Paris No. 4, Pennsylvania, and Clark's Cave, Virginia.

The increase in numbers and variety of soricine shrews and the influx of a northern form of *Blarina* in the upper levels of the deposit suggest a transition to cooler boreal forest conditions in the upper levels that would support shrews now confined to higher altitudes or latitudes.

Paralleling the stratigraphic behavior of the voles and shrews from the deposit, numbers of boreal sciurids, *Tamiasciurus hudsonicus* and *Glaucomys sabrinus,* increased in the upper levels (Fig. 12), whereas relative numbers of temperate species, *Sciurus carolinensis, Glaucomys volans,* and *Tamias striatus* increased with depth. The red squirrel (*Tamiasciurus hudsonicus*) and the northern flying squirrel (*Glaucomys sabrinus*) are characteristic of the northern hardwood/boreal coniferous forest belt of North America. The gray squirrel (*Sciurus carolinensis*) and the southern flying squirrel (*Glaucomys volans*) are temperate deciduous-forest forms common in the Baker Bluff area today. Numbers of the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), a midwestern prairie form today, increased dramatically from 2.2% in the lowest levels of the deposit to over 30% in the upper levels where it was the commonest species of sciurid. This reinforces a suggested change from closed to open-canopy forest in the upper levels of the deposit and is reflected by the correlated increase in numbers of the meadow vole (*Microtus pennsylvanicus*). The least chipmunk (*Eutamias minimus*), confined to the upper levels of the Baker Bluff deposit, also suggests a boreal parkland.

Much the same picture of stratigraphic change from cool temperate-woodland to boreal forest conditions of some sort is suggested by the voles from the deposit (Fig. 13). All boreal forest species decrease in relative numbers with depth, *Clethrionomys gapperi, Phenacomys intermedius, Microtus chrotorrhinus. Microtus xanthognathus,* a boreal taiga species today, is confined to the upper levels of the deposit. Remains of *Synaptomys borealis,* rare in this southern site, occurred throughout the stratigraphic column but become rarer relative to numbers of the temperate *S. cooperi,* with increasing depth. Only temperate species *Synaptomys cooperi* and voles of the subgenera *Pitymys* or *Pedomys,* increased in numbers with depth, and they did so markedly. A cooling trend as one ascends the stratigraphic column is suggested. A change in the woodland to grassland ratio is also suggested by a rise in relative numbers with decreasing depth of *Microtus pennsylvanicus,* a moist-grassland species, an observation reinforced by the stratigraphic distribution of the Sciuridae.

Detailed ecological reconstruction is obscured by the complicated topography of the area and the southern location of the site. While it has undergone considerable Pleistocene and post-Pleistocene change, it has done so under relatively benign conditions. Water has been available throughout its Quaternary history so that climatic changes cannot be as closely monitored by accompanying biotic changes as they can in the arid (today) West where organisms exist under more confining strictures.

Nevertheless a definite change from temperate to boreal small mammal species is noted at Baker Bluff Cave as one ascends the stratigraphic column. But the presence of such boreal species as *Synaptomys borealis* and *Phenacomys intermedius* in the lowest cave levels suggests that the lower level climatic episode was cooler than that of the Sullivan County area today.

DATING AND CORRELATIONS

Carbon-14 dates from the CMNH excavations at Baker Bluff Cave are as follows: 555 ± 185 years, BP, bone apatite, GX-3369, 4–5 ft level; 10,560 ± 220 years BP, bone apatite, GX-3370a, 6–7 ft level; 11,640 ± 250 years BP, bone collagen, GX-3370b, 6–7 ft level; 19,100 ± 850 years BP, bone apatite, GX-3495, 9–10 ft level. All dates were run on uncharred bone fragments selected from each level at

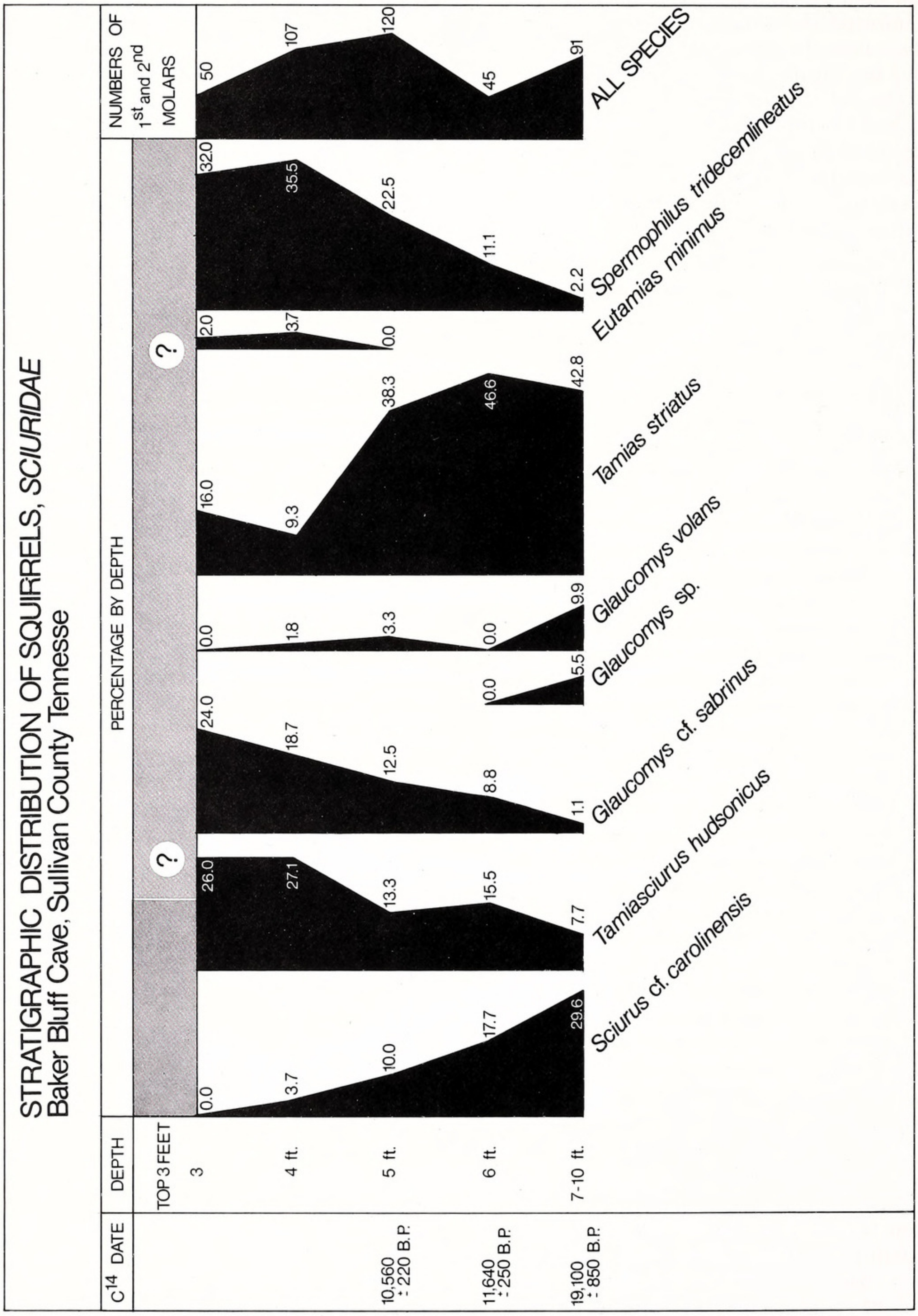

Fig. 12.—Squirrels, Family Sciuridae (*Marmota monax* omitted). Stratigraphic distribution, Baker Bluff Cave, Sullivan County, Tennessee.

random. Surface contamination may be present due to modern plant roots occurring throughout the deposit and perhaps from rodent burrowing. This is suggested by the relatively late date at the 4–5 ft level. Dates below 6 ft indicate a late Wisconsinan sequence.

The basal date of 19,100 ± 850 years BP suggests that infilling began in full-glacial times. The faunal interpretation indicates a transition from cool-temperate to boreal as deposition proceeded. This suggests that deposition occurred during the recovery phase of an interstadial. Alexsis Dreimanis, University of Western Ontario (personal communication), tentatively suggests that deposition at Baker Bluff Cave may have begun during the Connersville Interstadial, from 22,000 years BP to slightly less than 21,000 years BP. During this time the Laurentide ice mass retreated from its maximum boundary some 40 to 100 km over a broad front in Indiana and Ohio and the climate was apparently less severe. "The presence of spruce wood and even 'forest bed' in the Connersville interstadial silts suggests that open woodland probably reoccupied the area deglaciated during this interstade, and the climate was not too rigorous" (Dreimanis, 1977:74). It is possible that the more temperate conditions suggested by the lower level paleofauna at Baker Bluff Cave may record this interstadial or the influence of its later stages as climatic deterioration began again. The depositional sequence may record the transition from interstadial to renewed glacial conditions. Pollen studies from Quicksand and Bob Black Ponds, Bartow County, Georgia, 34°19'30"N, 310 km SW of the cave in the Ridge and Valley province, do not seem to indicate any interstadial oscillations after 22,900–20,100 years BP. Rather, a *Pinus-Picea* full-glacial boreal pollen assemblage followed in early postglacial times by a *Quercus*-dominated flora superseded by a modern *Pinus*-dominant woodland (Watts, 1970), is indicated.

It remains to be seen whether short-term interstadial oscillations produced relatively large-scale biotic adjustments as far south as Tennessee. The faunal change recorded in the Baker Bluff Cave deposits suggests that they might, assuming that the accompanying ^{14}C dates are correct. Watts' data suggest that they do not. The presence of tree roots throughout the excavation may cast doubt as to the validity of the dates. They may be too young and the deposit may represent a time interval prior to the full Wisconsinan maximum when climatic conditions were worsening.

THE RIDGE AND VALLEY PROVINCE FAUNAL GRADIENT

Three late Pleistocene cave deposits, New Paris No. 4, Pennsylvania, Clark's Cave, Virginia, and Baker Bluff Cave, Tennessee, lie along a 550 km transit of the Ridge and Valley physiographic province, 150 km, 340 km and 370 km respectively southeast of the terminal Wisconsinan moraines (Fig. 1). Sites and morainal lines trend northeast/southwest so that the distance differential south of the maximum continental glaciation is less than their actual distances apart. The three sites are spaced approximately two degrees of latitude from each other and extend from 40°N to 36°30'N. The maximum southern limit of the Laurentide Ice Sheet was approximately 39°N in the central lowlands of Illinois, Indiana, and western Ohio (Flint, 1971).

The sites lie in the unglaciated portion of the Ridge and Valley province (= Valley and Ridge province of Hunt, 1974), a narrow belt of long even-crested NE/SW trending parallel ridges and intermontane valleys formed of folded Paleozoic rocks 80 to 120 km wide lying between the Appalachian Plateau (Allegheny Plateau to the north, Cumberland Plateau to the south) and the higher pre-Cambrian Great Smoky Mountain/Blue Ridge/South Mountain range on its eastern boundary. Ridgetop elevations average 480 m, valley floors 360 m. The central portion of the Ridge and Valley province lies in the rainshadow of the Appalachian Plateau. This is especially marked in its central portion and has produced mildly xeric "shale barrens" that occur along the crest of low shale hills on the valley floors from southern Pennsylvania south to southern Virginia (Keener, 1970) and support several plant endemics of midwestern and coastal plain affinities. The drop in precipitation may be as much as 25–35 cm just east of the plateau at New Paris No. 4, Pennsylvania; it is also apparent at the latitude of Clark's Cave, Virginia, but is hardly evident as far south as Baker Bluff, Tennessee.

The topography of the Ridge and Valley province is such that a number of long parallel sheltered val-

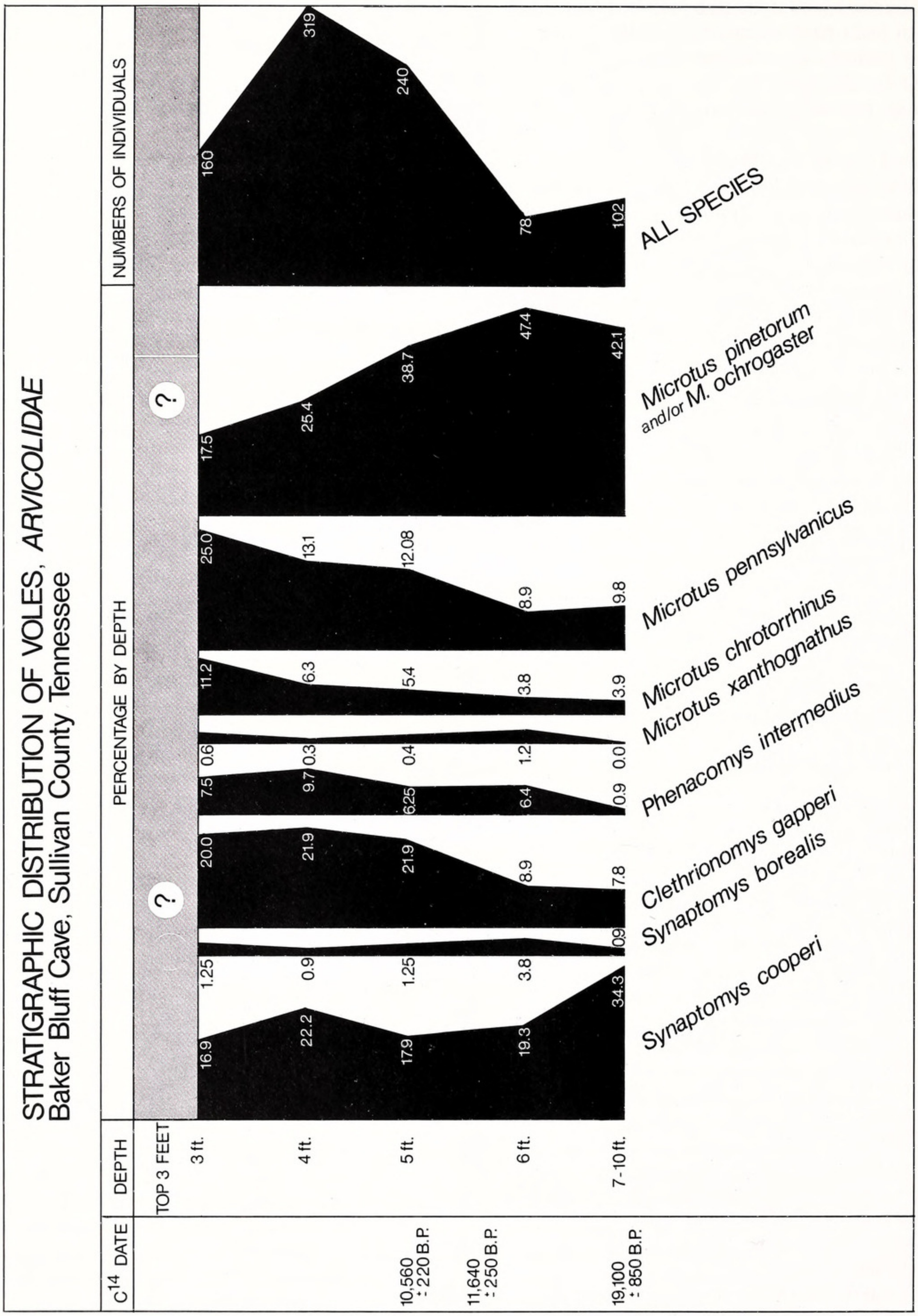

Fig. 13.—Voles, Family Arvicolidae (*Ondatra zibethicus* omitted). Stratigraphic distribution, Baker Bluff Cave, Sullivan County, Tennessee.

leys lead south or southwest from the former continental glacial margin directly into the southland unencumbered by any topographic obstacles for over 1,300 km. These long conduits, walled by ridges, should have furnished ideal migratory routes for northern late Pleistocene megafauna. They could also have provided relatively sheltered lanes for the northern penetration of tapir or armadillo into the central Appalachians.

The three sites are all late Wisconsinan or early Holocene but may not be exactly contemporaneous. New Paris No. 4, Pennsylvania, was a 10-m sinkhole fissure choked with colluvium, clay, and bones with a pollen profile indicative of an open *Picea/Pinus* cf. *banksiana* woodland and a ^{14}C date of 11,300 ± 1,000 years BP. Infilling was relatively rapid and the site data is interpreted as representing a transition from an open to a closed boreal woodland. Remains of 2,430 individual mammals were recovered.

Clark's Cave, Virginia, 243 km to the south of New Paris No. 4, was an extinct raptor roost at the mouth of a large cave. Its precise age is unknown, probably late Wisconsinan. Remains of 4,343 individual mammals were recovered.

Baker Bluff Cave, Tennessee, 307 km south of Clark's Cave, 550 km south of New Paris No. 4, was a 3-m stratified fissure fill just inside the antechamber of a small cave. Radiocarbon dating suggests that deposition began at about 19,000 years BP and the fauna records a transition from cool/temperate deciduous/coniferous woodland to boreal coniferous parkland. The top 1 m of the deposit was disturbed by both an aboriginal occupation and modern private excavations, so that evidence of the Pleistocene/Holocene transition was destroyed and late Pleistocene and Holocene material was intermingled. Remains of 1,909 individual mammals were recovered.

On the basis of ^{14}C dates the mid-levels of the Baker Bluff deposit, 10,560 to 11,640 years BP are contemporaneous with the New Paris No. 4 deposit. The Clark's Cave deposit is no younger than the late Wisconsinan/early Holocene faunal change about 10,000 years BP.

All three sites contain boreal, mid-continental, and eastern temperate elements in their respective paleofaunas. They demonstrate a faunal gradient both quantitatively and qualitatively in the direction boreal to temperate, from north to south. Only small mammals, shrews (Soricidae), squirrels (Sciuridae), and voles (Arvicolidae) are analyzed because of their abundance in each of the three sites (Figs. 14, 15, 16).

It is difficult to obtain a modern faunal equivalent for comparison. Most modern mammal collections are not heavily concentrated but reflect the regional ecology, agricultural lands, and multiple-growth woodlands, so that the relative numbers of small mammals do not represent the primeval climax fauna under the present climatic regime. Data are presented, however, for 1,447 soricids, 407 sciurids, and 1,367 arvicolids in the CMNH mammal collections from the Ridge and Valley section of central Pennsylvania—39°43′N to 42°N (Gifford and Whitebread, 1951; Roslund, 1951). Forest cover within the area today varies from 19% to 98% with a 22 county average of 61%. Collecting was concentrated in woodlands, forest edge, and meadowlands. Derived percentages of small mammals do not approximate those of primeval times but do accurately represent the present picture.

Small mammals at New Paris No. 4 were concentrated by tumbling into a funnel-shaped fissure opening; those at Clark's Cave and Baker Bluff by the hunting activities of birds of prey. The former site represents a local sample; the latter two microfaunas were drawn from a larger collecting area. Owls are opportunistic feeders, taking small vertebrates as they are encountered, but may differ in their habitat preferences. Some, the barn owl (*Tyto alba*) or the short-eared owl (*Asio flammeus*), hunt open country; others, such as the long-eared owl (*Asio otus*), prefer woodland and thicket.

Despite these obvious sources of bias and the fact that the data for New Paris No. 4 and Baker Bluff Cave represent pooled strata, comparative analysis does indicate some trends. As one progresses from north to south, New Paris No. 4, Pennsylvania, to Clark's Cave, Virginia, to Baker Bluff, Tennessee, the respective paleofaunas become progressively less boreal. Species of northern affinities either disappear from some faunas (collared lemming, *Dicrostonyx hudsonius*), or are present in diminishing numbers, whereas temperate species increase in relative numbers from north to south. Although boreal species are found at all three sites, the most southern of the paleofaunas, Baker Bluff Cave, most closely resembles the modern Pennsylvania temperate small mammal fauna.

Some few species did not follow this boreal to temperate gradient. The heather vole (*Phenacomys intermedius*) and the least chipmunk (*Eutamias minimus*) increased in relative numbers with dimin-

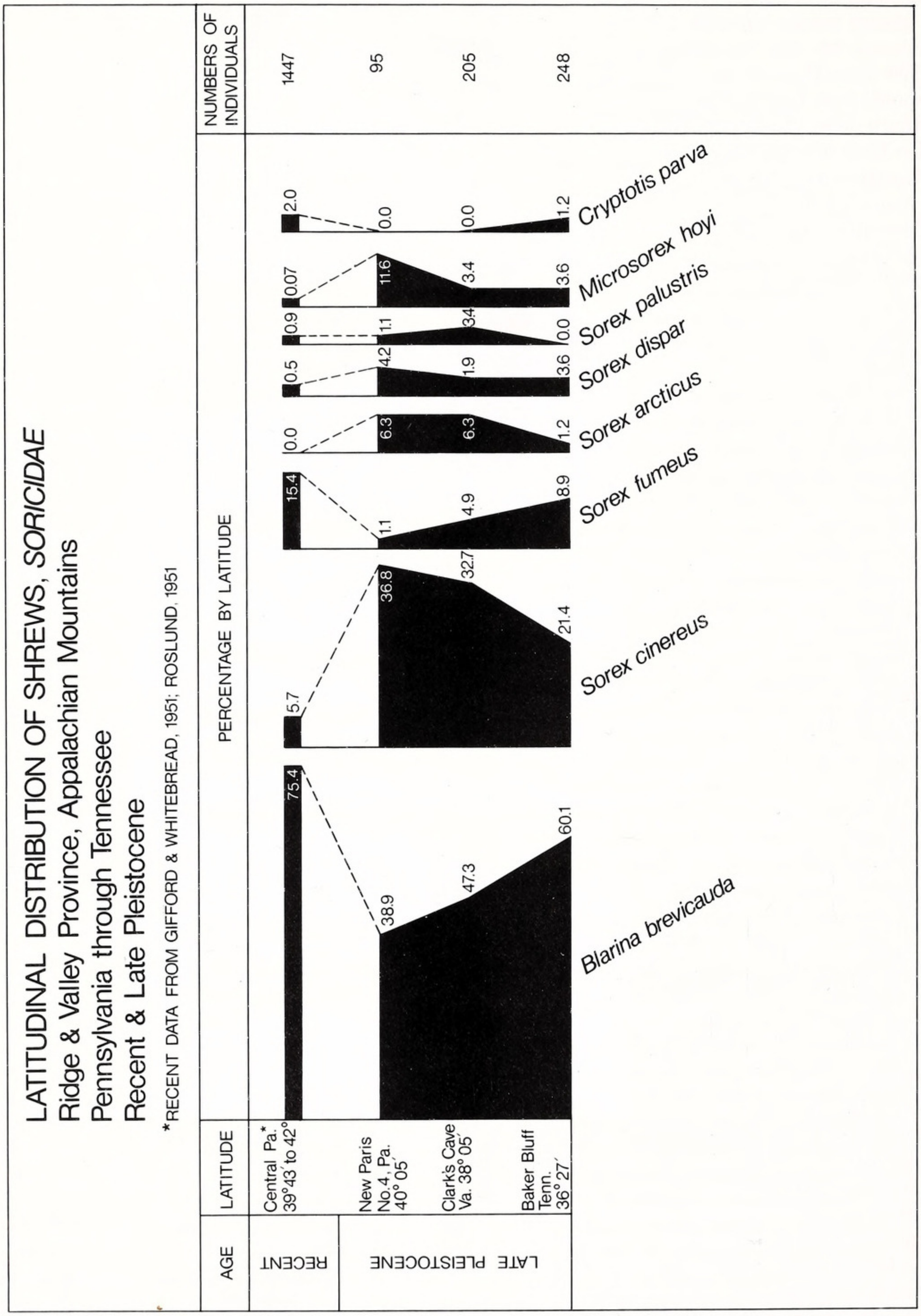

Fig. 14.—Shrews, Family Soricidae, late Pleistocene and Recent relative faunal composition, various sites, Ridge and Valley province, eastern USA.

ishing latitude. The number of *Eutamias* at any one site, however, is so low that relative numbers are meaningless, but the unexpected increase in *Phenacomys* to 7.1% of the Baker Bluff Cave vole fauna appears to have been a real event. It is supported by similar large relative numbers of *Phenacomys* (5.6% of all voles) from Carrier Quarry Cave, also in Sullivan County, Tennessee. One interesting lump of cave breccia from Carrier Quarry Cave (CM 30217) contains an incomplete but uncrushed skull of *Phenacomys* with associated mandibles and a partial skull of either *Microtus pinetorum* or *M. ochrogaster* in direct association, indicating contemporaneity of these now allopatric boreal and temperate voles. The relative increase of *Phenacomys* at Baker Bluff Cave may be associated with a marked increase in numbers of the midcontinental thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) and the relative absence of small mammals typical of mesic environments such as soricine shrews and the meadow vole (*Microtus pennsylvanicus*).

The voles furnish the most striking evidence of the boreal affinities of these three late Pleistocene Ridge and Valley paleofaunas relative to the fauna of the Recent Appalachian area. Five species currently live in the area (Fig. 16, central Pennsylvania; *Ondatra* omitted from analysis), but nine species were present at New Paris No. 4, and at least eight at both Clark's Cave and Baker Bluff Cave. The minimum number of individual voles of species still extant in the area constituted 62% of the New Paris No. 4 fauna (51% of that contributed by just two species, *Clethrionomys gapperi* and *Microtus pennsylvanicus*, both of northern affinities). At Clark's Cave this figure increased to 70% of the vole fauna, and at Baker Bluff Cave 91% of the number of individual voles were of species still extant at that latitude (of which *Clethrionomys gapperi* and *Microtus pennsylvanicus* comprised only 34%). Thus, although all three faunas contained the same large complement of vole species (only *Dicrostonyx hudsonius* dropping out of the Virginia and Tennessee sites), the percentage of boreal to temperate species, in terms of individual animals, dropped an 8% from New Paris No. 4 to Clark's Cave, and an additional 21% from Clark's Cave to Baker Bluff.

The situation in the case of the shrews is different and reflects primarily altitudinal rather than latitudinal range shifts. There are seven species now in the mid- and southern Appalachian area. There were seven species at both New Paris No. 4 and Clark's Cave, with an additional eighth at Baker Bluff Cave (Fig. 14). Different species were involved, however. *Cryptotis parva*, a temperate field form, now present at all three localities, did not occur in either the New Paris No. 4 or the Clark's Cave paleofaunas, but the arctic shrew (*Sorex arcticus*), a boreal forest form, was added to the fauna of all three sites. There was an increase from north to south of blarinine shrews (*Blarina*, *Cryptotis*). But all soricine shrews (*Sorex*, *Microsorex*), with the exception of the smoky shrew *S. fumeus*, decreased in relative numbers with decreasing latitude. *S. fumeus* is the commonest soricine in the Appalachians today, with the broadest regional environmental tolerance and might be considered the most temperate of those species of *Sorex* identified from the three sites. Changing proportions of blarinine to soricine shrews from the three paleofaunas are New Paris No. 4, 39%; Clark's Cave, 47%; and Baker Bluff Cave, 61%.

Species of sciurids also increased slightly to the south (Fig. 15). Six species of squirrels (*Marmota* omitted from analysis) are present in the area today. Five species were present at New Paris No. 4 and seven at both Clark's and Baker Bluff caves. The additional two, *Eutamias minimus* and *Spermophilus tridecemlineatus*, are of midwestern affinities; *E. minimus* favoring central and western boreal woodlands and *S. tridecemlineatus* grasslands.

Squirrels can be divided into two groups—arboreal (*Sciurus*, *Tamiasciurus*, *Glaucomys*) and terrestrial (*Tamias*, *Eutamias*, *Spermophilus*). Arboreal species were commonest at Clark's Cave, Virginia, 69% of all sciurids. At New Paris No. 4, Pennsylvania, they comprised only 53% (50% of this *Tamiasciurus hudsonicus* and *Glaucomys sabrinus*, the only two arboreal sciurids in the North American boreal forests), suggesting a more open boreal woodland. Relative numbers of arboreal to terrestrial squirrels were lowest at Baker Bluff Cave, 47% of the sciurid fauna, again suggesting an open woodland. But, although arboreal squirrels in general declined in importance at Baker Bluff Cave, one temperate species, *Sciurus carolinensis*, nonetheless increased from 0% at New Paris No. 4, to 3% at Clark's Cave, to 13% of all squirrels at Baker Bluff Cave. This suggests a sequential change in forest composition in the Ridge and Valley province north to south from a predominantly open boreal forest at New Paris No. 4, Pennsylvania, to a denser boreal woodland cover at Clark's Cave, Virginia,

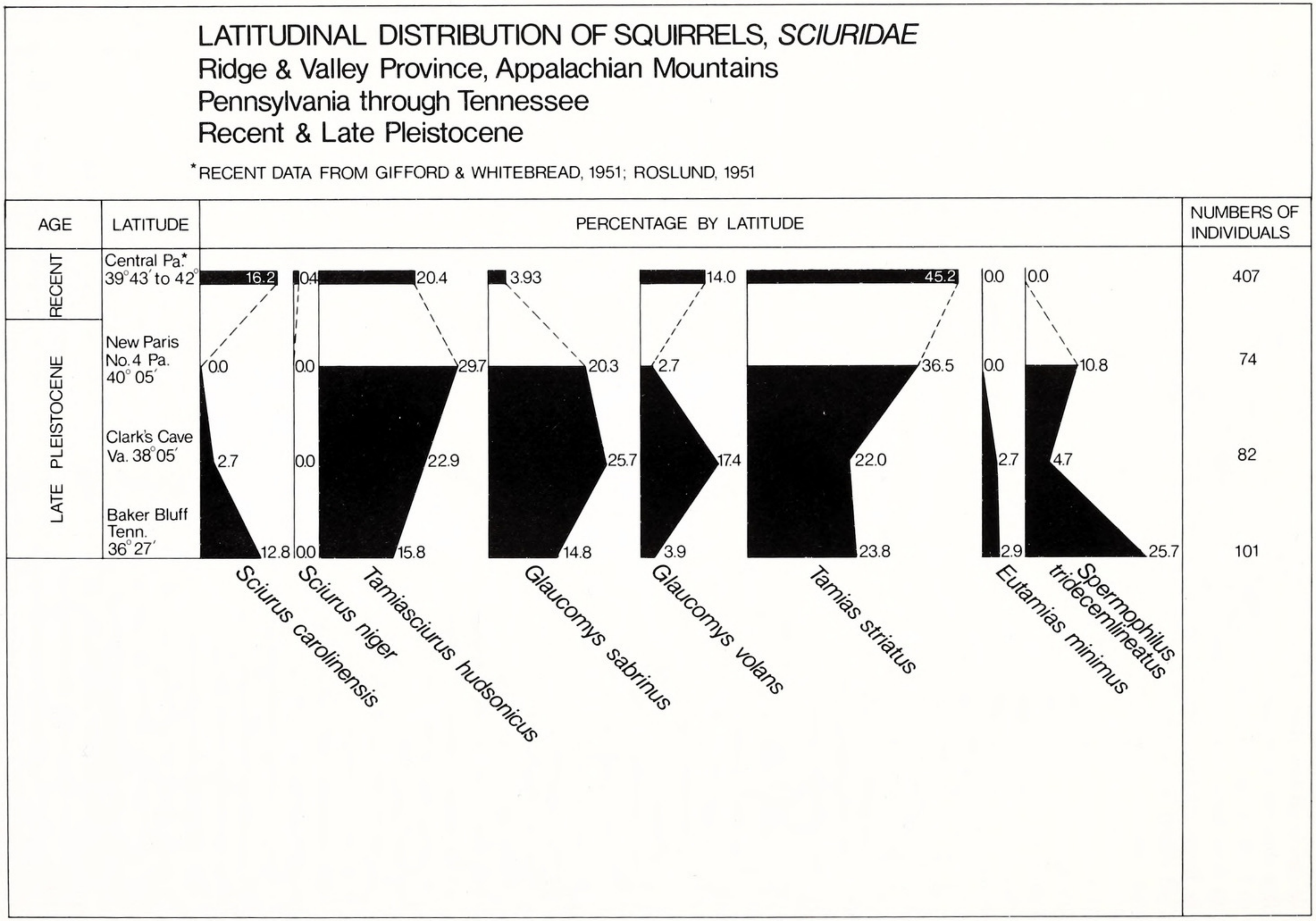

Fig. 15.—Squirrels, Family Sciuridae (*Marmota monax* omitted), late Pleistocene and Recent relative faunal composition, various sites, Ridge and Valley province, eastern USA.

to a mixed coniferous deciduous woodland at the latitude of Baker Bluff Cave, Tennessee. That all three sites were open to at least some extent is implied by the widespread late Pleistocene distribution of the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) in eastern North American periglacial sites from Kentucky to eastern Pennsylvania, south to at least Tennessee (Guilday et al., 1977). Its numbers were high (26% of all sciurids) at Baker Bluff Cave, where it was the commonest squirrel in the deposit, representing a distinct grasslands element.

Paleoenvironmental inferences based upon these few fossil faunas cannot be refined until additional sites are discovered and studied. But the analysis suggests that the effects of glacial cooling during the Wisconsinan glaciation profoundly affected mammalian distributions and, by inference, that of the entire biota in the Ridge and Valley province at least as far south as Tennessee. It also demonstrates the contemporaneity of both temperate and boreal species in these paleofaunas and the lack of any southern forms (except several extinct species, *Tapirus* cf. *veroensis, Dasypus bellus,* whose ecological requirements we do not know). There were no species in the Baker Bluff faunal sequence of southern affinities, which are at or near the northern edge of their modern distribution in the central Appalachians. So that while a more equitable climate is suggested, one that would allow presently allopatric boreal and temperate species to coexist, the mean climate must have been cooler.

The faunal gradient in late Wisconsinan times must have steepened south of Baker Bluff, Tennessee. Of the many boreal forms from that site only *Microtus pennsylvanicus, Erethizon dorsatum,* and *Vulpes vulpes* penetrated as far south as Florida (Webb, 1974). Ridge and Valley karst areas extend both north and south of the sites discussed here so that the late Pleistocene faunal gradient can be extended and refined by future work.

Ladds Quarry paleofauna, Bartow County, Georgia, 34°09′N, 84°50′W, 320 km SW of Baker Bluff Cave, just east of the Ridge and Valley province and south of the Great Smoky Mountains, at an altitude of about 300 m, also presents a mixture of presently allopatric species—a northern element, wood turtle (*Clemmys insculpta*), spruce grouse (*Canachites canadensis*), masked shrew (*Sorex cinereus*), fisher (*Martes pennanti*), New England cottontail (*Sylvilagus transitionalis*), southern bog lemming (*Synaptomys cooperi*); a southern faunal element which does not occur at late Pleistocene sites farther north, southern toad (*Bufo terrestris*), opossum (*Didelphis virginianus*), rice rat (*Oryzomys palustris*), cotton rat (*Sigmodon hispidus*), round-tailed muskrat (*Neofiber alleni*), hog-nosed skunk (*Conepatus leuconotus*), and ? jaguarundi (*Felis* (?) *Herpailurus*) (Holman, 1976; Ray, 1967; Wetmore, 1967).

With the exception of the spruce grouse, which reaches its present southern Appalachian limits in the Adirondack Mountains of New York, 44°N, and the wood turtle, which reaches its southern limit in northern Virginia, 39°N, the other species of northern affinities were broadly distributed throughout the Appalachian area in Historic times near the latitude of Ladds Quarry. Unfortunately the age of the site is not known, or even if it is a synchronous local fauna (see discussions in Ray, 1965, and Lipps and Ray, 1967). The presence of *Peromyscus cumberlandensis,* a species otherwise known only from two Irvingtonian age sites in the Appalachians (the type locality Cumberland Cave, Maryland, Guilday and Handley, 1967; Trout Cave, West Virginia, CMNH collections; and absent to date from all Appalachian sites of Wisconsinan age or later), in conjunction with *Platygonus compressus,* a Wisconsinan peccary, suggests that the Ladds Quarry paleofauna may in fact be heterochronic. Remains of *Neofiber alleni,* the Recent round-tailed muskrat, a Wisconsinan to Recent species, now confined to Florida and southern Georgia, 31°N, 640 km south of the Ladds Quarry paleofauna, suggests a Wisconsinan date and milder winter temperatures (Ray, 1965; Frazier, 1977). But spruce (*Picea*) pollen, indicative of a cooler environment has also been recorded from the site (Benninghoff and Stephenson, 1967).

If the Ladds Quarry paleofauna proves to be contemporaneous with the late Wisconsinan Baker Bluff Cave faunal sequence it demonstrates a steepening of the faunal gradient south of Baker Bluff Cave. As Ray pointed out, the problem can only be resolved by further fieldwork.

A comparison of the late Wisconsinan faunal gradient of the Ridge and Valley province with that of today shows significant differences. Based upon Recent small mammal ecological requirements the late Pleistocene gradient, Pennsylvania to Tennessee, was in the direction "boreal" to "temperate." Today the same gradient runs "temperate" to "austral." This reflects the regional postglacial rise in mean temperature.

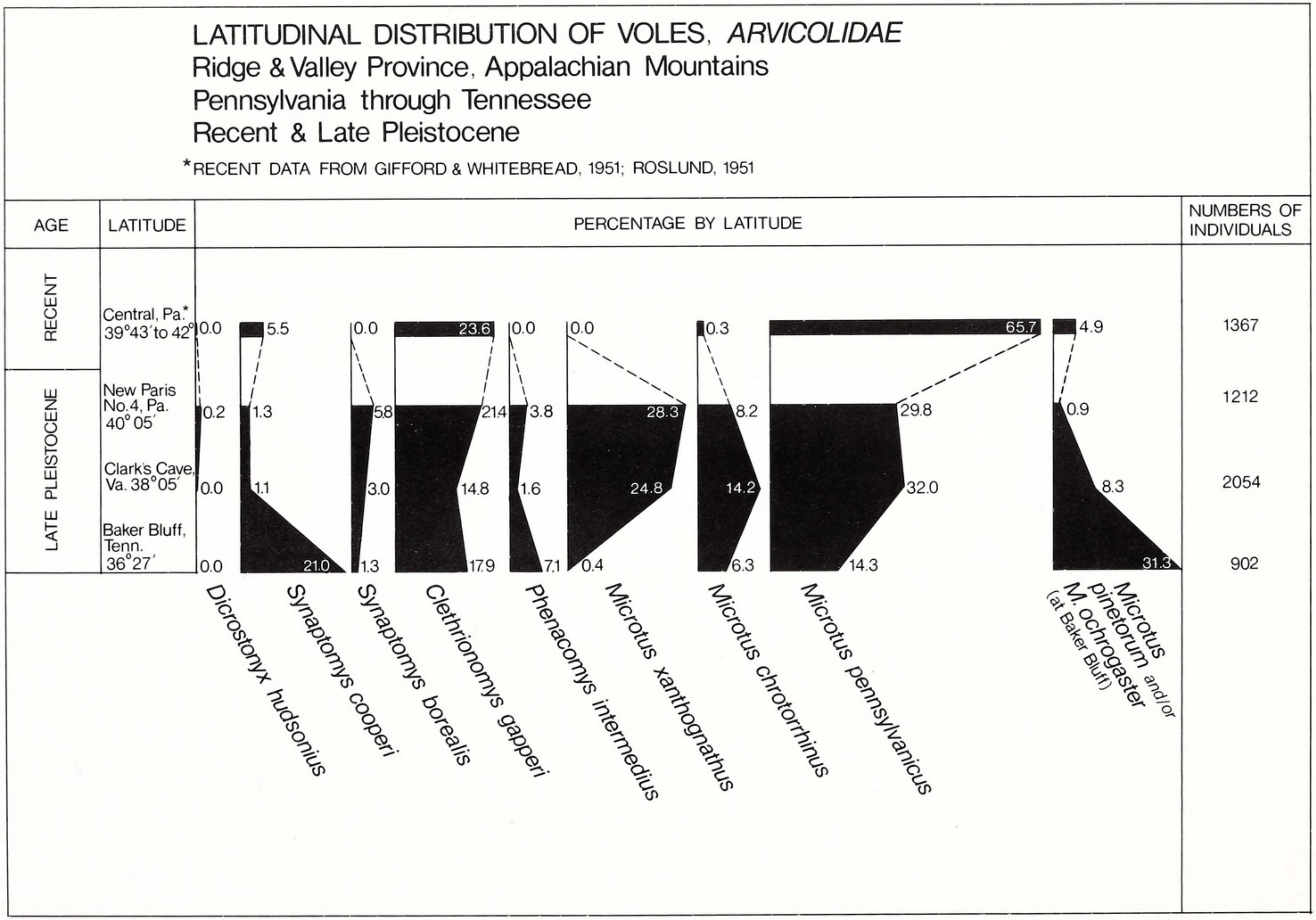

Fig. 16.—Voles, Family Arvicolidae (*Ondatra zibethicus* omitted), late Pleistocene and Recent relative faunal composition, various sites, Ridge and Valley province, eastern USA.

Perhaps the most significant fact to be drawn from the present study is that the faunal gradient is more extreme today than it was under late glacial conditions although different combinations of species are involved. This is best illustrated by comparing the two gradient sets of small rodents—cricetids, arvicolids, and zapodids. In south-central Pennsylvania, at the gradient's northern end, there are today 10 species of native small rodents (*Peromyscus leucopus, Peromyscus maniculatus, Neotoma floridana, Clethrionomys gapperi, Synaptomys cooperi, Microtus pennsylvanicus, Microtus pinetorum, Ondatra zibethicus, Zapus hudsonius,* and *Napaeozapus insignis;* Gifford and Whitebread, 1951). All but two, *Napaeozapus insignis* and *Clethrionomys gapperi,* occur throughout the gradient transect in the Ridge and Valley province south to East Tennessee. At its southern terminus at Baker Bluff Cave, 12 species of small rodents have been reported (*Reithrodontomys humulis, Oryzomys palustris, Peromyscus leucopus, Peromyscus maniculatus, Ochrotomys nuttalli, Sigmodon hispidus, Neotoma floridana, Microtus pennsylvanicus, Microtus pinetorum, Ondatra zibethicus, Synaptomys cooperi,* and *Zapus hudsonius;* Smith et al., 1974, Hall and Kelson, 1959). Four of these, *Reithrodontomys, Ochrotomys, Sigmodon,* and *Oryzomys,* do not range as far north as south-central Pennsylvania today. In other words, six out of a total of 14 species involved have restricted ranges within the transit (two reach their southern limits, four their northern limits); 43% of the small rodent fauna in the modern faunal gradient were involved in range termination.

During the late Pleistocene 15 species of small rodents were identified from the northern end of the gradient (New Paris No. 4, Pennsylvania) and 14 from its southern limit (Baker Bluff Cave, Tennessee). Only one species *Dicrostonyx hudsonius,* present at New Paris No. 4, failed to occur throughout the gradient, although there were changes in abundance of other species from north to south. There were no northern range terminations. Only 7% of the late Pleistocene small rodent fauna (one species) was involved in range terminations, contrasted with 43% in the modern faunal gradient.

A comparison of these two Ridge and Valley faunal gradients indicates that environmental conditions during late Pleistocene times were definitely boreal in character but more equable than today throughout the transect. This reinforces the concept of Pleistocene climatic equability developed primarily from Great Plains fossil faunas by the late C. W. Hibbard and others since the 1960s. Graham (1976) suggests that the increasing continental climate of the postglacial (heightened seasonality) accentuated climatic gradients, narrowed ecotones, and established the present diversities and distributional patterns. The Baker Bluff Cave faunal sequence and other Ridge and Valley late Pleistocene faunas bear out this concept.

FAMILY COMPOSITION OF THREE RIDGE AND VALLEY MAMMALIAN PALEOFAUNAS

Representatives of 20 mammalian families have been recovered from three large late Pleistocene cave faunas in the Ridge and Valley province—New Paris No. 4, Clark's Cave, and Baker Bluff Cave (Table 17). Dasypodidae, Tayassuidae, and Tapiridae represented by extinct species, no longer occur in the Appalachian region. The opossum sole representative of the Didelphidae, has not been found in a Pleistocene context in any Ridge and Valley site, although it is common in the area today. The Baker Bluff Cave record is based on bones of a Recent animal from the surface deposits.

Small mammals, marmot size or less, predominate in these faunas where they form 99% of all individual mammals from New Paris No. 4, 99% from Clark's Cave, and 96% from Baker Bluff Cave. The large numbers of small mammals reflects raptor bias at Clark's Cave and Baker Bluff Cave, both owl-roost deposits, and at New Paris No. 4 inadvertent trapping of unwary animals tumbling into a funnel-shaped sinkhole.

Bats, Vespertilionidae, fluctuated dramatically from a high of 42% MNI at New Paris No. 4, representing natural mortality of the resident bat colony, to 36% MNI at Clark's Cave, due to selective predation by raptors at a large cave system entrance, to a low of 2.4% MNI at Baker Bluff Cave, attributable to a low resident bat population in that unsuitably small cave.

Small rodents of the families Cricetidae, Arvicolidae, and Zapodidae formed the largest portion of each fauna; 50% at New Paris No. 4, 54.5%,

Table 17.—*Mammalian composition of three Appalachian cave deposits based upon minimum number of individuals (MNI).*

Family	Common name	New Paris No. 4, Pennsylvania (MNI = 2,957)	Clark's Cave, Virginia (MNI = 4,343)	Baker Bluff Cave, Tennessee (MNI = 1,910)
Didelphidae	opossums	—	—	.05%
Soricidae	shrews	3.61%	5.30%	14.55%
Talpidae	moles	.10%	.59%	1.67%
Vespertilionidae	evening bats	41.76%	35.78%	2.40%
Dasypodidae	armadillos	—	—	.05%
Leporidae	rabbits and hares	1.75%	.55%	4.97%
Sciuridae	squirrels	2.80%	2.69%	7.12%
Castoridae	beavers	—	—	.20%
Cricetidae	New World rats and mice	8.04%	6.26%	18.53%
Arvicolidae	voles	41.02%	47.43%	47.22%
Zapodidae	jumping mice	.57%	.85%	.30%
Erethizontidae	porcupines	.10%	.02%	.15%
Canidae	wolves and foxes	—	.02%	.20%
Ursidae	bears	—	.02%	.20%
Procyonidae	raccoons	—	.02%	.26%
Mustelidae	weasels, otters, etc.	.16%	.36%	1.09%
Felidae	cats	—	—	.05%
Tayassuidae	peccaries	.03%	—	.05%
Cervidae	deer	—	.04%	.78%
Tapiridae	tapirs	—	—	.05%
		99.94%	99.91%	99.89%

Clark's Cave, and 66% at Baker Bluff Cave. Insectivores, Soricidae and Talpidae, formed a low 4% MNI at New Paris No. 4, and 6% MNI at Clark's Cave, but a much higher 16% at Baker Bluff Cave, a mathematical artifact caused primarily by the low percentage of bats from the latter site. If bats had been eliminated from consideration at New Paris No. 4 and Clark's Cave, insectivores would have constituted a larger percentage of those faunas. The percent of small rodents to shrews is actually much the same at all three sites, about the same as that of the Baker Bluff Cave local fauna.

Carnivore remains—Canidae, Ursidae, Procyonidae, Mustelidae, Felidae—are rare in raptor sites. Only weasels, genus *Mustela,* appear with some consistency; their small size makes them vulnerable to predation. The almost total absence of carnivores from the sinkhole fauna of New Paris No. 4 is due to the small size of the fissure, the alertness and agility of most carnivores, and the absence of skunks (*Mephitis*) from that boreal fauna. (Skunks, because of their myopic, terrestrial habits, are common in Holocene sinkhole faunas in the New Paris area, Guilday and Bender, 1958.) The slightly larger percentage of large mammal remains at Baker Bluff Cave, Tennessee, all represented by isolated teeth or bone fragments, is due to woodrat scavenging. None of these sites present true cross-sections of the paleofaunas they sample. However, they may fairly approximate the relative abundance of small mammals present in the samples areas that can be profitably compared with other local faunas where the depositional and recovery factors are similar.

Relative percents at these three sites were based upon recovery procedures using screens of both 5-mm and 1-mm grid size for specimen recovery. The sites had not been exposed to selective processes such as weathering, water-sorting, or differential chemical decomposition, and are all primary deposits. As a result postdepositional disruption was minimal and specimen recovery thorough. These factors could drastically affect relative faunal composition and should be kept in mind when comparing fossil faunas.

LITERATURE CITED

American Ornithologists' Union. 1957. Check-list of North American birds. Lord Baltimore Press, Baltimore, Maryland, 5th edition, 691 pp.

Atwood, W. W. 1940. The physiographic provinces of North America. Athenaeum Press, Boston, xvi + 536 pp.

Auffenberg, W. 1963. The fossil snakes of Florida. Tulane Stud. Zool., 10:129–216.

Banfield, A. W. F. 1974. The mammals of Canada. Univ. Toronto Press, xxv + 438 pp.

Barbour, R. W., and W. H. Davis. 1974. Mammals of Kentucky. Univ. Press Kentucky, 322 pp.

Barkalow, F. S., Jr. 1972. Vertebrate remains from archeological sites in the Tennessee Valley of Alabama. Southern Indian Studies, 24:3–41.

Benninghoff, W. S., and A. L. Stephenson. 1967. Pollen analysis of cave breccia from Ladds Locality, Bartow County, Georgia. Bull. Georgia Acad. Sci., 25:188–191.

Bogan, A. E. 1976. A zooarchaeological analysis of vertebrate remains from Chota-Tanasi, a Historic Cherokee village in East Tennessee. Unpublished M.S. dissert., Univ. Tennessee, Knoxville, 156 pp.

Brattstrom, B. H. 1967. A succession of Pliocene and Pleistocene snake faunas from the High Plains of the United States. Copeia, pp. 188–202.

Broyles, B. J. 1966. Preliminary report: The St. Albans Site (46 Ka 27), Kanawha County, West Virginia. The West Virginia Archeologist, 19:1–43.

Cambron, J. W., and D. C. Hulse. 1964. Handbook of Alabama archaeology: Part I, point types. Privately printed, 170 pp.

Coe, J. L. 1964. The formative cultures of the Carolina Piedmont. Trans. Amer. Phil. Soc., n.s., 54(5):1–130.

Conant, R. 1975. A field guide to the reptiles and amphibians of eastern and central North America. Houghton Mifflin Co., Boston, 429 pp.

Cope, E. D. 1899. Vertebrate remains from Port Kennedy bone deposit. J. Acad. Nat. Sci. Philadelphia, ser. 2, 11:193–267.

Corgan, J. X. 1976. Vertebrate fossils of Tennessee. Tennessee Dept. of Conservation, Div. of Geol. Bull., 77:1–100.

Dice, L. R. 1943. The biotic provinces of North America. Univ. Michigan Press, Ann Arbor, 78 pp.

Doutt, J. K. n.d. Taxonomic review of white-tailed deer (*Odocoileus virginianus*) in eastern North America. Unpublished manuscript on file, Section of Mammals, Carnegie Mus. Nat. Hist., 45 pp.

Doutt, J. K., C. A. Heppenstall, and J. E. Guilday. 1973. Mammals of Pennsylvania. Pennsylvania Game Commission, Harrisburg, Pennsylvania, 3rd ed., 288 pp.

Dreimanis, A. 1977. Late Wisconsin glacial retreat in the Great Lakes region, North America. Ann. New York Acad. Sci., 288:70–89.

Flint, R. F. 1971. Glacial and Quaternary geology. John Wiley & Sons, Inc., 892 pp.

Frazier, M. K. 1977. New records of *Neofiber leonardi* (Rodentia: Cricetidae) and the paleoecology of the genus. J. Mamm., 58:368–373.

Gidley, J. W., and C. L. Gazin. 1938. The Pleistocene vertebrate fauna from Cumberland Cave, Maryland. Bull. U.S. Nat. Mus., 171:1–99.

Gifford, C. L., and R. Whitebread. 1951. Mammal survey of southcentral Pennsylvania. Final Report Pittman-Robertson Project 38-R, Pennsylvania Game Commission, Harrisburg, Pennsylvania, 75 pp.

Graham, R. W. 1976. Late Wisconsinan mammalian faunas and environmental gradients of the eastern United States. Paleobiology, 2:343–350.

Graham, R. W., and H. A. Semken. 1976. Paleoecological signficance of the short-tailed shrew (*Blarina*), with a systematic discussion of *Blarina ozarkensis*. J. Mamm., 57:433–449.

Graves, F. F., Jr., and M. J. Harvey. 1974. Distribution of Chiroptera in western Tennessee. J. Tennessee Acad. Sci., 49:106–109.

Guilday, J. E. 1958. The prehistoric distribution of the opossum. J. Mamm., 39:39–43.

———. 1961. Abnormal lower 3rd molar in *Odocoileus*. J. Mamm., 42:551–553.

———. 1962. The Pleistocene local fauna of the Natural Chimneys, Augusta County, Virginia. Ann. Carnegie Mus., 36:87–122.

———. 1971. Biological and archeological analysis of bones from a 17th Century Indian village (46 Pu 31), Putnan County, West Virginia. West Virginia Geol. and Econ. Surv., Rept. of Archeol. Invest., no. 4, 64 pp.

Guilday, J. E., and M. S. Bender. 1958. A Recent fissure deposit in Bedford County, Pennsylvania. Ann. Carnegie Mus., 35:127–138.

———. 1960. Late Pleistocene records of the yellow-cheeked vole, *Microtus xanthognathus* (Leach). Ann. Carnegie Mus., 35:315–330.

Guilday, J. E., H. W. Hamilton, and A. D. McCrady. 1969. The Pleistocene vertebrate fauna of Robinson Cave, Overton County, Tennessee. Palaeovertebrata, 2:25–75.

———. 1971. The Welsh Cave peccaries (*Platygonus*) and associated fauna, Kentucky Pleistocene. Ann. Carnegie Mus., 43:249–320.

Guilday, J. E., H. W. Hamilton, and P. W. Parmalee. 1975. Caribou (*Rangifer tarandus* L.) from the Pleistocene of Tennessee. J. Tennessee Acad. Sci., 50:109–112.

Guilday, J. E., and C. O. Handley, Jr. 1967. A new *Peromyscus* (Rodentia: Cricetidae) from the Pleistocene of Maryland. Ann. Carnegie Mus., 39:91–103.

Guilday, J. E., P. S. Martin, and A. D. McCrady. 1964. New Paris No. 4: A Pleistocene cave deposit in Bedford County, Pennsylvania. Bull. Nat. Speleo. Soc., 26:121–194.

Guilday, J. E., and A. D. McCrady. 1966. Armadillo remains from Tennessee and West Virginia caves. Bull. Nat. Speleo. Soc., 28:183–184.

Guilday, J. E., and H. McGinnis. 1972. Jaguar (*Panthera onca*) remains from Big Bone Cave, Tennessee and east central North America. Bull. Nat. Speleo. Soc., 34:1–14.

Guilday, J. E., and P. W. Parmalee. 1965. Animal remains from the Sheep rock Shelter (36 Hu 1), Huntingdon County, Pennsylvania. Pennsylvania Archaeologist, 35:34–49.

———. 1972. Quaternary periglacial records of voles of the genus *Phenacomys* Merriam (Cricetidae: Rodentia). Quaternary Res., 2:170–175.

Guilday, J. E., P. W. Parmalee, and H. W. Hamilton. 1977. The Clark's Cave bone deposit and the late Pleistocene paleoecology of the central Appalachian Mountains of Virginia. Bull. Carnegie Mus. Nat. Hist., 2:1–87.

Guilday, J. E., P. W. Parmalee, and D. P. Tanner. 1962. Aboriginal butchering techniques at the Eschelman Site (36 La 12), Lancaster County, Pennsylvania. Pennsylvania Archaeologist, 32:59–83.

Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. The Ronald Press Co., New York, 1:xxx + 1–546 + *79;* 2: viii + 547–1083 + *79.*

Hallberg, G. R., H. A. Semken, and L. C. Davis. 1974. Quaternary records of *Microtus xanthognathus* (Leach), the yellow-cheeked vole, from northwestern Arkansas and southwestern Iowa. J. Mamm., 55:640–645.

Handley, C. O., Jr. 1959. A revision of American bats of the genera *Euderma* and *Plecotus*. Proc. U.S. Nat. Mus., 110:95–246.

Hay, O. P. 1920. Descriptions of some Pleistocene vertebrates found in the United States. Proc. U.S. Nat. Mus., 58:83–146.

Holman, J. A. 1962. A Texas Pleistocene Herpetofauna. Copeia, pp. 255–261.

———. 1963. Late Pleistocene amphibians and reptiles of the Clear Creek and Ben Franklin local faunas of Texas. J. Grad. Res. Center, 31:152–167.

———. 1965. A Late Pleistocene herpetofauna from Missouri. Trans. Illinois Acad. Sci., 58:190–194.

———. 1967. A Pleistocene herpetofauna from Ladds, Georgia. Bull. Georgia Acad. Sci., 25:154–166.

———. 1968. Lower Oligocene amphibians from Saskatchewan. Quart. J. Florida Acad. Sci., 31:273–289.

———. 1969. Herpetofauna of the Pleistocene Slaton Local Fauna of Texas. Southwestern Nat., 14:203–212.

———. 1973*a*. A new Pliocene snake, genus *Elaphe,* from Oklahoma. Copeia, pp. 574–580.

———. 1973*b*. Reptiles of the Egelhoff Local Fauna (Upper Miocene) of Nebraska. Contrib. Mus. Paleontol., Univ. Michigan, 24:125–134.

———. 1976. Paleoclimatic implications of "ecologically incompatible" herpetological species (late Pleistocene: southeastern United States). Herpetologica, 32:290–295.

Howell, A. H. 1921. A biological survey of Alabama: I, Physiography and life zones; II, The mammals. N. Amer. Fauna, 45:1–88.

Howell, J. C., and C. H. Conaway. 1952. Observations on the mammals of the Cumberland Mountains of Tennessee. J. Tennessee Acad. Sci., 27:153–158.

Hunt, C. B. 1974. Natural regions of the United States and Canada. W. H. Freeman & Co., San Francisco, xii + 725 pp.

Keener, C. S. 1970. The natural history of the Mid-Appalachian Shale Barren Flora. Pp. 215–248, *in* The distributional history of the biota of the southern Appalachians, Part II: Flora (Perry C. Holt, ed.), 414 pp.

Kellberg, J. M. 1963. Chert and 'Flint' of the Tennessee area. Tennessee Archaeologist, 19:1–7.

Kellogg, R. 1939. Annotated list of Tennessee mammals. Proc. U.S. Nat. Mus., 86:245–303.

King, J. E., and T. R. Van Devender. 1977. Pollen analysis of fossil packrat middens from the Sonoran Desert. Quaternary Res., 8:191–204.

Kneberg, M. 1956. Some important projectile points found in the Tennessee area. Tennessee Archaeologist, 12:17–28.

———. 1957. Chipped stone artifacts of the Tennessee Valley area. Tennessee Archaeologist, 13:55–66.

Linzey, A. V., and D. W. Linzey. 1971. Mammals of Great Smoky Mountains National Park. Univ. Tennessee Press, Knoxville, 114 pp.

Lipps, L., and C. E. Ray. 1967. The Pleistocene fossiliferous deposit at Ladds, Bartow County, Georgia. Bull. Georgia Acad. Sci., 25:113–119.

Lundelius, E. L., Jr., and B. H. Slaughter. 1976. Notes on American Pleistocene tapirs. Pp. 226–243, *in* Essays on paleontology in honour of Loris Shano Russell (C. S. Churcher, ed.), Life Sci. Misc. Publ., Royal Ontario Mus., 292 pp.

Martin, R. A. 1974. Fossil vertebrates from the Haile XIV A Fauna, Alachua County. Pp. 100–113, *in* Pleistocene mammals of Florida (S. David Webb, ed.), Univ. Florida Press, Gainesville, x + 270 pp.

Martin, R. A., and S. D. Webb. 1974. Late Pleistocene mammals from the Devil's Den Fauna, Levy County. Pp. 114–145, *in* Pleistocene mammals of Florida (S. David Webb, ed.), Univ. Florida Press, Gainesville, x + 270 pp.

Meszoely, C. A. 1967. A new cryptobranchid salamander from the Early Eocene of Wyoming. Copeia, pp. 346–349.

Parmalee, P. W. 1967. A Recent cave bone deposit in southwestern Illinois. Bull. Nat. Speleo. Soc., 29:119–147.

Parmalee, P. W., A. E. Bogan, and J. E. Guilday. 1976. First records of the giant beaver (*Castoroides ohioensis*) from Eastern Tennessee. J. Tennessee Acad. Sci., 51:87–88.

Parmalee, P. W., P. J. Munson, and J. E. Guilday. In press. The Pleistocene mammalian fauna of Harrodsburg Crevice, Monroe County, Indiana. Bull. Nat. Speleo. Soc.

Phillips, L., and M. Richmond. 1971. The distribution of vertebrates on the islands of Boone and Watauga lakes. J. Tennessee Acad. Sci., 46:124–129.

Ray, C. E. 1958. Additions to the Pleistocene mammalian fauna from Melbourne, Florida. Bull. Mus. Comp. Zool., 119:421–449.

———. 1965. A new chipmunk, *Tamias aristus,* from the Pleistocene of Georgia. J. Paleontol., 39:1016–1022.

———. 1967. Pleistocene mammals from Ladds, Bartow County, Georgia. Bull. Georgia Acad. Sci., 25:120–150.

Ritchie, W. A. 1961. A typology and nomenclature for New York projectile points. Bull. New York State Mus. Sci. Serv. 384:1–119.

Roslund, H. R. 1951. Mammal survey of northcentral Pennsylvania. Final Report Pittman–Robertson Project 37-R, Pennsylvania Game Commission, Harrisburg, Pennsylvania, 55 pp.

Scully, E. G. 1951. Some Central Mississippi Valley projectile point types. Mimeograph, Mus. Anthropol., Univ. Michigan, Ann Arbor.

Severinghaus, W. D., and L. E. Beasley. 1973. A survey of the microtine and zapodid rodents of West Tennessee. J. Tennessee Acad. Sci., 48:129–133.

Smith, C. R., J. Giles, M. E. Richmond, J. Nagel, and D. W. Yambert. 1974. The mammals of northeastern Tennessee. J. Tennessee Acad. Sci., 49:88–94.

Soler, E. I. 1950. On the status of the family Desmognathidae. Univ. Kansas Sci. Bull., 33:459–480.

Tihen, J. A. 1954. A Kansas Pleistocene herpetofauna. Copeia, pp. 217–221.

———. 1958. Comments on the osteology and phylogeny of ambystomatid salamanders. Bull. Florida State Mus., 3:1–50.

———. 1962. A review of New World fossil bufonids. Amer. Midland Nat., 68:1–50.

U. S. Department of Agriculture. 1941. Climate and Man. Yearbook of Agri., 1248 pp.

Watts, W. A. 1970. The full-glacial vegetation of northwestern Georgia. Ecology, 51:17–33.

Webb, S. D. [ed.]. 1974. Pleistocene mammals of Florida. Univ. Florida Press, Gainesville, x + 270 pp.

Wells, P. V. 1976. Macrofossil analysis of wood rat (*Neotoma*) middens as a key to the Quaternary vegetational history of arid America. Quaternary Res., 6:223–248.

Wetmore, A. 1962. Ice Age birds in Virginia. The Raven, 33(4):3.

———. 1967. Pleistocene Aves from Ladds, Georgia. Bull. Georgia Acad. Sci., 25:151–153.

Williams, S. C. 1927. Lieut. Henry Timberlake's memoirs, 1756–1765; with annotation, introduction and index. Johnson City, Tennessee, 197 pp.

Wrigley, R. E. 1972. Systematics and biology of the woodland jumping mouse, *Napaeozapus insignis*. Illinois Biol. Monogr., 47:1–118.