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DISCUSSION of papers published in the Bulletin is invited. Discussions should be 2000 words or less in length with not more than 3 illustrations. Discussions of papers in this issue should be forwarded to the editor by January 15, 1968.

A Recent Cave Bone Deposit in Southwestern Illinois

By Paul W. Parmalee

ABSTRACT

A large bone deposit in Meyer Cave fissure, located in the Mississippi River bluff in Monroe County, Illinois, was removed during periodic excavations in 1959, 1960 and 1961. Approximately one quarter of a million vertebrate remains were taken from this fissure that had functioned as a den site and natural death trap for animals since early post-glacial times. At least 115 species of vertebrates, representing a minimum of 12,400 individuals, and 27 species of invertebrates (mollusks and insects), were identified. The deposit was not stratified, but recovery of elements of boreal or northern species (e.g. pigmy shrew, least weasel, red-backed and yellow-cheeked voles, porcupine) suggested a period of cool and moist climate, probably during the early post-Pleistocene (*ca.* 10,000 - 8,000 B.C.). The presence of spotted skunk and wood rat reflected a later period of a warm and dry environment (*ca.* 4,000 - 1,000 B.C.). Except for passenger pigeon, no remains of extinct species were recovered.

INTRODUCTION

There are few caves in Illinois that can compare in magnitude with those typical of neighboring states. Much of Illinois is covered by glacial drift and most cavernous regions lie south or west of the limit of the drift. The majority of known caves occur in the Ozark foothills of southern Illinois and in the bluffs of the Mississippi, lower Ohio and Illinois rivers. A great many small solution-made cavities are to be found in these river bluffs but, unlike other types such as sewer and pit caves, and vertical fissures, they are rarely of a size or form to permit an extensive accumulation of debris or faunal remains.

Prior to the discovery in 1959 of the huge deposit of bone in Meyer Cave, Monroe County, no comparable quantity of Recent animal remains had ever been encountered in any other Illinois cave. This cave deposit and its varied faunal contents, to be described here, is unique in the state.

This region of southwestern Illinois is included in the Carolinian biotic province established by Dice (1943) although the river bluff, its soil and vegetation types with a mixture of prairie and forest animals, is more indicative of the Illinoian biota. Vegetation of the bluff top, face and talus slope shows considerable variation today with both upland and river bottom species represented. The following plants predominate on the talus and on sections of the numerous bluff ledges:

DOMINANTS

Plane-tree, *Platanus occidentalis*
Cottonwood, *Populus deltoides*
Hackberry, *Celtis occidentalis*
American Elm, *Ulmus americana*
Chestnut Oak, *Quercus muhlenbergii*
Red Oak, *Quercus rubra*
Pin (Swamp) Oak, *Quercus palustris*
Silver Maple, *Acer saccharinum*
Sugar Maple, *Acer saccharum*
Red Maple, *Acer rubrum*

SUBDOMINANTS

American Bladdernut, *Staphylea trifolia*
Wahoo, *Euonymus atropurpureus*
Spice-bush, *Lindera benzoin*
Box Elder, *Acer negundo*
Staghorn Sumac, *Rhus hirta*
Red-bud, *Cercis canadensis*
Papaw, *Asimina triloba*
Eastern Red Cedar, *Juniperus virginiana*
Chickasaw Plum, *Prunus angustifolia*

Both wild grape, *Vitis* spp., and trumpet-creeper, *Campsis radicans*, occur along the face of the bluff; while elder, *Sambucus canadensis*, and pokeweed, *Phytolacca americana*, are common roadside and understory plants in this area. Numerous species of grasses and herbs carpet the ground in varying density, depending upon soil depth and exposure to sunlight.

Cave Location and Description

Meyer Cave is located in the limestone bluff of the Mississippi River four miles south-southwest of Columbia, Monroe County, Illinois (N.W. ¼ Sec. 6, T. 2 S., R. 10 W., New Hanover Township: fig. 1). During the early stages of investigation and excavation, this cave was referred to simply as Bluff Cave. The cave was later named in honor of Mrs. Louisa Meyer, R. R. 4, Waterloo, the property owner who gave permission to investigate and eventually excavate the bone deposit. To be more precise, the cave is actually a vertical fissure within the bluff, joined to the outside by a 15-foot long, narrow, horizontal passageway. At the end of this passageway and slightly to the side of the 2½ x 5 foot entrance to the fissure is a small room. The floor of this room (approximately eight feet high and eight feet in diameter) slopes slightly towards the hole in the floor of the passageway that forms the entrance to the fissure.

The total depth of the fissure deposit was never determined. The top of the debris fill, composed of pieces of limestone, soil and bone, was approximately 14 feet below the entrance. Dripstone covers all wall surfaces, both in the bell-shaped fissure and the room

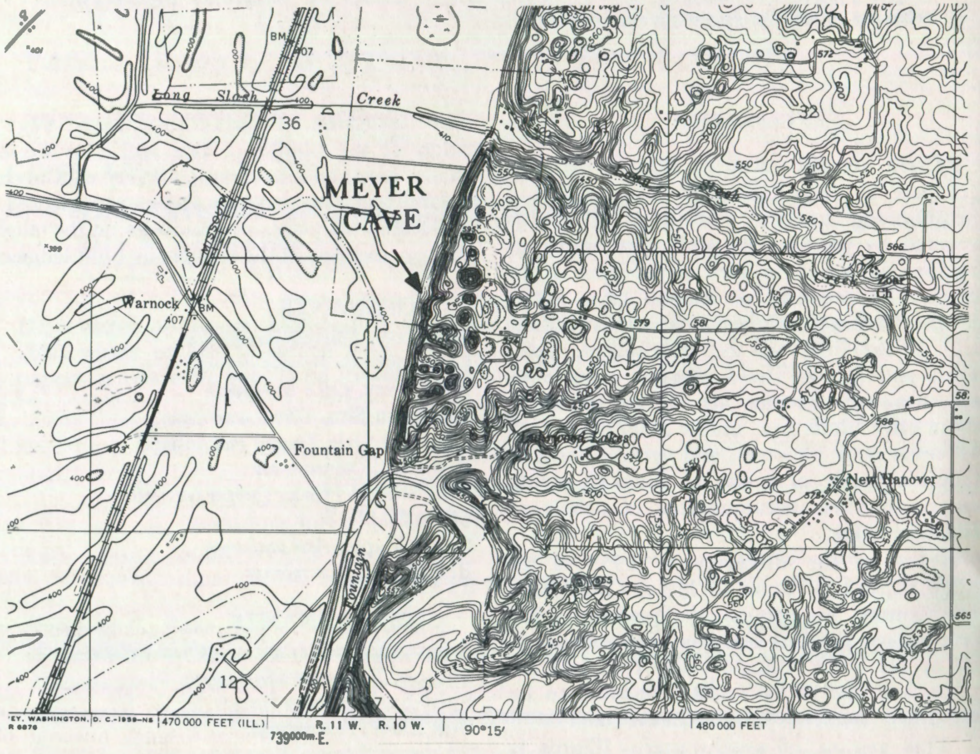

Figure 1.

Location of Meyer Cave, Monroe Co., Illinois, showing floodplain and bluff elevations. Oakville/Columbia quadrangles: Topographic 7.5 min. series, U. S. Dept. Interior, Geological Survey.

above. Numerous shallow ledges and irregularities occur as part of the fissure walls (fig. 2); generally, the fissure is oval in shape at the surface level of the fill and measures about 10 x 16 feet. It was possible to stand upright within the fissure only directly below the entrance. Figure 3 illustrates the relationship of the fissure, upper room and passageway to the face of the bluff and talus slope.

Figure 2.

Fissure wall of Meyer Cave, showing flowstone layers and suspended rope and pulley (looking up toward the opening).

Certain aspects of cave formation are not clearly understood, and those methods or steps which are known to produce natural caves vary, depending to a considerable extent on the topography of the area in question. Bretz and Harris (1961) have discussed the several proposed theories concerning the formation of limestone caverns; they have presented a generally accepted concept that the limestone and dolomite caves of Illinois were formed by an almost entirely solutional process by which ground water action dissolved and removed the carbonate rock. The statement by Bretz and Harris "Less common are vertical shafts that plainly were originated by falling water, even though there is no surface opening at the top of the shaft" is apparently applicable to Meyer Cave.

Basically, initial cave development resulted from hydraulic circulation below the water table, and eventual enlargement of the solution channels often resulted as vadose water drained down towards the lowered water

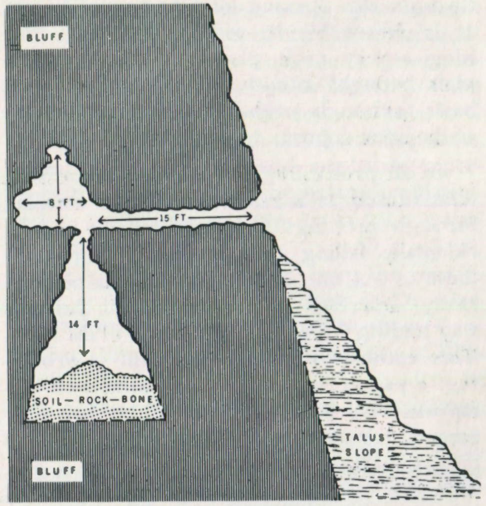

Figure 3.

Diagrammatic illustration of Meyer Cave; relationship of upper room, fissure and passageway.

table. The relatively uniform coating of flowstone and dripstone covering the walls of Meyer Cave is indicative of the more common method by which only minor trickles of ground water percolate through minute fissures in the roof rock. After the original development of the solution cavity, its possible enlargement through percolation and typical deposition of dissolved clay particles at the bottom, it then eventually becomes completely drained when the water table drops below the floor level.

The methods by which so large a bone deposit, both in quantity and number of species, accumulated in this relatively small fissure were apparently of two basic types. Although the possibility exists that some animals – or their parts – were thrown in by man or carried in by the Mississippi River during early post-glacial periods of extreme high water, it is unlikely that either source would have contributed much to this accumulation. Remains of a mountain lion kitten, numerous bobcat kittens and fox pups suggest that some predators probably used the small room above the lower fissure periodically as a denning site; if this assumption is correct, remains of prey animals brought to the young would eventually fall through the opening into the fissure below. It is reasonable to assume that such denning activity took place and that prey animals brought into the cave constituted one basic, although probably not major, source of the bone deposit.

In all probability, the majority of the bone accumulated as a result of animals entering through openings from the outside and accidentally falling into the fissure. Presently there is but one opening which has been already described – the horizontal passageway leading inward from the face of the bluff. This entrance provided, and still is providing, a passage through which animals can enter the inner areas. However, there is a fracture in the bluff that extends from the top through the entrance of this horizontal passage. Although no opening now exists above the room or lower fissure, it is probable that such an opening was present in earlier times and that the remains of animals falling into such a crack or the open fissure on top of the bluff gradually "filtered" down or were carried to the bottom of the fissure by phreatic water.

There are several factors that tend to substantiate such a possibility. First, mixed with the matrix of soil, bone and pieces of limestone was a quantity of pebbles, mostly chert and a type of quartz, both local and glacial in origin. These "Lafayette" gravels (Lamar and Reynolds, 1951) are, in part, the reworking of bed rock materials by glacial action and are presently found as fill on the top of these St. Louis limestone bluffs in this local area. These pebbles, along with the small animal remains which were finally deposited at the bottom of the fissure, probably fell or were carried by water action through such a crevice(s), solution cavity or fracture that has since closed or filled. Secondly, many of the species whose remains were found abundantly in the deposit (*e.g.*, shrews, especially *Cryptotis; Microtus; Peromyscus; Spilogale; Marmota; Coluber*) occur more typically in a dry, timbered upland habitat characteristic of the bluff top. Logically, the majority of animals of such upland species entered or fell into an opening on top of the bluff rather than moved through a passage at the base which was, until the last 50-75 years, bordered by bottomland marsh.

Methods and Materials

Meyer Cave was brought to the author's attention by Mr. Raymond A. Bieri, Belleville, a personal friend and known amateur archaeologist. Mr. Bieri, accompanied by Robert K. and Harold W. Mohrman, found and entered the cave on November 14, 1959 while searching for archaeological sites along the Mississippi River bluff south of Columbia, Illinois. A few local residents knew of the cave's existence and it (the fissure) had apparently been investigated before as evidenced by the eventual recovery of a rusted double-bladed ax head and a few other modern objects. Rock and debris in the passageway and the undisturbed appearance of the fill surface, including an almost solid layer of skulls and other skeletal elements that would have been crushed if stepped on, indicated that a considerable period of time had elapsed since prior human entry.

On November 21, 1959, Messrs. Mohrman and Bieri and the author made the first visit to the fissure for the purpose of removing a sample of bone; this and subsequent Saturday trips by the author alone or with Mr. Bieri, averaged seven hours in duration of excavation. By squeezing through the narrow opening of the fissure (fig. 5) and using projecting shallow ledges as "steps," it was possible to enter and leave without the aid of a ladder. Artifical light was first supplied by plumber's candles and flashlights but these sources were later supplemented by a Coleman gasoline lantern (Model No. 228E). Prior to the final week of excavation July 24-28, 1961, visits to Meyer Cave were made on the following dates and samples of bone were removed: Nov. 21 and Dec. 19, 1959; Jan. 23, Feb. 20, April 30, Sept. 14-15 and Nov. 10,1960; March 18 and April 21, 1961.

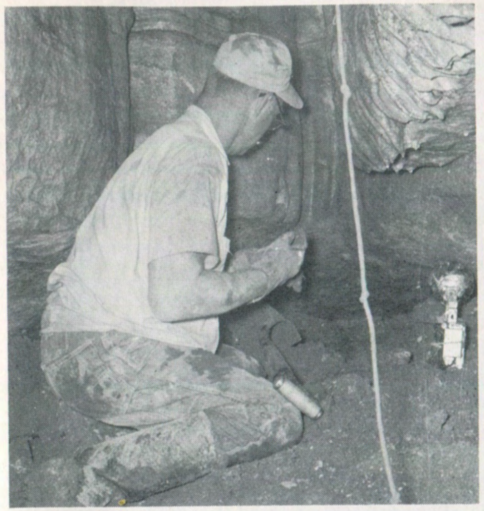

Figure 4.

Surface of the fissure deposit, illustrating the soil/rock/bone matrix, irregular wall surfaces and ledge formations.

Surface bone was removed during the first visit by picking up each element by hand and placing it in a small cardboard box or cloth feed sack. Before the second visit to the fissure, a screen (2' x 4' wooden frame with ¼ inch hardware cloth) was built for the purpose of sorting the bone from the soil and rock while in the fissure as an attempt to speed the work. However, this soon proved impractical because of the quantity of limestone fragments in the matrix and because the soil, if only slightly damp, would not readily pass through the screen. Also, in examining the soil that had sifted through the screen, it was quickly realized that quantities of small bone were passing through unnoticed.

After each sample of bone was removed from the fissure, it was brought to the Illinois State Museum zoology laboratory, washed, and the elements identified. Unfortunately all evidence of stratigraphy was lost due to the burrowing action of animals, especially the woodchuck, which were not killed by the fall and subsequently attempted to dig their way out. On the second visit, Dec. 19, 1960, excavation of a five foot square test pit was initiated and the matrix was removed by six inch levels until a depth of five feet (from the surface of the fill) was reached. Between this time and the following visit, a woodchuck had fallen into the fissure and its extensive burrowing completely filled and obliterated the test square.

Although several species identified from this deposit are probably indicative of an early post-glacial period (to be discussed under ACCOUNTS OF SPECIES), no remains of extinct Pleistocene forms were found. Six test squares or holes, evenly spaced about four feet apart and reaching to a depth of approximately 10 feet from the original surface, revealed that the bone content of the fill ended at about seven feet. At this level the soil, a gray clay with streaks of fine sand, appeared undisturbed and probably represents the final stage of the fissure formation and its beginning as a repository for remains of animals.

Six soil samples, taken from the four to six foot levels, were submitted to Dr. Harvey Nicholls, palynologist, Wisconsin Center for Climatic Research, University of Wisconsin, Madison. The samples proved to be sterile; the reasons for this are not apparent.

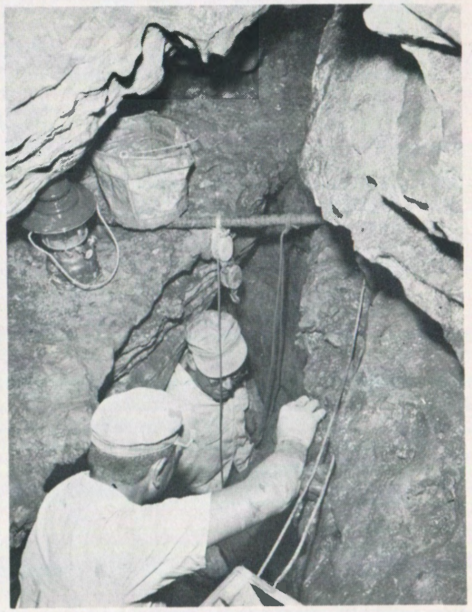

Figure 5.

Fissure opening at inner end of passageway/edge of floor of upper room.

Although pollen may have been present in the first four feet of soil, samples were not taken because of its heterogeneous nature due to mixing by rodent burrowing activities. It was thought that pollen samples from excessively disturbed soil levels would offer little in the way of climatic implications. The few seeds recovered in the matrix were from plants common to the area today.

The circumstances or methods by which prehistoric Indian artifacts, as well as human (Indian?) remains, became a part of the fill is a matter of speculation. One Raddatz side-notched Middle Archaic (5,000 ± 1,500 B.C.) projectile point was found against the east wall of the fissure approximately two feet below the surface and 30 sherds, representing at least three pots, were recovered mainly in the two to four foot levels. These sherds were the cord-marked type characteristic of the Late Woodland (500-1,000 A.D.) cultures in the Midwest. Also, flakes and small fragments of charcoal occurred mostly within this two foot level; a sample (M 1195) was submitted to the University of Michigan-Phoenix Memorial Radiocarbon Laboratory, Ann Arbor, and a date of 1040 ± 150 B.P. was obtained. This date correlates with the cultural time period represented by the sherds. The upper room is large enough to serve as a temporary shelter and the charcoal in the fissure fill may have resulted from a man-made fire in this room. Broken pots discarded by an Indian in the upper room perhaps account for the presence of the sherds; however, it is possible that they were brought in as nest material by wood rats (*Neotoma*) which were once common inhabitants of this bluff area.

Final work at the cave was completed during the week of July 24-28, 1961. Previously excavated test pits and the extensive samples of bone recovered established the fact that no stratigraphy was evident in the fill. There-

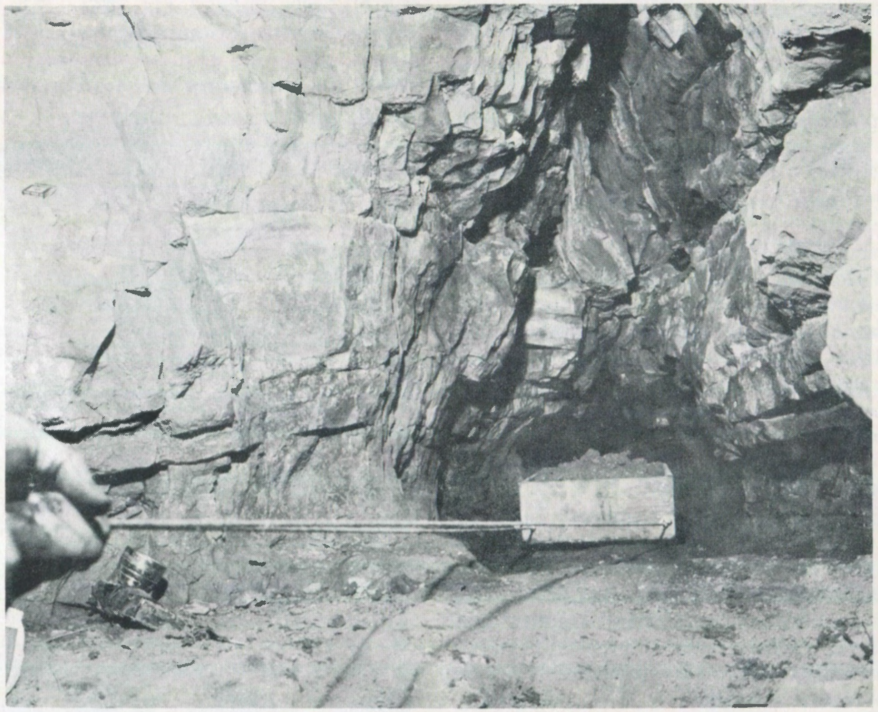

Figure 6.

Outside opening of passageway, showing box used to transport fill through the passageway.

Figure 7.

A view of the bluff face, entrance to Meyer Cave and the washing process.

fore, an attempt was made to remove as much of the matrix as was possible during the final week of excavation in order to obtain a maximum sample of the faunal remains. Approximately 200 cubic feet of the soil/rock/bone matrix were removed from the Meyer Cave fissure.

A crew of four laborers (two the last day – July 28) and the author equally divided the several phases of work that involved: (1) shovelling the matrix into two-gallon pails (fig. 4), (2) hauling the filled pails to the fissure entrance by block-and-tackle (figs. 2 and 5,), (3) dumping the matrix from the pails into a specially built wooden box that could be pulled through the passageway to the bluff opening (fig. 6), (4) stockpiling the matrix on a platform beside the water tank, (5) washing the matrix (fig. 7) by placing it in 2' x 2' wood-frame screens (copper door screen), which were then partly submerged in water, and agitating the matrix by hand and arm action and, finally (6), placing the washed bone-rock mixture in cardboard boxes. A 300 gallon capacity stock watering tank was used for washing the matrix; the tank was refilled once or twice a day by pumping fresh water from a truck storage tank that could be brought to the lower edge of the talus slope.

ACKNOWLEDGEMENTS

I am indebted to Mrs. Louisa Meyer, owner of the site, and to Mrs. Meyer's son-in-law, Mr. Marcellus Hartman, both of Waterloo, who willingly gave their permission for excavation of the cave. Special thanks are due Mr. Herbert L. Mueller, Jr., Columbia, tenant farmer on the land (cave site) controlled by Mr. Hartman. Mr. Mueller was interested in the project from the beginning, arranging for permission to excavate, hiring a crew and for providing many "extras" that enabled the work to progress without interruption. To the crew members, Lester

Gruenewald and Harvey Van Vuren, Millstadt; Alvin Rey, Columbia; and Walter Schnellbecher and Arthur Riebeling, Waterloo, I would like to express my appreciation for their part in the field work. I owe a special debt of gratitude to Mr. Raymond A. Bieri, Belleville, who informed me of this cave bone deposit and who was interested enough to give his time and energy in assisting with the excavation work in 1959 and 1960.

Finances provided by the Illinois State Museum for the final week of cave excavation, as well as salaries for an assistant in zoology during the summers of 1963 and 1964 to help with preliminary sorting of the bone/rock matrix, are gratefully acknowledged. This time-consuming work of separating bone from rock and sorting the faunal materials into the major classification categories was skillfully accomplished by Mrs. Ruth Major, Springfield and Mr. Frederick C. Hill, Illinois State University, Normal. Appreciation is given to Mr. Arthur Witman and the St. Louis Post-Dispatch for permission to use their photographs (figs. 2, 4, 5, 6, 7) for this article.

I would like to thank the following specialists for their help in the identification of certain specimens and/or loan of comparative material: Dr. Henry van der Schalie, University of Michigan, Ann Arbor (mollusks); Dr. Milton W. Sanderson, Illinois Natural History Survey, Urbana (insects); Dr. Glen S. Winterringer, Illinois State Museum (plants); Dr. Harvey Nicholls, University of Wisconsin, Madison (pollen); Mr. Neil D. Richmond, Carnegie Museum, Pittsburgh, (amphibians and reptiles); Dr. J. Alan Holman, Illinois State University, Normal (amphibians and reptiles); Dr. Robert Weigel, Illinois State University (birds); Dr. Ralph M. Wetzel, University of Connecticut, Storrs (*Synaptomys*); Mr. John E. Guilday, Carnegie Museum (mammals). In addition to the basic work of identification, I am especially indebted to John Guilday for additional assistance with some of the shrew and microtine material, and for a critical review of the manuscript.

ACCOUNTS OF SPECIES

INVERTEBRATES

The majority of animal remains recovered in the Meyer Cave fill were those of vertebrates. Representatives of the phyla Mollusca and Arthropoda were the only invertebrates encountered; the former included 15 species of gastropods and the latter, two Orders of insects with a minimum of 12 species represented. Snails, beetles and flies identified from the fill deposit are listed in Table 1. Actual counts were made of the snail shells; insect identifications were based, with the exception of *Nicrophorus* and the blow fly, on fragmentary body parts without an attempt to determine exact numbers.

Except for the one specimen of an aquatic snail (*Physa*), all shells recovered in the fill were terrestrial forms characteristic of the wooded limestone bluffs and/or floodplain bottomlands in this area. These land snails occur in forest floor litter and debris in timber stands dominated by oak, hickory, elm and maple, and all, with one exception, inhabit this bluff region today. Although only one specimen was recovered, *Discus cronkhitei anthonyi* from Meyer Cave is noteworthy since it is associated with a more northern environment in Illinois. Baker (1939) stated that "This variety appears to be confined to the northern half of Illinois, no specimens having been seen from regions south of Fulton County." Shells, particularly those of small species such as *Discus* and *Zonitoides*, probably accumulated in the fill by washing or filtering down through cracks in the roof rock, while some of the larger forms (*e.g., Anguispira, Triodopsis, Mesodon*) entered through the passageway. No living gastropods were encountered within the fissure.

Most of the insects identified from the fissure are associated with carrion or dung and undoubtedly they were attracted there by decomposing carcasses. Several hundred blow flies (*Calliphoria*) were noted emerging from a dead woodchuck that had fallen into the fissure. Only two living carrion beetles (*Nicrophorus*) were found in the fill. A greater variety of insects (mosquitoes, crickets, moths) and occasionally spiders occurred at the entrance of, or a few feet within, the passageway but apparently few reached the inner room or fissure. One of the ground beetles (*Scaphinotus*) is a known predator of snails. The insect complex of this fissure deposit resulted from an accumulation of dead animals which provided an attractive and continuing source of food.

Table 1.

Invertebrates from Meyer Cave, Illinois

Species	No. of Shells
MOLLUSCA (Gastropoda)	
Polygyridae	
Stenotrema hirsutum (Say)	16
Mesodon thyroidus (Say)	1
Mesodon clausus (Say)	1
Mesodon inflectus (Say)	95
Triodopsis fosteri (F. C. Baker)	346
Triodopsis albolabris (Say)	3
Haplotrematidae	
Haplotrema concavum (Say)	13
Zonitidae	
Hawaiia minuscula (Binney)	1
Zonitoides nitidus (Muller)	182
Endodontidae	
Anguispira alternata (Say)	18
Anguispira kochi (Pfeiffer)	17
Discus cronkhitei anthonyi (Pilsbry)	1
Discus patulus (Deshayes)	53
Helicodiscus parallelus (Say)	65
Physidae	
Physa gyrina (Say)	1
ARTHROPODA: Insecta (Coleoptera)	
Carabidae — Ground Beetles	
Scaphinotus elevatus	
Scaphinotus sp.	
Dicaelus sp.	
Silphidae — Carrion Beetles	
Nicrophorus tomentosus Weber	
Nicrophorus sp.	
Histeridae — Hister Beetles	
Species?	
Scarabaeidae — Scarab Beetles	
Pinotus sp.	
Copris sp.	
Onthophagus sp.	
Geotrupes sp.	
Curculionidae — Snout Beetles	
Species?	
ARTHROPODA: Insecta (Diptera)	
Calliphoridae — Blow Flies	
Calliphora sp.?	
Anthomyiidae	
Fannia sp.	

VERTEBRATES

The concentration of vertebrate remains found in the relatively small amount of fill of the Meyer Cave fissure is unique for Illinois and unparalleled in relation to Recent cave bone deposits in eastern North America. A minimum of 115 species (12,400 individuals) were represented and approximately 106,000 elements were determined to the genus and/or species level. Considering the number of remains of animals representing the five Classes of vertebrates, bones of snakes were the most numerous; nearly 157,500 vertebrae and 7,100 identifiable skull parts were recovered. Remains of at least 42 species of mammals occurred in the fill, followed by birds (32,), reptiles (22), amphibians (12) and fishes (8 species). The species of vertebrates identified from the Meyer Cave fissure, the number of determined elements, and minimum number of individuals of each are listed in Table 2.

With reference to the Pleistocene, Hibbard (1949) has stated that "In general, the smaller forms have rather restricted habitats and are the best indices for the study of past climatic conditions." This principle is applicable to post-glacial times as well; for this reason, more emphasis has been given here to the amphibians, reptiles and small mammals as their presence in a given area is more indicative of certain climatic and environmental conditions than migratory (e.g., birds) or wide-ranging forms.

PISCES – Fishes

Representatives of six families of fish, including at least four genera, were found in the fissure matrix. Except for opercle and preopercle elements of a large buffalofish that were found at about the center of the passageway, all other fish remains within the fissure were from small individuals. Of the 130 gar remains, 117 were scales, possibly all from the same fish.

There is little, if any, evidence to indicate that the Mississippi River had again reached the present level of the numerous shallow bluff caves and solution cavities since its recession at the end of the glacial era. Therefore, the presence of fish bones in the fill probably resulted from the animals being brought in as food for the young of denning mammals or by other predators utilizing the passageway and cave. Possibly some were actually part of the stomach contents of otters or other mammals and reptiles (*Natrix*), known to feed on fish, that had fallen into the fissure.

Amphibia – Amphibians

By the turn of the century, most of the floodplain lakes, sloughs and backwater ponds comprising much of the area between the main Mississippi River channel and the bluff had been drained. Numerous remains of water snakes (*Natrix*), the sora, otter, mink and other species associated with an aquatic or semi-aquatic environment suggest the close proximity of such a habitat to Meyer Cave. A minimum of six species of salamanders, four frogs and two species of toads were represented in the fissure fill.

Some of these species occur on top of the bluff in and around the numerous sink holes and on the damp forest floor. Many of the amphibian remains may have accumulated from those individuals which inhabited or fell into the bluff-top crevice, although probably the majority entered or were brought in by predators from the floodplain marsh that formerly reached to the foot of the bluff talus.

Caudata: salamanders. -During the nine visits to Meyer Cave in 1959-1961 and the week of excavation in July, 1961, only eight live salamanders were encountered. One specimen of the long-tailed salamander (*Eurycea longicauda*) was found under a limestone slab in the upper room and seven slimy salamanders (*Plethodon glutinosus*) occurred in the fissure fill. Skeletal remains of representatives of these genera were rare and it appears that their presence in the fissure is of very recent occurrence.

The three species of *Ambystoma* were differentiated on the basis of skull elements and certain post-cranial bones, particularly the humeri, femora and ilia. In the case of the tiger salamander, bones of both the appendicular and axial skeleton, including vertebrae, were referred to *A. tigrinum* on the basis of their large size; a major per cent of those remains assigned to *Ambystoma* sp. are probably *A. tigrinum*. The tiger, spotted and narrow-mounted salamanders presently occur in this bluff area and locally may become abundant, especially *A. tigrinum*. Except for the entirely aquatic siren, all species of salamanders encountered in the fill deposit are fossorial and could have entered the fissure through former wall crevices. The high concentration of ambystomid remains, however, suggests a former dense population in the wooded ravine on top the bluff or in the marshland at the base; in the latter case, occasionally some individuals may have been brought into the upper room as prey.

No skull parts of the siren were recovered, and the determination of *S. intermedia* was based on the 29 vertebrae which compared closely with those of reference specimens taken in southern Illinois. According to Smith (1961), ". . . the extensive river bottoms seem to offer ideal habitat. . . ." for the dwarf siren, and the specimen(s) represented in the fill was probably brought from the nearby marsh into the cave by a predator.

Salienta: frogs and toads. -Approximately 35,500 frog bones were determined as *Rana;* although most limb elements of the appendicular skeleton are not diagnostic enough for specific identification, gross structure and length-girth ratios enabled identification to the genus level. Certain salient characteristics of some elements made recognition of small bullfrog remains possible, but identification of about three-fourths of the *Rana catesbeiana* bones was based on size. The ilia and sacral vertebrae appeared to be the most diagnostic elements in determining species of *Rana,* and although some subtle variation was noted in the remains of the small ranids, those that could be specifically determined were referred to the leopard frog (*Rana pipiens*).

The pickerel frog (*R. palustris*), wood (*R. sylvatica*) and green frog (*R. clamitans*) occur along the bluff in the Meyer Cave vicinity but none of the ranid elements, even those few apparently distinct from *pipiens* and *catesbeiana,* could be satisfactorily assigned to any of these three species. On several occasions, numerous small leopard frogs were noted on the talus slope and near the entrance to the cave. Probably some of the frogs and

Table 2.

Vertebrates from Meyer Cave, Illinois

Species	*No. of Identified Remains*	*Minimum No. of Individuals*
PISCES (Fishes)		
Ammiidae		
Amia calva, bowfin	10	2
Lepisosteidae		
Lepisosteus sp., gar	130	2
Castostomidae		
Suckers and buffalofish spp.	9	2
Ictiobus sp., buffalofish	4	1
Cyprinidae		
Minnow spp.	2	2
Ictaluridae		
Ictalurus sp., catfish	3	1
Ictalurus spp., bullhead	64	8
Ictalurus melas, black bullhead	8	3
Catfish spp.	7	1
Centrarchidae		
Sunfishes	4	1
AMPHIBIA (Caudata: Salamanders)		
Ambystomidae		
Ambystoma spp., salamander	8,923	322
Ambystoma cf. *texanus,* small- mouthed salamander	13	3
Ambystoma cf. *maculatus,* spotted salamander	73	9
Ambystoma tigrinum, tiger salamander	1,822	273
Plethodontidae		
Plethodon glutinosus, slimy salamander	2	2
Eurycea sp., cave and/or tong-tailed salamander	3	1
Sirenidae		
Siren cf. *intermedia,* dwarf siren	29	1
AMPHIBIA (Salientia: Frogs & Toads)		
Pelobatidae		
Scaphiopus cf. *holbrooki,* eastern spadefoot	566	51
Bufonidae		
Bufo spp., toad	413	49
Hylidae		
Hyla cf. *versicolor,* eastern gray treefrog	11	4
Ranidae		
Rana spp., frog	24,262	—
Rana catesbeiana, bullfrog	973	52
Rana pipiens, leopard frog	10,272	4,772
Microhylidae		
Gastrophryne carolinensis, eastern narrow-mouthed toad	2	1
REPTILIA (Testudines: Turtles)		
Turtle spp.	64	—
Chelydridae		
Chelydra serpentina, snapping turtle	2	1
Kinosternidae		
Sternothaerus odoratus, musk turtle	2	1
Testudinidae		
Terrapene sp., box turtle	80	5
Pseudemys, Graptemys and/or *Chrysemys* spp., turtle	16	3
Pseudemys sp., slider	9	2
Trionychidae		
Trionyx sp., softshell	5	3
REPTILIA (Sauria: Lizards)		
Iguanidae		
Sceloporus undulatus, fence lizard	1	1
Teiidae		
Cnemidophorus sexlineatus, Six-lined racerunner	4	2
Scincidae		
Eumeces sp., skink	15	8
Eumeces laticeps, broad-headed skink	9	5
REPTILIA (Serpentes: Snakes)		
Colubridae		
Heterodon cf. *platyrhinos,* eastern hognose snake	10	2
Coluber constrictor, blue racer	1,804	235
Masticophis flagellum?, coachwhip	4	2
Elaphe sp., rat and/or Black snake	35	6

Species	No. of Identified Remains	Minimum No. of Individuals
Elaphe cf. *guttata*, rat snake	25	6
Elaphe obsoleta, pilot black snake	123	14
Pituophis melanoleucus, bullsnake	14	3
Lampropeltis spp., milk snake and/or kingsnake	14	2
Thamnophis spp., ribbon and/or garter snake	6	4
Natrix spp., water snake	60	11
Natrix erythrogaster, yellow-bellied water snake	26	7
Natrix rhombifera, diamond-backed water snake	1	1
Natrix sipedon, water snake	2	2
Snake spp.: Family Colubridae (vertebrae)	54,695	—
Crotalidae		
Agkistrodon contortrix, copperhead	321	35
Crotalus horridus, timber rattlesnake	3,894	370
Snake spp.: Family Crotalidae (vertebrae)	102,713	—
AVES (Birds)		
Ardeidae		
Botaurus lentiginosus, American bittern	1	1
Anatidae		
Chen, sp., blue and/or snow goose	2	1
Anas sp., mallard or black duck	1	1
Duck spp.	5	—
Lophodytes cucullatus, hooded merganser	1	1
Cathartidae		
Cathartes aura, turkey vulture	41	6
Coragyps atratus, black vulture	9	2
Vulture spp.	28	3
Accipitridae		
Buteo cf. *jamaicensis*, red-tailed hawk	3	2
Buteo sp., hawk	1	1
Falconidae		
Falco sparverius, sparrow hawk	11	2

Species	No. of Identified Remains	Minimum No. of Individuals
Phasianidae		
Colinus virginianus, bobwhite	39	9
Meleagridae		
Meleagris gallopavo, turkey	3	2
Rallidae		
Porzana carolina, sora	71	21
Fulica americana, American coot	3	1
Columbidae		
Ectopistes migratorius, passenger pigeon	3	2
Strigidae		
Strix varia?, barred owl	-	1
Picidae		
Colaptes cf. *auratus*, yellow-shafted flicker	23	5
Woodpecker sp.	1	1
Tyrannidae		
Sayornis cf. *phoebe*, phoebe	1	1
Empidonax sp., flycatcher	1	1
Myiarchus crinitus, crested flycatcher	1	1
Troglodytidae		
Troglodytes sp., wren	3	2
Turdidae		
Hylocichla sp., thrush	4	2
Sialia sialis, eastern bluebird	1	1
Bombycillidae		
Bombycilla cedrorum, cedar waxwing	2	1
Vireonidae		
Vireo cf. olivaceus, red-eyed vireo	1	1
Parulidae		
Dendroica sp., warbler	1	1
Seiurus cf. *aurocapillus*, ovenbird	1	1
Icteridae		
Quiscalus quiscula, grackle	9	2
Thrapuidae		
Richmondena cardinalis, cardinal	4	3
Ploceidae		
Passer domesticus, house sparrow	1	1
Loxia sp., crossbill	3	1
Fringillidae		
Spiza americana?, dickcissel	1	1

Species	No. of Identified Remains	Minimum No. of Individuals
Pipilo erythrophthalmus, spotted towhee	17	7
Junco cf. *hyemalis*, slate-colored junco	9	3
MAMMALIA (Mammals)		
Didelphidae		
Didelphis marsupialis, opossum	5,853	314
Talpidae		
Scalopus aquaticus, eastern mole	272	29
Soricidae		
Sorex cf. *longirostris*, southeastern shrew	51	27
Microsorex hoyi, pigmy shrew	2	1
Blarina brevicauda, short-tailed shrew	1,047	262
Cryptotis parva, least shrew	2,609	1,049
Shrew: most probably *C. parva*	152	—
Vespertilionidae		
Myotis spp., bat	124	63
Pipistrellus subflavus, eastern pipistrel	22	10
Eptesicus fuscus, big brown bat	153	86
Plecotus sp., big-eared bat	14	7
Bat spp.	110	—
Procyonidae		
Procyon lotor, raccoon	520	*(7) 26
Mustelidae		
Mustela rixosa, least weasel	3	1
Mustela cf. *frenata*, long-tailed weasel	124	10
Mustela vison, mink	433	28
Lutra canadensis, river otter	201	10
Spilogale putorius, spotted skunk	306	25
Mephitis mephitis, striped skunk	4,849	383
Taxidea taxus, badger	20	1
Canidae		
Vulpes fulva, red fox	12	*(2)
Urocyon cinereoargenteus, gray fox	81	*(8) 5

Species	No. of Identified Remains	Minimum No. of Individuals
Fox: *Vulpes* and *Urocyon* (mostly pups)	87	—
Canis spp., canid: dog?	129	5
Canis familiaris, dog	6	3
Felidae		
Felis concolor, cougar	4	*(1)
Lynx cf. *rufus*, bobcat	145	*(8) 5
Sciuridae		
Marmota monax, woodchuck	12,600	597
Tamias striatus, eastern chipmunk	1,573	177
Sciurus carolinensis, eastern gray squirrel	55	5
Sciurus sp.	64	5
Glaucomys volans, southern flying squirrel	10	2
Geomyidae		
Geomys bursarius, plains pocket gopher	29	6
Cricetidae		
Peromyscus spp., deer/white-footed mouse	11,922	4,737
Mouse spp.: most probably *Peromyscus* and *Microtus*	39,800	—
Oryzomys palustris, rice rat	30	15
Neotoma floridana, eastern wood rat	6,053	535
Synaptomys cooperi, southern bog lemming	210	66
Clethrionomys cf. *gapperi*, red-backed vole	3	3
Microtus pennsylvanicus, meadow vole	21	10
Microtus xanthognathus, yellow-cheeked vole	13	5
Microtus spp., meadow mouse; *Pitymys*, pine vole	2,160	830
Pitymys pinetorum, pine vole	26	26
Ondatra zibethica, muskrat	84	5
Muridae		
Mus musculus, house mouse	2	1
Zapodidae		
Zapus hudsonicus, meadow jumping mouse	1	1

Species	No. of Identified Remains	Minimum No. of Individuals
Erethizontidae		
Erethizon dorsatus, porcupine	84	10
Leporidae		
Sylvilagus floridanus, eastern cottontail	6,947	456
Cervidae		
Odocoileus virginianus, white-tailed deer	99	3
Suidae		
Sus scrofa, domestic pig	4	*(1)
Hominidae		
Homo sapiens, man	13	2

* (Juvenal: milk dentition)

toads were carried into the cave as prey animals, but it seems unlikely that so great an accumulation of their remains can be attributed entirely to this source.

Both the American toad (*Bufo americanus*) and Fowler's toad (*B. woodhousei*) appear to be represented in the sample, but the close similarity of bone structure between the two made specific identification questionable. Although both occur in the area, Fowler's toad is the more common of the two species. The eastern narrow-mouthed toad (frog) has been recorded from only Monroe and Randolph counties in Illinois (Smith, 1961) although where it occurs along the Mississippi River bluffs, it is locally common. Only two ilia (same frog?) of *G. carolinensis* were recovered in the fissure. Eleven bones, representing at least four individuals, of a treefrog (probably *Hyla versicolor*) were the only remains found of a representative of this common group of Illinois frogs.

One of the most noteworthy aspects of the amphibian complex from Meyer Cave was the presence of numerous bones (566, at least 51 individuals) of the spadefoot toad (*Scaphiopus* cf. *holbrooki*). Prior to the recent capture of a single male spadefoot near Fults, Monroe County (Brandon and Austin, 1966), this toad was known only from the southern tip of the state; according to Smith (1961), it probably entered southern Illinois by way of the Mississippi River valley. On the basis of this one specimen, Meyer Cave is now only 15 miles north of the present known range of *S. holbrooki* in Illinois, but these cave remains represent the most northern occurrence of this toad along the Mississippi River. Since the spadefoot toad does reach more northern latitudes in eastern United States, however, its occurrence at Meyer Cave is not indicative of an earlier warmer climate.

Reptilia – Reptiles

Remains of reptiles were more numerous in the fissure fill than representatives of any other single Class of vertebrates. At least five species of turtles, three lizards and thirteen species of snakes were identified from the sample; this species total comprised approximately 800 individuals and 165,000 bones. The species of snakes listed in Table 1 were determined from cranial parts, the vertebrae being separated only into Families, primarily on the basis of the presence or absence of the haemal spine. Future study of the vertebrae may disclose species not represented by skull elements, but because of the more diagnostic character of several cranial parts, it was felt that specific identification based on these elements would be more reliable than those determined from vertebrae. Also, no entirely satisfactory method of separating the vertebrae of *Crotalus* and *Agkistrodon* was developed and the time factor in examining nearly 55,000 vertebrae of colubrids, which included several genera with closely related species, was prohibitive.

Testudines: turtles. -Of the four species of turtles identified from Meyer Cave, box turtle remains were the most numerous. Both the ornate box turtle (*T. ornata*) and the eastern box turtle (*T. carolina*) inhabit the timbered sections of the bluff top as well as the talus slope; since they are terrestrial species, their presence in the fissure fill would more likely have resulted from normal entry through the passageway and/or by falling into the bluff top crevice. On the other hand, aquatic forms (*Chelydra, Pseudemys, Trionyx, Sternothaerus*) were probably brought in as prey since they would not normally be found at – or could traverse – the upper levels of the talus near the cave entrance. Most of the turtle elements were fragmentary.

Sauria: lizards. -This group of reptiles is poorly represented in the Meyer Cave material even though the species identified from

the fill are presently common in the area. Their agility in climbing may account for this paucity of remains since most lizards, if not injured in the fall, could easily ascend even vertical walls of such a fissure.

Identification of the broad-headed skink (*Eumeces laticeps*) was based on those skull elements which exceeded the maximum size range of the smaller, closely related five-lined skink (*E. fasciatus*). Both skinks occur in the timbered areas above and below the cave and the latter species may well be represented; overlap in the size range of elements between these two lizards makes specific identification of the smaller bones impossible.

Serpentes: snakes. -Considering all elements, the ratio of crotalid bones to those of the colubrids was approximately two to one; the per cent of identifiable skull parts of *Crotalus* compared with *Agkistrodon* was 70 to 30 per cent. The predominance of rattlesnake and copperhead remains in the fill probably resulted from the natural activity of these snakes entering the passageway or the bluff top crevice in search of cover, food and/or den sites. Both of these species inhabit wooded hillsides and rock outcrops typical of the Mississippi River bluffs and talus; with reference to *C. horridus*, Smith (1961) comments that "In the fall the timber rattler congregates at den sites, which are usually rock bluffs with many deep cracks and fissures."

Both of these poisonous snakes are present in the vicinity of Meyer Cave today but they are considered to be uncommon. Individuals from the fissure varied in size from new born to at least one specimen that approached five feet in length. Although the cottonmouth (*Agkistrodon piscivorus*) ranges up the Mississippi River valley bottomlands as far north as Monroe County, and is similar to the timber rattlesnake in denning habits, no remains of this aquatic snake were found.

A variety of both upland and river bottom species of colubrids were identified from the fissure deposit. Although water snakes (*Natrix*) occur along creeks and around ponds, sink holes and other aquatic situations along the bluff top, the number of elements of certain species of natricines suggests that most of the water snakes came or were brought into the cave from the floodplain. The osteological similarities among species of *Natrix*, and variation within a species, often made specific identification uncertain. Remains of the copperbelly or redbellied water snake (*N. erythrogaster*), of which both Illinois subspecies are associated with the quiet waters of ponds and swamps, were the most numerous of the water snakes. However, less than 100 elements – representing 21 individuals – were determined as *Natrix* and these aquatic forms comprised only a small part of the total snake complex from the Meyer Cave fissure.

Cranial elements, as well as number of individuals, of the blue racer (*Coluber constrictor*) ranked second to the timber rattlesnake, while those of the pilot black snake (*Elaphe obsoleta*) were fourth in number. These snakes may be considered characteristic of a dry, timbered upland although the wooded bluff talus is an equally well suited habitat. Other colubrids represented in the snake material from Meyer Cave may also occur above or below the face of the bluff. Actually, the bluff face is not a complete barrier or obstruction to either upland or floodplain forms since irregular surfaces, vegetation and ledges enable agile climbers like the pilot black snake to move from one level or elevation to another.

Populations of the coachwhip (*Masticophis flagellum*) and rat snake (*Elaphe guttata*), which are restricted to areas of hill prairie and adjacent forest edge along the Mississippi River in southwestern Illinois (Smith and Minton, 1957), are small and represent the eastern limit of ranges situated predominately west of the Mississippi River. Although both snakes have been reported from Monroe County, they are uncommon to rare, judging by the paucity of specimens collected. On the basis of 25 skull elements, at least six individuals of the rat snake were represented in the fissure fill; like the pilot black snake, *E. guttata* is adept at climbing and occurs in similar habitats.

The remains of bullsnake (14 elements, 3 individuals) in Meyer Cave are noteworthy in light of this reptile's known distribution in Illinois. Presently the range of *Pituophis melanoleucus* includes primarily the northwestern quarter of the state although there are two early records in adjacent counties (St. Clair, Madison: Smith, 1961) bordering Monroe County. Remains of this prairie snake in the fissure deposit, even though not common, are indicative of either an earlier southward extension of its range or, like the coachwhip and rat snake, part of the eastern limit of a range predominately west of the Mississippi River.

Aves – Birds

Except for the vultures, there is little likelihood that the majority of birds represented in the fissure fill entered the cave of their own volition. The aquatic or semi-aquatic species such as goose, merganser and sora were probably captured in the floodplain marshes and brought into the cave by predators; many of the smaller birds (e.g., passerines) typical of the wooded uplands may have become trapped in the once-open crevice on top of the bluff. Possibly some were taken by raptorial birds and their remains, in the form of regurgitated pellets below hawk and owl roosts, fell or were washed into the crevice opening.

Approximately 700 avian remains, comprising at least 120 individuals from 21 Families, were recovered from the Meyer Cave fissure. Of this total, about 400 specifically unidentified bones – mostly broken elements and those (radius, ulna, femur) less diagnostic than the humerus – were primarily small passerines, many belonging to the Fringillidae.

The avian complex from this fissure was diversified, but none of the species could be considered indicative of a climate or habitat unlike the existing regional environment today. The quantity of sora remains is unusual, but this marsh-dwelling rail is common in suitable habitat (that formerly existed as floodplain between the cave and the river) and would have been easy prey for mink, weasel and other predators. With the exception of the flicker and vultures, remains of basically ground-dwelling birds (bobwhite, towhee, junco) predominated. Several other species such as the thrushes (*Hylocichla*), vireos, warblers, ovenbird and wrens are typical of forest-edge and understory layers; such species as well as strictly ground-inhabiting birds might conceivably blunder into a partially concealed crevice or fissure. Because of their agility at climbing, the possibility of woodpeckers becoming trapped would be greatly reduced; the number of flicker remains in the fissure matrix can probably be attributed to birds taken by predators.

Parmalee and Jacobson (1959), in reporting the vertebrate remains found in a Recent cave (fissure) bone deposit in Ralls County, Missouri, encountered 291 elements (16 individuals) of the turkey vulture (*Cathartes aura*). Although this fissure was deeper (45 feet) than Meyer Cave, it was similar in having a horizontal passageway leading inward from the face of the bluff; the authors suggested that the vultures had been attracted to the cave by the odor or sight of carrion on the floor of the fissure. Rock ledges and shallow crevices are often selected as nest sites by vultures. However, the lack of remains of nestlings in both caves would indicate that the horizontal passageways were not used as a nest site and that only adult birds were trapped after entering the fissure in search of carrion.

Mammalia — Mammals

The number of species and the quantity of remains of mammals identified from the Meyer Cave fissure are perhaps the most noteworthy of all the vertebrate groups. At least 42 species are represented, comprising 19 Families, nearly 10,000 individuals and approximately 59,000 remains determined to genus and/or species. Thirteen species had not previously been reported from, or were known to have occurred in, Monroe County; three of these, the yellow-cheeked vole (*Microtus xanthognathus*), red-backed vole (*Clethrionomys gapperi*) and the porcupine (*Erethizon dorsatum*), constituted new state records.

Order Marsupialia: Marsupials

Didelphidae. -Opossums are common throughout most of Illinois, and the wooded bluff and talus bordering the Mississippi River provides ideal habitat for this marsupial. Many of the trapped animals probably entered the passageway in search of food or a protected retreat during the daylight period. All elements of the opossum and all ages were noted, ranging from a few very young individuals (still in the pouch?) in which the milk teeth had not fully erupted, to old adults. Of those mammals identified to

species, the opossum ranked fourth with 5,853 remains representing at least 314 individuals.

Order Insectivora: Moles and Shrews

Talpidae. -Bones of the "prairie" mole (*Scalopus aquaticus machrinus*) were fairly common in the fissure fill. Today this species occurs in the talus and in cultivated areas of the floodplain, although it is more numerous in the well-drained soils of the uplands. Prior to reclamation of these bottomland marshes, the eastern mole was probably restricted to the bluff tops and most, if not all, of these fossorial animals entered or fell into the crevice that led to the fissure from above.

Soriciade. -Four species of shrews were identified from the Meyer Cave bone deposit; remains of two, the least shrew (*Cryptotis parva*) and the short-tailed shrew (*Blarina brevicauda*) were abundant and totaled 2,609 and 1,047 respectively. Except for a few complete post-cranial elements of *B. brevicauda* that could be specifically identified, the number of determined bones of these four species listed in Table 2 were based on skulls and jaws. On the basis of the lower right jaw, at least 1,049 individuals of *C. parva* are represented.

The least shrew is probably the most common soricid in Illinois and occurs in almost all habitat types except extensive stands of timber. They usually reach greatest abundance in weedy fields, brushy areas and meadows; the quantity of remains of *C. parva* in the fissure fill, coupled with those of bobwhite, blue racer, mole and other species characteristic of this habitat type, suggest a former grassland and forest-edge area on the bluff top above the fissure. Two subspecies occur in Illinois, *C. p. parva* occupying the northern two-thirds and *C.p. harlani*, the southern third (Hoffmeister and Mohr, 1957). Hall and Kelson (1959) include the western half of Illinois, as well as the northern one-third, in the range of the form *harlani*. On the basis of osteological material only, differences between the two subspecies are almost impossible to ascertain; probably the Meyer Cave specimens are *C.p. harlani*.

On the other hand, two distinct size differences were noted in the series of jaws of the short-tailed shrew. Presently, *Blarina brevicauda brevicauda*, the larger form, occurs in the northern part of the state and *B.b. carolinensis*, in the southern half. A total of 227 complete lower jaws of *Blarina* were measured and based on their total length, toothrow and mandibular condyle width, two distinct groups or subspecies could be recognized (Table 3). Those jaws considered to be *B.b. brevicauda* exhibited a more massive appearance than *carolinensis*; the depth of the jaw, measured from the rim of the alveolus of M_1 to the ventral margin of the jaw averaged 2.5m and 1.8m, respectively. These general size differences may be clearly noted in a representative sample of each shown in figure 8.

No complete skulls of *Blarina* were recovered and, consequently, general size differences were less apparent than in the jaws. However, the alveolar length (posterior edge of I^1 to

Table 3.

Summary of BLARINA jaw measurements (mm.) from Meyer Cave.

	No. of jaws	Average total length	Range total length	Toothrow alveolus C_1-M_3	Width mandibular condyle
Blarina brevicauda cf. *brevicauda*	93	14.79	14.0-16.0	6.17 (Rg. 5.9-6.6)	3.92 (Rg. 3.7-4.1)
Blarina brevicauda cf. *carolinensis*	134	12.65	12.0-13.4	5.50 (Rg. 5.2-5.7)	3.23 (Rg. 3.1-3.4)

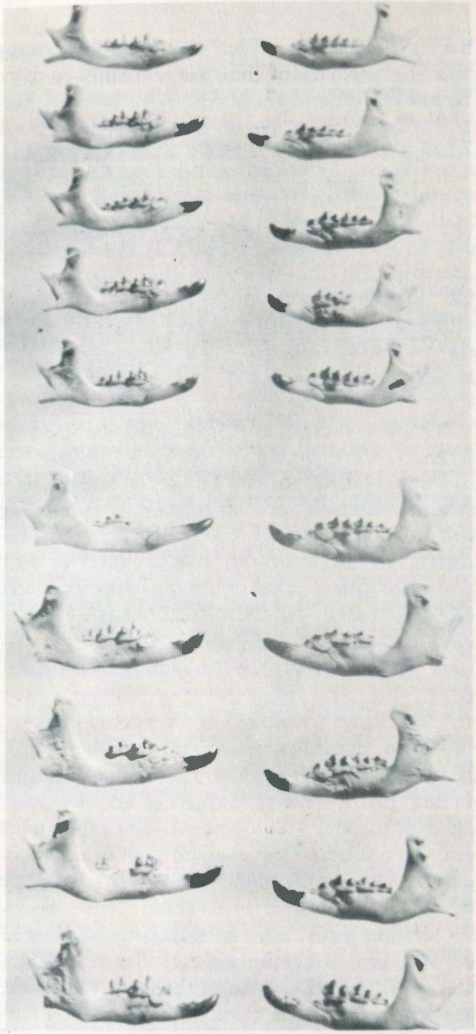

Figure 8.

Sample series of Blarina brevicauda cf. carolinensis (top) and B. b. brevicauda (bottom) from Meyer Cave.

posterior edge of M_3) was measured in 71 skulls; the larger series (34 skulls – *B.b.* cf. *brevicauda*) averaged 8.47m (Range 8.0 – 9.0) and the smaller (37 skulls – *B.b.* cf. *carolinensis*) averaged 7.43m (Range 7.1 – 7.7). The *Blarina* material from Meyer Cave, therefore, apparently represents a mixture of two distinct subspecies or populations. Monroe County falls within the area of intergradation and although the two size groups of *Blarina* in the Meyer Cave material are distinct, it is somewhat problematical as to whether these races were contemporaneous or occupied the cave area during different periods.

The rare southeastern shrew (*Sorex longirostris*) is known from only four counties in east-central and southern Illinois; remains of this insectivore in the fissure fill are noteworthy in that the species was previously unknown from the west-central region of the state (Monroe County). Compared with the number of remains of the least and short-tailed shrews, *S. longirostris* was (or is) uncommon in the vicinity of Meyer Cave, but the presence of at least 27 individuals suggests an established local population.

Guilday, Martin and McCrady (1964) state that "The pygmy shrew is rare in Recent mammal collections from eastern North America." Since remains of *Microsorex boyi* were common in their Pleistocene cave deposit (New Paris No. 4) from Pennsylvania, the authors suggest this shrew was more widespread and common in the east during the late Pleistocene than in Recent times. A complete lower left jaw and the rostal section of a skull of the pigmy shrew were recovered in the Meyer Cave deposit, and these elements constitute the second record of *M. boyi* for Illinois (Parmalee and Munyer, 1966). A single specimen of this northern shrew was taken in Cook County (Hoffmeister and Mohr, 1957), approximately 300 miles northeast of Meyer Cave. Although only these two cranial elements were recovered, the presence of this shrew, considering its present range, is of significance in possibly being indicative of a prolonged cooler and more moist climate in southwestern Illinois during at least one post-glacial period.

Order Chiroptera: Bats

Vespertilionidae. -The low, narrow existing passageway leading to the inner room and fissure of Meyer Cave does not provide a type of entrance easily maneuvered by bats. However, the fact that bats can, and did, utilize the cave is apparent by the 423 remains (166 individuals) present in the fissure fill, but this count is small compared with those from caves having larger and more accessible entrances. At least four species of bats were determined from cranial and jaw elements; only two complete bat skulls (big brown bat, *Eptesicus fuscus*) were recovered. The eighteen rostral skull sections of *Myotis* lacked complete dentition, and on the basis of only lower jaws and these incomplete skulls, no attempt was made at identification beyond genus. Of the 63 lower left mandibles and 47 lower rights, those which were complete fell within the size range of Keen's bat (*M. keenii*) and the little brown bat (*M. lucifugus*). These two species are probably the most common *Myotis* in the southern half of the state today although occasionally large local hibernating colonies of *M. grisescens* and *M. austroriparius* do occur (Smith and Parmalee, 1954).

Both the eastern pipistrel (*Pipistrellus subflavus*) and the big brown bat are common throughout most of Illinois, inhabiting urban as well as rural areas and utilizing a variety of roosting and hibernating situations (Smith and Parmalee, ibid.). Cracks and small fissures in the bluff face as well as the underside of rock ledges and overhang are used as daytime roost areas by bats, especially by the big brown bat. The open fissure on top of the bluff could have been occupied as a roost, remains of the dead animals eventually filtering down to the inner fissure. John E. Guilday examined the bat material from Meyer Cave and found (pers. comm.) that most of the skull and jaw elements of *Eptesicus* fell within the size range of the Pleistocene species *E. grandis*. However, he is of the opinion that *grandis* is not a valid species, and that it is not separable from the Recent *E. fuscus* on the basis of size or any series of unique characteristics.

Remains of the big-eared bat (*Plecotus* cf. *rafinesquii*) in Meyer Cave are noteworthy in that this species has been previously recorded from only two counties in extreme southern and southeastern Illinois (Hoffmeister and Mohr, 1957). This bat is known to occupy caves during all seasons, singly or in small colonies. Southern Illinois is included within the possible range of the western big-eared bat (*P. townsendii*) by Hall and Kelson (1959) and possibly the Meyer Cave *Plecotus* (2 incomplete skulls; 7 lower left jaws, 5 lower rights) may include both species. Species identification on the basis of cranial material only is impossible; *Plecotus* from the fissure was referred to the eastern big-eared bat (*P. rafinesquii*) solely on the evidence of modern records of this bat in southern Illinois.

Order Carnivora: Carnivores

Procyonidae. -Raccoons are common in wooded areas throughout Illinois, and locally they often become abundant in timbered river bottoms and floodplains. Giles (1942) has discussed the use of rock crevices and fissures for den sites and escape cover by racoons in Iowa; it was implied that such sites were preferred to those in trees. These limestone bluff den sites in Iowa were also utilized by the opossum, cottontail, woodchuck, striped skunk and two species of foxes. The small inner room forming part of the Meyer Cave complex would have been ideally suited for escape cover and dens, and probably many of these animals – and their young – fell into the fissure opening while trying to circumvent it at the inner end of the passageway. At least seven of the 33 raccoons represented in the fill were juvenals (milk dentition); a total of 520 elements were identified as *Procyon lotor*.

Mustelidae. -Members of this Family were well represented in the fissure deposit; nearly 6,000 bones, comprising seven species and 458 individuals, occurred in the bone sample. Approximately 82 per cent of the mustelid bones were those of the striped skunk (*Mephitis mephitis*), and judging from this quantity of remains, it was the most numerous member of the Family in the area during the period of bone accumulation. Four of the species no longer occur in the cave area: ranges of two, the least weasel (*Mustela rixosa*) and badger (*Taxidea taxus*), include only northern sections of Illinois while the otter (*Lutra canadensis*) and the spotted skunk (*Spilogale putorius*) are extirpated in the state.

Remains of the mink (*Mustela vison*) and otter are indicative of an aquatic environment and the former floodplain marshes adjacent to the bluff talus would have provided an ideal habitat for these species. Weasels are also usually associated with a like habitat. Except for the otter, which seldom wanders far from water, it is conceivable that some individuals of the other six species could have fallen into the bluff top crevice as well as entering through the passageway. Also, because of the irregular surface of the bluff face in some sections and the numerous ledges, individuals of typically upland species (e.g., spotted skunk, badger) could descend from the bluff top to the talus slope. Except for possibly the spotted skunk, the majority of the mustelids probably inhabited the wooded talus and floodplain bottomlands and entered the cave passageway in search of food, dens or escape cover.

Presently the badger occurs in Illinois as far south as Fulton and Douglas counties; the Meyer Cave record represents a range extension for *T. taxus* of at least 100 miles to the south-southwest in the state. The presence of badger in the fissure fill is also of interest in that it was the only mammal skeleton found *in situ*. Only part of the skeleton was recovered, occurring six feet below the fill surface, but its relatively undisturbed state suggests that the animal had entered through the passageway and died in the fissure rather than parts of the disarticulated carcass working down through the bluff top crevice.

Parmalee and Munyer (1966) reported range extensions of the least weasel (*Mustela rixosa*) in Illinois, one of which was based on the complete lower mandible and anterior half of a skull, probably from the same animal, recovered from the Meyer Cave deposit. This (early?) Monroe County record extends the range of the least weasel in Illinois approximately 165 miles southwest of its established, southernmost locality and, coupled with the recovery of remains of such species as pigmy shrew, least weasel, yellow-cheeked and red-backed voles, and porcupine, serves as an indicator of a cooler climatic period following the glacial retreat.

The first evidence for the possible former occurrence of the spotted skunk in Illinois was presented by Parmalee and Hoffmeister (1957). This evidence consisted of five skull and 13 lower jaw sections, representing at least nine individuals, which were recovered at the Archaic (*ca.* 8,500 – 1,500 B.C.) Modoc Rock Shelter site located two miles northwest of Modoc, Randolph County. All of these skull parts occurred at levels (dated by C14) that fell in a time period of approximately 4,500 to 2,500 B.C. No post-cranial elements were recovered and Van Gelder (1959) suggested – and rightly so – that it was entirely possible that these animals were transported to Illinois by the Indians. However, with the recovery of 306 bones, representing a minimum of 25 individuals, of the spotted skunk in the Meyer Cave fissure (25 miles north of the Modoc site), there is little question as to the existence of a former population of *S. putorius* in southwestern Illinois. It is reasonable to assume the Meyer Cave and Modoc site populations of spotted skunk were contemporaneous; this time period of 4,500 – 2,500 B.C. falls within the upper limits of the post-Wisconsin xerothermic period (Kendeigh, 1961), characterized by a warm and dry climate.

Canidae. -Both the gray fox (*Urocyon cinereoargenteus*) and red fox (*Vulpes fulva*) occur throughout Illinois; the gray is more common in the heavily wooded areas of the southern half of the state while the red appears to be evenly distributed within Illinois in rolling country made up of semi-open woodlands, cultivated fields and meadows. The red fox normally utilizes (by enlarging) the ground burrows of woodchucks, skunks and rabbits while, on the other hand, the gray fox typically dens in the hollow of a standing tree or log, or in a hole in rocky outcrops and cliffs. The greater abundance of gray fox in southern Illinois and its preference for den sites in rocky hillsides and bluffs is reflected in the proportion of remains of these two canids in Meyer Cave.

Eighty seven percent of the fox bones were those of *U. cinereoargenteus*; eight of the 13 individuals represented were pups and, judging from the fox elements which could be specifically identified, most of the remains (primarily pups) recognized as either *Urocyon* or *Vulpes* were probably gray fox. Only bones of pups of the red fox occurred in the fissure fill. The upper room of Meyer Cave would have provided a good den location for foxes and the quantity of fox pup remains is indicative of its use for that purpose.

Analyses of the remains of *Canis* from the Meyer Cave deposit were limited because it was not possible to ascertain whether the bones were those of Indian dogs, modern forms or a mixture of both. Also, none of the animals or skeletons were articulated, thus making it difficult to determine which

elements comprised a particular individual. The one probable exception consisted of 13 skull and post-cranial elements which, because of their size and proportion, were apparently all from the same small dog. At the beginning of this project, the first three of these bones (femur, tibia, humerus) recognized as a small canid, were sent to John E. Guilday for an opinion; Guilday later forwarded them to Dr. Barbara Lawrence at Harvard. Dr. Lawrence stated in a letter (Jan. 26, 1961) to Guilday that these elements ". . . .resemble very closely those of a small spaniel, No. 10731, in our collection." Surprisingly, remains of very few modern "intrusive" animals (*e.g.*, pig, *Sus*; house mouse, *Mus*; house sparrow, *Passer*) were found; however, dogs certainly could have entered the passageway and some of those represented in the fill may well be recent or modern breeds.

Two lower jaws, probably from the same animal, were measured (right: M1, alveolar length of P_1 -M_3 and C-M_3; left: alveolar length of P_1 -M_3 and C-M_3), and fell within the Range, and within three mm. of the Mean, of the Alabama shell-heap dogs recorded by Haag (1948). See Table 4. Measurements of one complete femur and humerus also fell within the Range of those referred to by Haag (ibid.) as the Alabama shell-heap dogs, but also the Woodland and Mississippian dogs; they were closest to the Mean of the latter. Dimensions of paired tibiae were at the maximum of the Range of Mississippian dogs (largest of prehistoric dogs considered by Haag); probably these elements were not from the same individual. Six lower (M_1) and six upper (P^4) carnassials fell within the Range, and were equal to, the Mean given by Haag (ibid.) for the Mississippian dogs. Although the carnassial (M_1) from the "small dog" was equal in size to the "large dog" and other isolated first molars, the total length of the jaw was considerably shorter (P_1 -M_3 length of 50 mm. vs. P_1 -M_3 length of 64 mm.: left jaw), thus suggesting some remains were those of modern breeds.

Some of these extreme variations in size range are probably due to a mixture of elements of both Indian and modern breeds of dogs. None of the molar teeth, skull sections or jaws were suggestive of coyote (*Canis latrans*) and, although specific identification of post-cranial elements of *Canis* is often arbitrary, no limb elements approached coyote in length/girth proportions.

Table 4.

Measurements of complete CANIS elements from Meyer Cave.

Element	Measurement (mm.) "Small Dog"	"Large Dog"	Single Teeth
Femur	92, 94	156	
Humerus	84, 84	138	
Ulna	102, 102		
Tibia	93, 94	155, 156	
Left jaw: M_1	18	—	
P_1 -M_3	50	64	
C-M_3	—	78	
Right jaw: M_1	—	18	
P_1 -M_3	51	61	
C-M_3	61	78	
M_1			18-21
P_4			16-18

Felidae. -Cory (1912) discussed the former status of the cougar (*Felis concolor*) in Illinois, stating that it was not uncommon throughout the forested regions of the state but that by 1850 it had been nearly exterminated. Bobcats (*Lynx rufus*) also occurred in the wooded areas of the state, especially in the bluff sections along rivers; although this cat has been extirpated in most of its former range in Illinois, occasionally an individual is seen or taken in the extreme southern or northwestern sections.

Remains of cougar from Meyer Cave consisted of three deciduous teeth (lower left M_1; upper right P^3 and M^1), a nearly complete lower right jaw containing P_2 and the incisor and canine alveoli of the lower left. The cusp section of a lower P_2 is also probably referable to *F. concolor* and presumably all of these elements were from the same kitten. The post-cranial elements of bobcat and lynx (*Lynx canadensis*) are inseparable and although there exists a remote possibility that the lynx may have formerly occurred in Illinois, probably the Meyer Cave *Lynx* are all referable to *L. rufus*. Eight of the 13 bobcats represented in the fissure deposit were kittens; as also evidenced by the numerous remains of juvenal raccoons and fox pups, the presence of numerous kittens suggests periodic use of the upper room in Meyer Cave as a den site.

Order Rodentia: Rodents or Gnawing Animals

Sciuridae. -Bones of at least four of the species included in this Family occurred in the fissure fill and one, the woodchuck (*Marmota monax*), ranked first of all the mammals in the total number of identified elements (12,600) and second in minimum number of individuals represented (597). Because of the woodchuck's abundance in the vicinity of Meyer Cave and its burrowing habits, the passageway leading to the inner room and fissure was probably under continual investigation by individuals seeking escape cover and den sites. Remains of the woodchuck ranked second (388 bones; 28 individuals) in Jerry Long Cave, Missouri (Parmalee and Jacobson, 1959); typically, elements of this sciurid are usually encountered in archaeological sites (Parmalee, 1965, *et. al.*) and caves where they exist within its range. More than any one animal, woodchucks – not killed by the fall – were probably responsible for destroying any evidence of stratigraphy in the fissure by attempting to dig their way out.

Squirrels were poorly represented in the cave fissure, possibly because of their ability to climb and escape or because of a reluctance to enter a cave of this type. Only ten elements of the southern flying squirrel (*Glacomys volans*) were recovered: of the 119 bones determined as *Sciurus*, 55 were those of the gray squirrel (*S. carolinensis*). This squirrel is generally associated with heavily timbered, brushy areas. None of the *Sciurus* elements could be referred to fox squirrel (*S. niger*), although it is the most common of these two squirrels in the area today. The eastern chipmunk (*Tamias striatus*) is abundant in rocky, wooded ravines, and the bluff and talus slope provides ideal habitat for this rodent. Unlike the tree squirrels, chipmunks would not be able to ascend the vertical walls of the fissure once they had fallen in. Nearly 1,600 remains of *T. striatus* were recovered with at least 177 individuals being represented.

Geomyidae. -The presence of the plains pocket gopher (*Geomys bursarius*) in the Meyer Cave fill is noteworthy considering its present distribution in the state. Its primary range includes the sandy and black soils east and south of the Illinois and Kankakee rivers in north-central Illinois; an "isolated" population also occurs in Madison and St. Clair counties east of the East St. Louis area. Mohr (1946) presented old locality records from five southern Illinois counties from which the gopher has apparently disappeared. Remains of *G. bursarius* from the Archaic Modoc Rock Shelter site established the former occurrence of the gopher in Randolph County (Parmalee and Hoffmeister, 1957) and apparently represents the southernmost record for the state. Although only 28 elements (six individuals) were recovered from the fissure fill, this first record of *Geomys* from Monroe County helps to substantiate a former continuous range of the gopher along the west-central edge of the state. Probably it inhabited the drier upland sections of the bluff top.

Cricetidae. -No complete skulls of *Peromyscus* were recovered. Although the lower jaws are extremely difficult to identify to the species level, John E. Guilday was able to tentatively determine a few as either the white-footed mouse (*P. leucopus*) or the deer mouse (*P. maniculatus*); however, he indicated (pers. com.; letter of 10/4/64) that ". . . every gradation between 'typical' mandibles of *leucopus* and *maniculatus* was present." Also, only jaws with complete dentition were submitted to Guilday and most of these showed extreme tooth wear, suggesting a predominance of old animals. Extreme tooth wear renders the jaws even less diagnostic; the suggested absence of young individuals in the sample is misleading since the teeth in old animals were less likely to fall out when the jaws were handled or washed, being better anchored by well developed roots.

Considering the fact that much of the bluff top and talus was apparently heavily wooded, the white-footed mouse was probably the most numerous of the two species in the area. Nearly 12,000 skull sections and jaws of *Peromyscus* spp. were recovered from the fill, representing a minimum of 4,737 individuals. Post-cranial elements, most of which were probably referable to *Peromyscus* and *Microtus*, totaled 39,800. These small rodents occur commonly in the wooded and brushy areas throughout the bluff area and the huge accumulation of deer/white-footed mice resulted as individuals became trapped probably while in search of food and nest sites in the bluff.

Distribution of the rice rat (*Oryzomys palustris*) in Illinois is now restricted to the southernmost counties although its former prehistoric range extended as far north as Peoria County (Baker, 1936). Remains of this rodent were numerous in the Cahokia site midden (Parmalee, 1957), a Middle Mississippian village (*ca.* 950 – 1500 A.D.) located approximately 20 miles northeast of Meyer Cave. *O. palustris* is associated with bottomland marshes and swamps; the 30 skull and jaw sections (representing a minimum of 15 individuals) found in the fill were from animals which, in all probability, entered or were brought into the fissure as prey from the floodplain.

Presently the eastern wood rat (*Neotoma floridana*) no longer occurs in the vicinity of Meyer Cave and it is known only from the bluffs in Jackson and Union counties, about 65 miles southeast of the cave. Only two elements of the wood rat were found in the Archiac (*ca.* 8,500 – 1,500 B.C.) Modoc Rock Shelter site in Randolph County (Parmalee, 1959) although, in prehistoric times, it probably occurred commonly along all sections of the Mississippi River bluffs at least as far north as the East St. Louis area. The reasons for the disappearance of the wood rat from these former parts of its range are not clearly understood since it is relatively tolerant of varying climates and vegetation types; the bluffs, themselves, in contrast to the adjoining cultivated lands above and below, have undergone apparently little physical change since prehistoric times. *N. floridana* is common within its present range, and judging by the quantity of bones (6, 053) recovered and the number of individuals represented (535) from the fissure, it was formerly abundant in the Meyer Cave area. Like the chipmunk, the wood rat inhabits the bluff ledges and crevices; many were probably taken by predators denning in the cave's upper room while others were trapped by falling into the fissure. Skull and jaws of the wood rat from Meyer Cave were indistinguishable from the species *N. floridana illinoensis* presently found in southwestern Illinois.

The southern bog lemming (*Synaptomys cooper*) is of sporadic occurrence in the southern two-thirds of the state; however, Hoffmeister (1947) found that it may become locally abundant in thick stands of bluegrass, wet meadows and marshes. Remains of the bog lemming were fairly common (54 lower left and 66 lower right jaws, 90 skull sections plus numerous isolated teeth) in the cave deposit; today populations occur both on the bluff top and in the bottomland marshes. Early in this study, a small series of the more complete *Synaptomys* material was sent to Ralph M. Wetzel, University of Connecticut, Storrs. Dr. Wetzel stated (pers. com., letter of 8/9/65) that, based on a series of 11 right mandibles with an average alveolar $M_1 - M_3$ length of 7.5 mm., the material appeared quite similar to the present large *Synaptomys* which occur in isolated pockets in the western part of its range. After completion of the identification, 37 skull and jaw sections were measured and the data are presented in Table 5 (incorporating the material sent to Wetzel).

Table 5.

Summary of SYNAPTOMYS jaw and skull measurements (mm.) from Meyer Cave; alveolus M^1 - M^3 and M_1 - M_3 lengths.

	No. of jaws	Average M_1-M_3	No. of skulls	Average M^1-M^3
Meyer Cave specimens	33	7.47 (Rg. 7.0-8.0)	4	8.35 (Rg. 7.8-8.6)
S. c. gossii (Sangamon Co., Ill.)	4	6.57 (Rg. 6.4-6.8)	4	7.10 (Rg. 6.9-7.3)

The *Synaptomys* from Meyer Cave, based on the alveolar length of the toothrow M1 – M3, are considerably larger than the form (*S. cooperi gossii*) presently occurring in Illinois. Compared with similar measurements presented by Hibbard and Rinker (1942) for *S. c. paludis* from Meade County, Kansas, the Meyer Cave specimens appear more closely related to this large western form. Wetzel (1955) stated that "The isolated colony of *paludis* in Meade County is, in the sense of its larger dimensions, a relic of late Pleistocene." The presence of this large *Synaptomys* (with apparent complete absence of the smaller *S. c. gossii*), combined with pigmy shrew, porcupine and yellow-cheeked vole, again suggests a faunal complex indicative of an early post-Pleistocent environment.

Three lower right M_1's of the red-backed vole (*Clethrionomys gapperi*) from Meyer Cave constitute the first record of this microtine in Illinois. This vole is associated with moist conifer and deciduous forests having some low herbaceous vegetation and a thick floor layer of leaves, rotted logs and other debris. Its closest present range locality to Illinois is in extreme southeastern Wisconsin (Jackson, 1961) a distance of only 40 miles from the Illinois border, but approximately 375 miles northeast of the cave site.

Approximately 2,160 partial skulls and jaws of *Microtus* spp. and/or the pine vole, *Pitymys*, comprising at least 830 individuals, were identified from the fissure fill. Presently, of the two species of *Microtus* occurring in Illinois, only the prairie vole (*M. ochrogaster*) is found in the vicinity of Meyer Cave. The meadow vole (*M. pennsylvanicus*) is found mainly in the northern one third of the state, and its occurrence in the Meyer Cave area represents a former southern range limit of approximately 125 miles. Eight lower jaws and 16 M1's (10 individuals) of this vole were identified from this series of *Microtus* material. The nearly identical dental pattern of *M. ochrogaster* and *Pitymys pinetorum* made specific identification impossible in most instances. However, Guilday pointed out (pers. com., letter of 6/9/66) that the generally smaller size of the *Pitymys* skull, flat forehead and lack of a notch at the anterior edge of the zygomatic process, just above the infraorbital foramen, would usually separate it from *Microtus*.

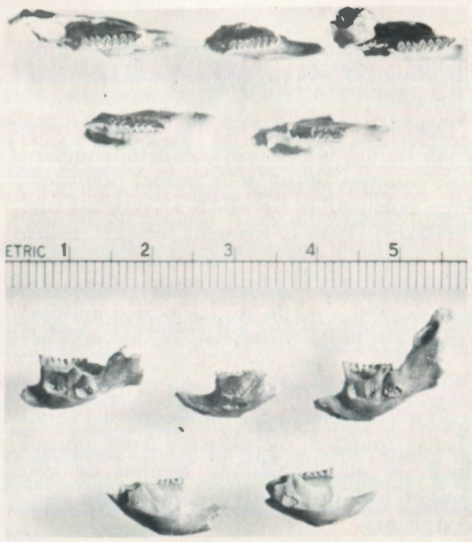

Figure 9.

Lower jaws of Microtus xanthognathus from Meyer Cave, Illinois. Occlusal (top) and buccal (bottom) views.

Although size and shape of forehead varied considerably in the Meyer Cave material, the third characteristic appeared the most stable and 26 skull sections were determined as *Pitymys*, primarily on this character. The pine vole is found throughout the state in habitat that varies from woodland to grassy fields, but it is sporadic in occurrence and usually uncommon (Hoffmeister and Mohr, 1957).

One of the most interesting and significant finds with regard to the microtine material was the recovery of two M^3, five M_1, four left and two right lower jaws (fig. 9) of the yellow-cheeked vole (*Microtus xanthognathus*). This rodent is found throughout the Hudsonian life zone of western Canada from Churchill, Manitoba north and west to Alaska. There are only three known late Pleistocene records of it from the United States: Pennsylvania (Guilday, Martin and McCrady, 1964; Guilday, Hamilton and McCrady, 1966); Virginia (Guilday, 1962).

Probably the presence of *M. xanthognathus* at Meyer Cave represents a late Pleistocene – early Recent period and it may well have been part of a northern fauna that included red-backed vole, porcupine and pigmy shrew.

Meyer Cave is approximately 650 miles west-southwest of the three Appalachian records, and 1,500 miles south-southeast from the vole's present southern range in Manitoba. The yellow-cheeked vole is apparently flexible with regard to habitat preference, occurring in both dry upland and swampy lowlands; according to references cited by Guilday, Martin and McCrady (1964), however, it is typically a boreal woodland form. Only five individuals of *M. xanthognathus* were represented in the Meyer Cave material; however, these few remains of this northern microtine reflect a cooler, more moist environment indicative of an early post-Pleistocene period in southwestern Illinois, possibly when the climate of the area was directly influenced by the retreating last (Valders) advance of the Wisconsin glaciation.

Muskrats were doubtlessly common in the floodplain marshes adjacent to the bluff talus prior to bottomland reclamation. However, compared with the quantity of remains of other semiaquatic mammals found in Meyer Cave, such as mink and otter, the muskrat (*Ondatra zibethica*) was poorly represented (a minimum of five individuals). Although these rodents are known to wander considerable distances from their aquatic habitat and could have entered the cave passageway during forays, the difficulty in climbing the rocky talus would more logically indicate that they were brought in by predators. Surprisingly, no remains of the beaver (*Castor canadensis*) were encountered in the fill; formerly, this semiaquatic rodent was abundant in suitable habitat (such as river marshes) throughout the state.

Muridae. -Only two lower jaws of the house mouse (*Mus musculus*) were recovered in the cave fill: no remains of Old World rats (*Rattus* spp.) were found. These introduced species are common in association with almost all farm out-buildings and stock enclosures; in the case of the latter, tool and equipment sheds, pig pens and storage bins are often built against the base of the bluffs. The nearly complete absence of these recently-introduced but abundant rodents from Meyer Cave tends to strengthen the assumption that the accumulation of most of the small rodents in the fissure occurred prior to 1900.

Zapodidae. -The meadow jumping mouse (*Zapus hudsonicus*) occurs throughout Illinois but is usually not abundant. This mouse is associated with thick, herbaceous cover bordering streams, ponds and other bodies of water; the one individual (lower left jaw) represented in the cave faunal sample may well have come from the former bottomland marshes at the base of the talus slope.

Erethizontidae. -Remains of the porcupine (*Erethizon dorstaum*) from Meyer Cave constituted the first record of this rodent for Illinois (Parmalee, Bieri and Mohrman, 1960). At least ten individuals (nine adults, one juvenal) were represented; in addition to post-cranial elements (talus, 2; calcaneum, 1; sections of ulna, 1; radius, 6; tibia, 1; femur, 5; humerus, 7), parts of three skulls (premaxilla, 1; maxilla, 4), ten lower right and six lower left jaws, plus 15 incisors and 28 cheek teeth, were recovered. These remains are indicative of a former population of *E. dorsatum* that probably occurred all along the Mississippi River bluffs in Illinois south at least as far as Monroe County.

The prehistoric occurrence of porcupine in regions of eastern United States where it is now extirpated, or where it was unrecorded as part of the Modern fauna, has been well documented (Parmalee: 1960, 1961; Handley, 1956; Simpson, 1949; Barkalow, 1961). Many of these localities apparently represent the extremities of its former range; the disappearance of porcupine from such areas may have been the result of hunting pressure by the Indian or land use practices (lumbering activities) by settlers. Possibly the animal was unable to survive post-glacial environmental changes that produced a warm, dry climate towards the end (3,000 – 1,000 B.C.?) of the hypsithermal, although there are numerous historic records of porcupine in Indiana (Lyon, 1936). No differences in tooth structure, alveolar length or mandibular proportions were noted between the Meyer Cave specimens and the Modern form (*E. d. dorsatum*) occurring in northeastern United States.

Order Lagomorpha: Hares and Rabbits

Leporidae. -Two species of rabbits occur in Illinois – the cottontail (*Sylvilagus floridanus*), which is statewide in distribution, and the swamp rabbit (*Sylvilagus aquaticus*) which is found in about the southern one-fourth of the state. Bones of the cottontail ranked second in abundance with regard to all the species of mammals represented in the Meyer Cave fill. All of the nearly 7,000 rabbit remains (at least 456 individuals) are probably referable to *S. floridanus*. No doubt many of the cottontails had been brought into the cave by denning predators (*e.g.*, gray fox, bobcat) although others, as evidenced by a starved but still alive cottontail found in the fissure December 19, 1959, entered the passageway while possibly searching for escape cover.

Order Artiodactyls: Even-toed hoofed mammals

Cervidae. -White-tailed deer (*Odocoileus virginianus*) could not have possibly entered the cave of their own volition but rather were brought in by the larger predators such as bobcat and cougar. Even as prey, a deer carcass probably could not have been dragged through the narrow passageway; perhaps the animals were carried to the cave entrance, torn apart and brought into the cave in pieces or sections. Nearly all skeletal elements were found and at least three (adult) animals were represented.

Suidae. -One lower jaw section and four deciduous teeth of a domestic pig shoat (*Sus scrofa*), probably from the same animal, were found in the cave fill. This animal represents a modern time period and it may have been brought into the cave by a predator.

Order Primates: Man

Hominidae. -Remains of two humans (*Homo sapiens*), one an infant or young child judging by four deciduous incisors, were recovered. It was not possible to determine race on the basis of the fragmentary remains, although it might be assumed that the bones were those of Indians since numerous aboriginal mounds, village sites and burials occur within close proximity of Meyer Cave. Whether there is any connection between these human remains and the Woodland pottery, and the methods by which the bones (individuals) became part of the cave faunal complex, is a matter of speculation.

Summary and Conclusions

Most of Illinois was formerly covered by at least one of the great ice sheets, and only a narrow area bordering the Mississippi River and sections of the extreme northwest and southern regions of the state remained unglaciated. It is within these latter regions that the somewhat limited formation of caves has taken place, with most caves being developed by solution. The discovery of a concentrated bone deposit of Recent origin in Meyer Cave, Monroe County, represents the first of its type in Illinois; the species complex included both a modern fauna and one of a possibly early post-glacial period. Meyer Cave served as a natural death trap for animals which entered through the extant horizontal passageway at the base of the bluff and/or for those falling into the now-filled crevice above (and leading to) the inner fissure. A total of approximately 264,000 bones, comprising at least 115 species and a minimum of 12,400 individuals, was recovered from the fissure fill during periodic excavations in 1959, 1960 and 1961.

Lack of stratigraphy in the deposit due to the burrowing actions of trapped animals prohibited any determination of a possible fauna-time sequence. Had the bones of all animals falling or "washing" into the fissure remained undisturbed after reaching the fill surface, it might have been possible to detect changes in the faunal complex of the area as correlated with climatic fluctuations during the hypsithermal. The presence of certain species such as pigmy shrew, the meadow, red-backed and yellow-cheeked voles, least weasel and the porcupine are indicative of a period of cooler and more moist climate (*ca.* 9,500 – 7.500 B.C.), while the pocket gopher and spotted skunk suggest a warm and dry (xerothermic) period, approximately 3,500 – 1,500 B.C. Kendeigh (1961) has summarized the following generally accepted sequence of events in post-Pleistocene times: "In the northern states from Minnesota and Illinois eastward, pollen data indicate changes of climate from cool-moist to warm-moist to warm-dry, then back

to the cooler, moister conditions of the present time. Accompanying these climatic changes was a succession of vegetation from spruce-fur to pine to bak-hemlock-beech to oak-hickory and the prairie peninsula, then back to oak-beech."

The Mississippi River bluffs and the bordering floodplain represent a composite of habitats within a very narrow belt, which includes both upland and bottomland forests, marsh and prairie. With such a diversity of environmental conditions within a local area, occupants typical of prairie – or, for example, those normally restricted to woodlands – may have been better situated to cope with and adjust to major climatic changes. In the case of porcupine, spotted skunk, wood rat, red-backed and yellow-cheeked voles, and probably a few others, some obviously could not withstand change. No doubt a replacement of one vegetation type with another as a result in climatic change, rather than temperature alone as a major factor, resulted in the extirpation of these species at the extremities of their range. "All short-term observations that suggest changes in animal ranges must be interpreted with caution, for one day of adverse circumstances can erase a decade of range expanding" (Smith, 1965). Conversely, changes in habitat brought about by a gradual but long-term climatic change of several hundreds or thousands of years, can cause a reduction in the range of a species restricted or limited to any such given habitat.

Excluding the extinct passenger pigeon, man, domestic and Old World species, and those mammals which occurred throughout Illinois (white-tailed deer, otter, bobcat, cougar) but were eliminated by European settlement, 15 of the approximately 115 species represented in Meyer Cave were previously unknown for the area. The zoogeographical relationship of these 15 animals is as follows:

NORTHERN	WESTERN	SOUTHERN	EASTERN
Pigmy shrew (*Microsorex hoyi*)	Plains pocket gopher (*Geomys bursarius*)	Eastern wood rat (*Neotoma floridana*)	
Least weasel (*Mustela rixosa*)	Big-eared bat (*Plecotus* sp.)	Rice rat (*Oryzomys patustris*)	
Red-backed vole (*Clethrionomys gapperi*)	Spotted skunk (*Spilogale putorius*)	Southeastern shrew (*Sorex longirostris*)	
Meadow vole (*Microtus pennsylvanicus*)		Eastern spadefoot (*Scaphiopus holbrooki*)	
Yellow-cheeked vole (*Microtus xanthognathus*)			
Porcupine (*Erethizon dorsatum*)			
Badger (*Taxidea taxus*)			
Bullsnake (*Pituophis melanoleucus*)			

Hoffmeister (1953) concluded that the majority (65per cent) of Illinois mammals were wide-ranging, but the remaining species are predominantly southern and western, this being correlated with the invasion of southern swamplands and western prairies in Illinois. He also listed 12 northern species whose ranges approach but do not enter northern Illinois; one (the red squirrel, *Tamiasciurus hudsonicus*), however, was known, prior to 1912, to occur locally in the northern part of the state. Parmalee (1960) reported the recovery of fisher remains (*Martes pennanti*), a boreal mustelid, from two archaeological sites in west-central Illinois; one of the sites (Cahokia: Madison/St. Clair counties: occupied *ca.* 950 – 1,500 A.D.) is located only 20 miles northeast of Meyer Cave. These data, coupled with the recovery of at least four primarily northern mammals in Meyer Cave, are indicative of a former and probably prolonged cool and more moist climate which affected much of Illinois. Towards the end of the hypsithermal, the climate became warmer and dryer, prevailing long enough for the invasion (by range extension) and establishment of southern or western forms such as the spotted skunk and wood rat. Following this period, the climatic trend was again towards the cooler, more moist conditions with an accompanying vegetation change that eliminated these species at the extremities of their range in Illinois.

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Extinct Florida Spectacled Bear Tremarctos floridanus (Gidley) From Central Tennessee

By John E. Guilday* and David C. Irving**

ABSTRACT

An isolated skeleton of the extinct Florida spectacled bear, *Tremarctos floridanus* (Gidley), was found in Grassy Cove Saltpeter Cave, Tennessee. This is the first record of this species from the state of Tennessee, extending its range north and west from Florida and Georgia.

Introduction

Grassy Cove Saltpeter Cave (Lat. 35°50' 16" N.; Long. 84°56'45" W.; alt. 1,890 ft.) is located on the east flank of Brady Mountain, Cumberland County, east-central Tennessee. Brady Mountain is one rim of Grassy Cove, a large uvula in the Cumberland Plateau, 55 mi west of Knoxville. The cave contains over three miles of passages, is well known, and has been extensively explored since at least Civil-War times when it was mined for saltpeter. Barr (1961, p. 140) discusses the cave briefly and gives a partial map.

We wish to thank Mrs. Grace Brady, owner of the cave, for permission to carry out the excavation and remove the bone material for study; Charles De Poe and Richard Finch for donating portions of the skeleton that they had gathered previously; the following members of the East Tennessee Grotto of the National Speleological Society for assistance in excavation: Charles De Poe, Francis McKinney, Steve Blizard, Everett Blizard, Charles Fullam, William Koehler, Stanley Adamson, Sandra Irving, Kenneth Klipple, Richard Trinko, Fred O'Hara, John McNees, Jay Robers, William Trout, Michael Davis, and Sally Livingston; Paul Thomason and Jack East of the Oak Ridge National Laboratories for qualitative analysis of the "black stain;" and Dr. Björn Kurtén, University of Helsingfors, for his helpful comments on this manuscript and his kindness in sending us then unpublished data on tremarctine bears. Photography is by W. Galen Barton, art work by Donald P. Tanner and measurements by Eleanor K. Adam. The research was conducted under NSF grant GB 3083.

The Site

The site is approximately 1 mi from the entrance. One reaches it from the fireplace room by traveling northwest approximately 1000 ft., descending into the lower level and going southwest for approximately 2000 ft, then turning sharply left and proceeding northeast for approximately 400 ft to a small side canyon extending northwest from the main passageway. This site is marked on the map of the cave surveyed by the East Tennessee Grotto in August 1964 by Keller, Amsbury, Beatty, Feldman and Miller (fig. 1). This map in larger scale, is on file with the National Speleological Society.

Only the relative inaccessibility of the small passage where the bones were found kept this skeleton from being discovered, and perhaps destroyed, years ago. They lay in a small dead-end canyon opening off a larger passage about 1 mi from the entrance. The bone material was found exposed on the surface and extended less than 2 in. down into the reddish-brown unconsolidated cave earth that floored the canyon.

Most of the bones were found in a small area (2 ft by 4 ft) in this canyon; however, a few were found scattered over a much larger area in the main passageway. Since the latter

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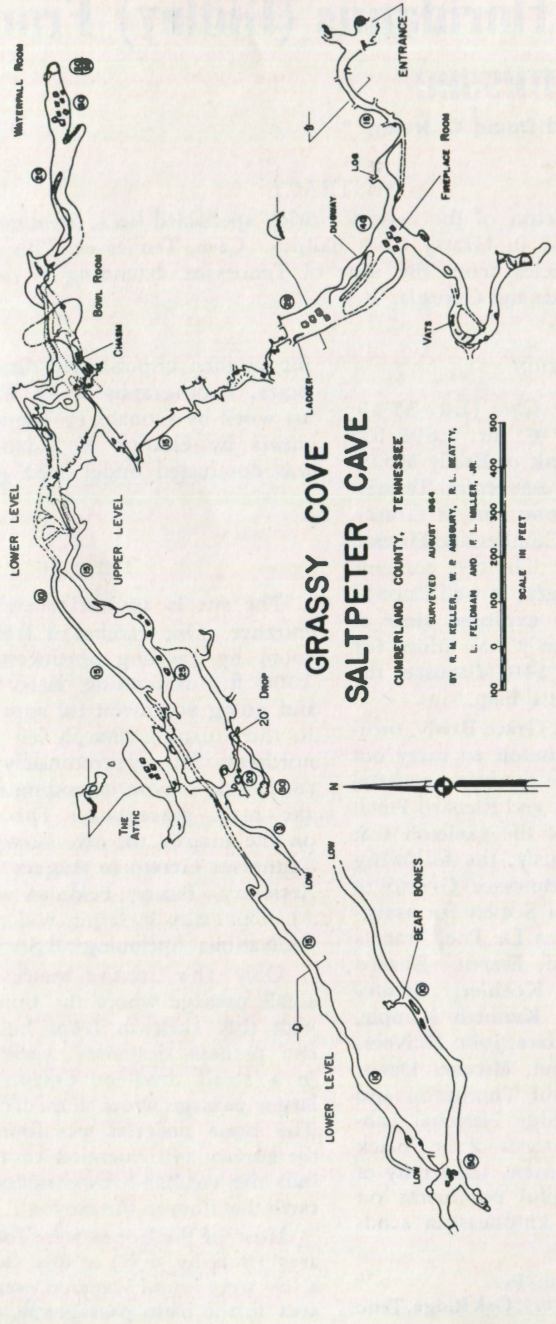

Figure 1.

Map of Grassy Cove Saltpeter Cave, Cumberland County, Tennessee.

area is slightly downhill from the canyon, the bones were undoubtedly transported there by washing from the main site. Two sets of phalanges were uncovered in an articulated position at the main site. This establishes the site of the death of the animal as being in the small side passage and eliminates the possibility that the bones may have washed it from elsewhere. Although all of the skeleton was not recovered and what was found was in fragments, it is obvious that most of the skeleton of one bear was present.

The bones were originally found in an undisturbed condition by Stewart Dismuke in 1962. There were a few attempts to investigate the site by cavers in 1963, but the material was not considered important until

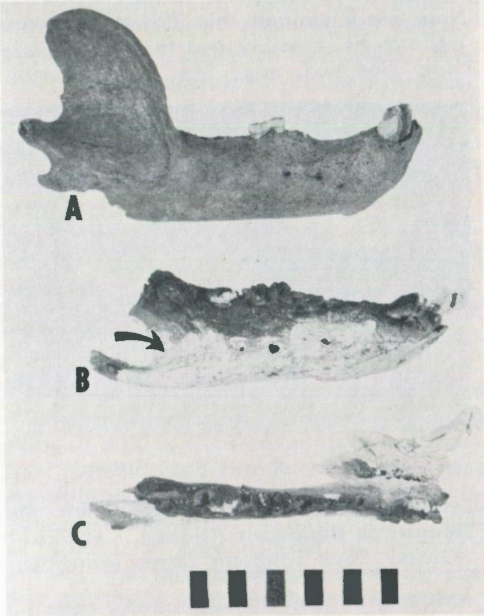

Figure 2.

A. Right lower jaw, **Ursus americanus** Pallas. Eschelman Indian site, 17th Century, Lancaster County, Pennsylvania (36 La 12). B. Partial right lower jaw, **Tremarctos floridanus** (Gidley). CM 12611. Grassy Cove Saltpeter Cave, Tennessee. Arrow points to premasseteric fossa. Note broken teeth and black flowstone along alveolar margin. C. Lower jaws, dorsal view, **Tremarctos floridanus** (Gidley). CM 12611. Scale in centimeters.

Figure 3.

Partial left maxilla with P^4-M^1, **Tremarctos floridanus** (Gidley). CM 12611. Grassy Cove Saltpeter Cave, Tennessee. A. Crown view. B. Buccal view. Scale in mm.

Richard Finch, a Nashville caver, suggested a Pleistocene origin for the bones. Finch (1964, p. 51) records the discovery of the skeleton of a bear (the specimen discussed throughout this paper, Carnegie Museum, Section of Vertebrate Fossils, no. 12611) in "an especially intriguing-looking crawlway. . . . Apparently some previous explorer(s) had unearthed the remains from the cave floor, nonchalantly piling them in a jumble to one side of the passage." We are indeed fortunate to be able to study this important specimen at all considering its checkered career and the chalk-like fragility of the individual fragmented bones.

The site is a mile from the present cave entrance. The main passage just beyond it terminates in a rock crawl too tight for either human beings or bears. A survey of the cave, combined with regional topographic map (Grassy Cove quadrangle), places the site deep in the mountain under 300 ft of rock. Some 100-ft-tall domes in the vicinity of the site were climbed (certainly not by the senior author!), but no passage was found at the top. All available evidence suggests that the bear entered the cave through the present entrance, became trapped by a 30-ft fall to the lower level, and then wandered into the small side passage where it died.

At the site, the earthen floor was composed of cave-derived solution residue. It was covered, both in the side and the main passages, with a secondary deposit consisting of three layers of calcite, containing varying amounts of iron and aluminum impurities. The total calcite sheet was nowhere more than 1 in. in thickness, and where it covered the exposed portions of the bones, it was no more than a thin skin, less than 1 mm, in thickness. It was deposited after the bear had been reduced to bones. Its presence implies a wetter episode than exists at present (see discussion of probableage). At sometime after the death of the bear, the bones were very likely covered with cave fill. subsequently some of the fill and bone was washed away. This would explain the finding of a few bones a short distance from the main site as well as the disappearance of part of the skeleton. The topmost remaining bones were left exposed on the surface of the fill. Deposition of the flowstone over the canyon floor and the exposed bones then occurred.

The original orientation of the skeleton is not known. If it can be assumed that those portions of the bones that were free of incrustation were below the surface, and that those portions heavily incrusted with muddy calcite and showing signs of severe deterioration were above the surface of the cave floor, it may be possible to reconstruct the original orientation of the animal. The patination pattern of the femur, the innominate, both humeri, and the left tibia, plus elements of both left paws would seem to indicate that the bear died while lying on its left side. The mandibles and one anterior lumbar vertebra, however, apparently lay with their right sides uppermost. The condyle of the left lower jaw was clean and presumably was imbedded in the cave earth beneath the flowstone layer. The left glenoid fossa of the skull, however, was encrusted and eroded. This lack of orientation in vertebrae and skull elements would seem to indicate some dis-

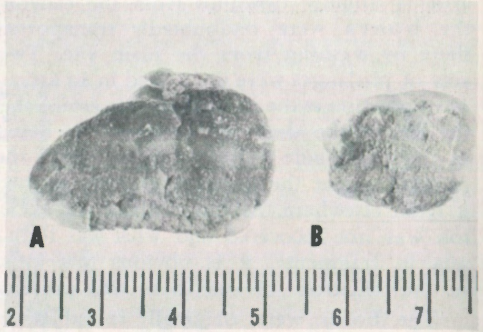

Figure 4.

A. right M^2, B. right M$_3$, **Tremarctos floridanus** (Gidley): Crown view. CM 12611. Grassy Cove Saltpeter Cave, Tennessee. Note black stained thin flowstone investing crowns, possibly due to organic staining. See text, page 158. Scale in mm.

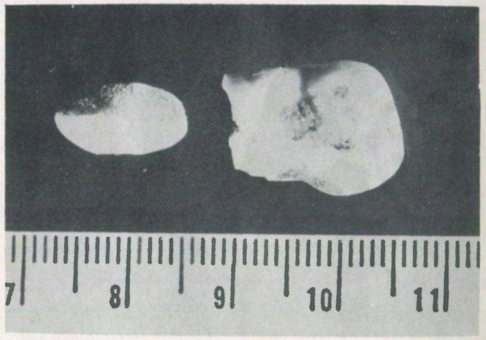

Figure 5.

Left to right: left P$_4$; talonid left M$_1$, **Tremarctos floridanus** (Gidley). CM 12611. Grassy Cove Saltpeter Cave, Tennessee.

turbance, possibly nothing but slumpage during decomposition of the bear and prior to the deposition of the flowstone.

Judging from the degree of mineral deposition on the broken edges of the left humerus, it is possible that the bear had a badly fractured front leg at the time of its death. This could have resulted from the 30-ft. fall from the upper to lower cave levels which would have been encountered if the bear entered from the present entrance, as it seems it must have.

In a few areas, the bones and their investing flowstone were stained black. This

is apparently the reason for Finch's statement that some of the bones are burned (1964, p. 52). Note black staining on center mandible, fig. 2B. Portions of this black crust were submitted to the Geochronology Laboratories of the University of Arizona for pollen analysis for fungal hyphae and/or spores (results were negative), and to the Oak Ridge National Laboratories for qualitative analysis. The latter reported (personal communication) "black particles dispersed over the top brown layer are organic carbohydrates. The black material was separated from $CaCO_3$ by a dissolution of the carbonate with concentrated hydrochloric acid. The black material was then heated with a burner which charred it and gave off a sweetish sugary odor. This material undoubtedly comes from leached decayed vegetation which contained saccharides." The stain therefore appears to be the byproduct of some organic growth, probably a fungus, nurtured by the wetter conditions implied by the flowstone covering.

TAXONOMIC HISTORY

Remains of *Tremarctos floridanus*, representing a minimum of 35 animals, are known from 14 sites in Florida (30 animals), one in Texas (one specimen), Nuevo Leon, Mexico (at least two), Laddas, Ga. (Clayton Ray, letter) and the animal reported here from Tennessee (See Kurtén, 1966, for localities). Prior to Stock's work on the specimens from San Josecito Cave (Stock, 1950), the relationship of this species to the modern Andean spectacled bear was unsuspected, and all specimens were referred to the genus *Arctodus*, the short-faced cave bear. Despite this seemingly large number of specimens, remains were fragmentary, and consisted of isolated teeth and skull fragments. The one exception was the excellent series from Devil's Den, Levy County, Fla. (seven partial skeletons). These have been exhaustively studied by Kurtén (1966).

The Florida spectacled bear was almost twice the size of the Andean spectacled bear – about the size of a large black bear, *Ursus americanus*. Kurten's excellent study of the distinguishing characteristics of both forms may result in extending the "range" of this nominally southern form, as witness the present paper. The Grassy Cove bear, despite its fragmentary condition, provides additional data on the variability of this poorly known form and extends its known range to the rugged Cumberland Plateau of central Tennessee, about 1,500 ft higher and some 5° latitude or 400 mi north of Florida, and approximately 150 mi north of Laddas, Georgia.

No spectacled-bear bones have been subjected to radiodating techniques; all finds are considered to be Illinoian to early post-glacial in age. The fauna accompanying the Grassy Cove bear, fragmentary bat remains (*Myotis* sp.?, *Pipistrellus* sp.?), are widespread both geographically and in time. They may or may not have been contemporaneous with the bear. The best clue to the age of the animal is that it died on what is essentially the present cave floor and was subsequently lightly covered with a caliche-like flowstone patina.

Cave formations are not building at the present time, although the deposit investing the bones implies wetter conditions. This would seem to establish the minimum age of the bear as early post-Pleistocene (c. 8,000 B.P.) if we correlate wetter conditions in the cave with cooler and more moist periods outside. The flowstone may have dated from the Valder's advance (c. 9,000 B.P.) or it may conceivably span the entire Wisconsin Period. In the latter case, the bear would be beyond the limits of C-14 analysis. All that can be said at present is that the cave interior was wetter at some time after the bear died. This tells us nothing, however, of conditions as they were when the bear succumbed.

DESCRIPTION OF SKELETON

The skeleton was extremely fragile, soft as chalk, excessively broken, often to powder. Even partial restoration of many bones was impossible, but fortunately, dimensions of certain elements could be reliably measured to estimate the size of the animal for comparison with other known cases. Bones were hardened with Elmer's Glue and Glyptol, but a large number of unassignable fragments were left untreated and are so marked.

The skeleton consists of a fragmentary left maxilla with P^4 and M^1 in place and the alveoli for P^1, P^2, and P^3; right M^1;

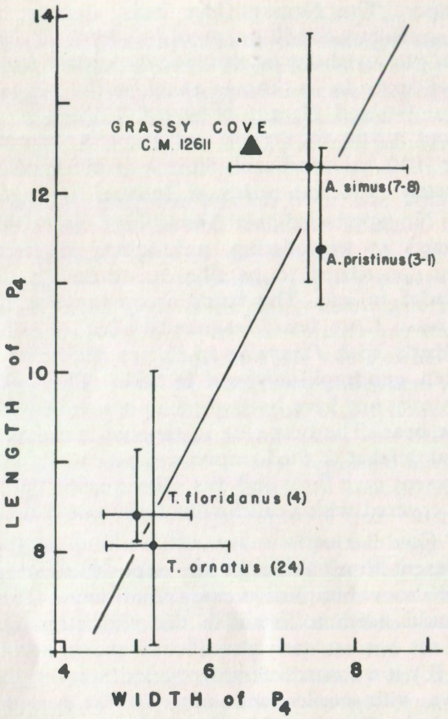

Figure 6.

Length and width of P_4 of various tremarctine bears. A = Arctodus, T = Tremarctos, figures in ( ) = sample size. Data from Kurtén, 1966 (except for CM 12611). Regression line fitted by eye. Scale in mm.

C^1; M_1; M_3; fragments of left and right temporals; unassigned braincase fragments; one cervical vertebra; two lumbar vertebrae; three caudal vertebrae; the distal half of the right mandible with all alveoli and the root of the canine present; the ascending ramus and condyle of the left mandible; both ulnae; the distal two-thirds of the left humerus; the distal one-third of the right humerus; the left femur; the distal and proximal ends of the right femur; the proximal half of the left tibia; the partial left innominate; two sternebrae; one hyoid fragment; elements of both fore and hind paws; rib and vertebral fragments.

The teeth are not well-preserved, but enough of them remains to describe the relatively massive dentition of this individual.

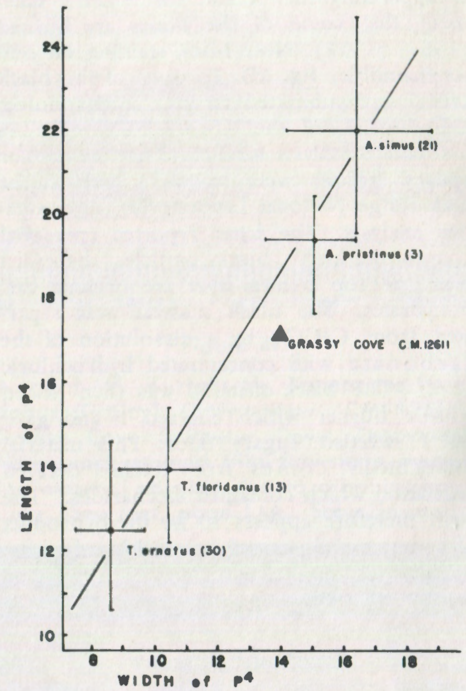

Figure 7.

Length and width of P^4 of various tremarctine bears. See figure 6 for explanation.

Although the limb bones are of average size, the dentition is the largest known for a Florida spectacled bear. It is fortunate indeed that the circumstances of preservation guarantee that we are dealing with but a single animal, or the association of post-cranial with cranial remains might have been questioned. The taxonomic interpretation of this massive dentition must await recovery of additional subjects from Appalachian caves.

An isolated crown of an unassigned upper incisor and the battered root of the lower left I_3 still in its socket are all that remain of the incisor series. The alveoli for the lower incisors are present; the animal had the normal complement of six.

Three partial canine teeth were preserved, consisting of shattered roots of both lower canines still in their sockets and a partial

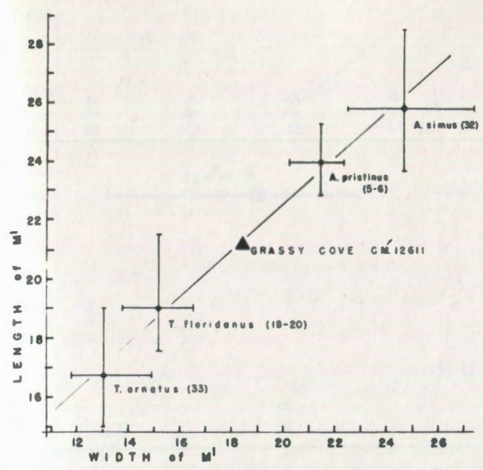

Figure 8.

Length and width of M^1 of various tremarctine bears. See figure 6 for explanation.

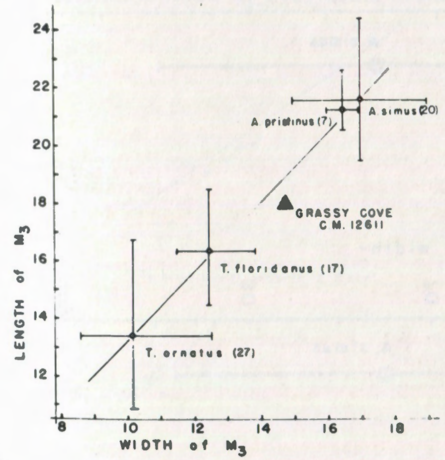

Figure 9.

Length and width of M_3 of various tremarctine bears. See figure 6 for explanation.

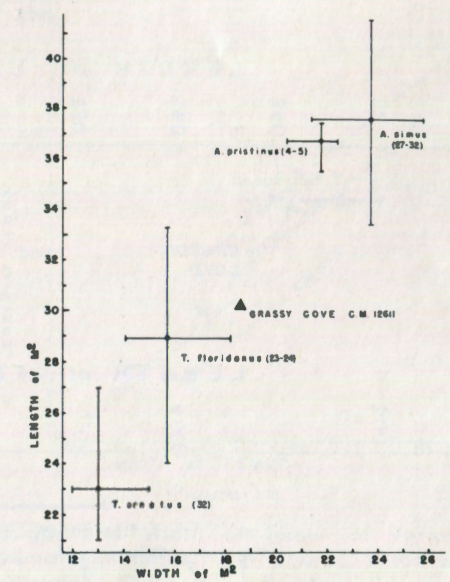

Figure 10.

Length and width of M^2 of various tremarctine bears. See figure 6 for explanation.

right upper canine. All are fully erupted, and the root canal is firmly closed. The lower canines are too poorly preserved to permit any valid measurements. The one upper canine preserves all of the root and about one third of the posterior half of the crown, but not the tip. Maximum diameter of the root is 24.6 by 15.6 mm.

The left maxilla (fig. 3) is partially preserved. The P^4 and M^1 were recovered separately from the maxilla fragment, but fitted into their respective alveoli when the fragments were assembled. The posterior border of the canine alveolus was present, covered with the same thin brown mineral deposit that invested the anterior and superior margins of the bone. It is obvious that the canine had dropped out, and the bone shattered or deteriorated long before the final recovery. The alveoli for P^1, P^2, and P^3 were present and well developed as is normal in *Tremarctos floridanus* (Kurtén, 1966, p.

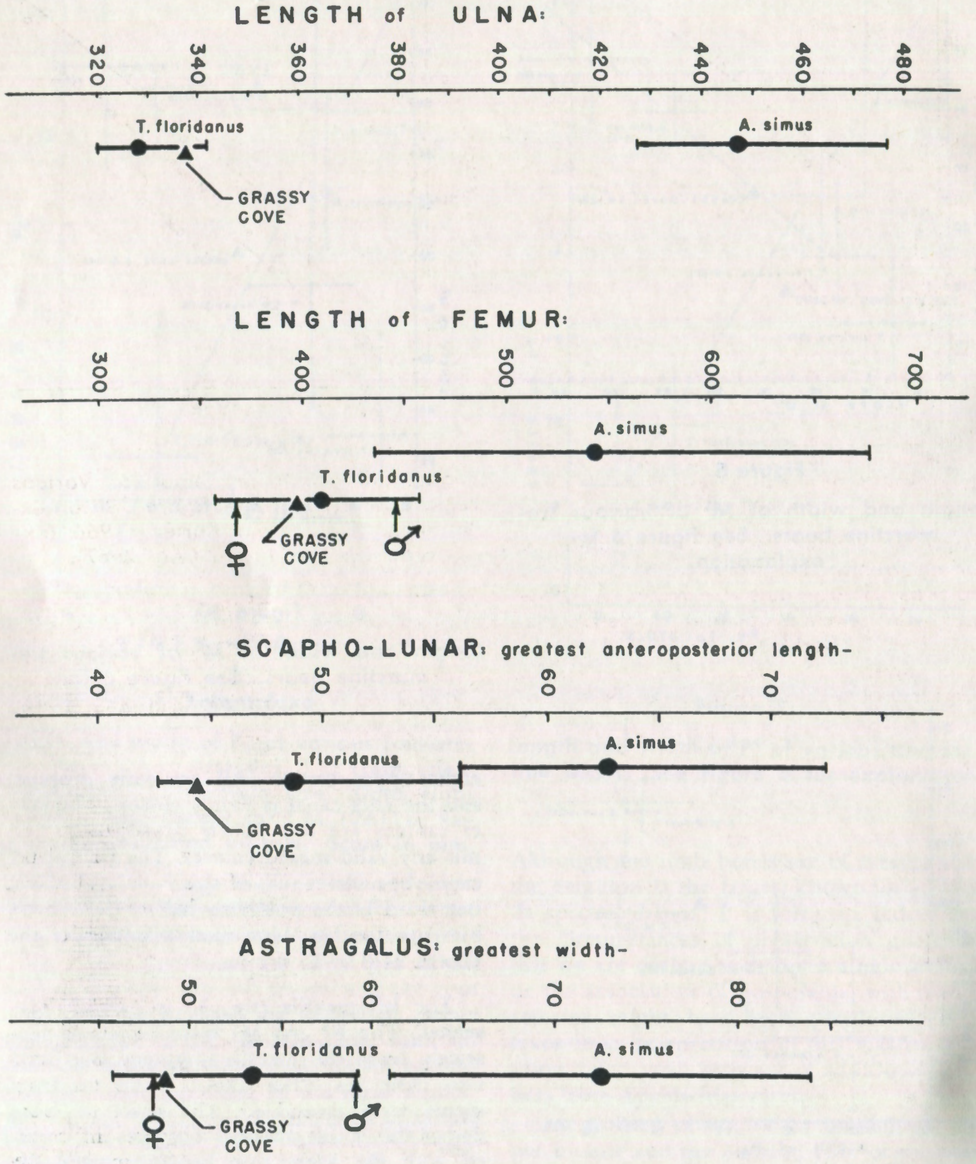

Figure 11.

Dimensions of selected skeletal elements, **Tremarctos floridanus** (Gidley). CM 12611. Grassy Cove Saltpeter Cave, Tennessee. A = **Arctodus**, T = **Tremarctos.** Data for **A. simus** and **T. floridanus** (except CM 12611) from Kurtén, 1966. Length of line = observed range, black circle = mean, triangle = CM 12611 measurement. Scale in mm.

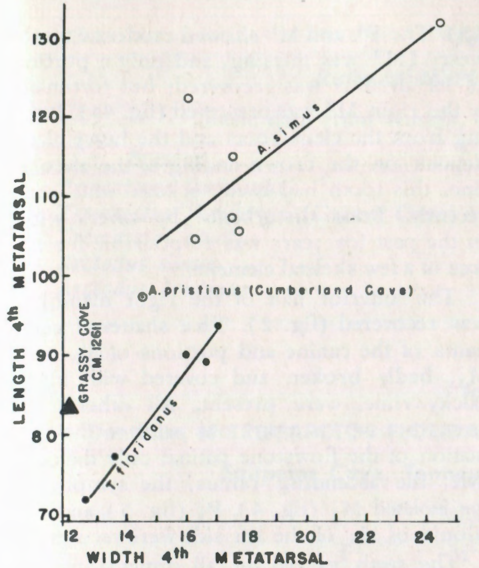

Figure 12.

Length and width of 4th metatarsal of various tremarctine bears. Open circle = **Arctodus simus,** dotted circle = **A. pristinus,** solid circle = **Tremarctos floridanus,** triangle = **T. floridanus** CM 12611. Data from Kurtén, 1966 (except for CM 12611). Regression line fitted by eye. Scale in mm.

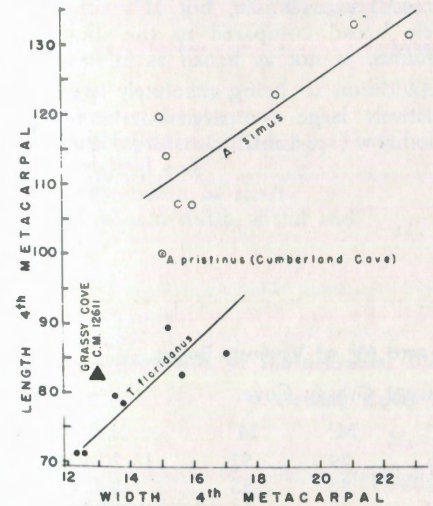

Figure 13.

Length and width of 4th metacarpal of various tremarctine bears. See figure 11 for explanation.

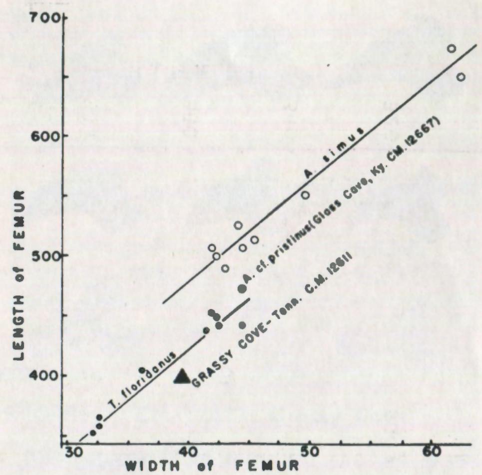

Figure 14.

length and width of femur of various tremarctine bears. See figure 12 for explanation. Data from Kurtén, 1966 (except CM 12611 and CM 12667).

Figure 15.

Left: partial left humerus, **Tremarctos floridanus** (Gidley). CM 12611. Grassy Cove Saltpeter cave, Tennessee. Center: right humerus, **Ursus americanus** Pallas. CM 6547. Sinkhole No. 3, New Paris, Pennsylvania. Right: right humerus, **Ursus americanus** Pallas, Eschelman Indian site (36 La 12) 17th Century, Lancaster County, Pennsylvania. Note entepicondylar foramen in **Tremarctos.** Scale in centimeters.

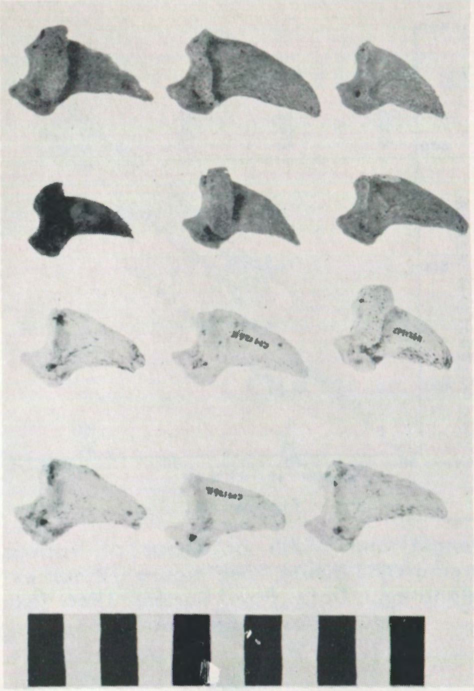

Figure 16.

Ungual phalanges. Top two rows: *Ursus americanus* Pallas. 17th Century archaeological site (36 La 12), Lancaster County, Pennsylvania. Bottom two rows: *Tremarctos floridanus* (Gidley). CM 12611. Grassy Cove Saltpeter Cave, Tennessee. Note similarity both in size and form. Scale in centimeters.

15). The P^4 and M^1 showed moderate toothwear; LM^2 was missing, and only a portion of its alveolus was recovered; but fortunately the right M^2 was preserved (fig. 4a). Judging from the clean roots and the heavy black deposit on the crown ending at the alveolar line, this tooth had been socketed until very recently. Prior disturbance by cavers within the past few years was responsible for the loss of a few skeletal elements.

The anterior half of the right mandible was recovered (fig. 2). The shattered remnants of the canine and portions of M_1 and M_2, badly broken and covered with black calcity rime, were present. All other teeth seem to have dropped out prior to the formation of the flowstone patina; only the condyle, the ascending ramus, the symphysis, the isolated M_3 (fig. 4), P_4 (fig. 5), and the talonid of M_1 of the left side were recovered.

The teeth exceed in all dimensions the mean of *T. floridanus*. In length and width of upper and lower P4's and in width of all molars (but not length), the Grassy Cove specimen is the largest known. Both upper and lower P4's are exceptionally large; P^4 exceeds any previously known (14 specimens) by 11% in length and 19% in width. In relative breadth, the Grassy Cove P^4 (fig. 7) exceeds even *Arctodus*, but M^1, although relatively broad compared to the southern *T. floridanus*, is not as broad as in *Arctodus*.

In addition to being absolutely large, P^4 is relatively large compared to the rest of the toothrow (see Table 2.).

Table 1.

Percent Crown Width to Length, P^4, M^1, and M^2 of Various Bears.

Basic data from Kurtén, 1966, except Grassy Cove.

Species	P^4	M^1	M^2	N
Tremarctos floridanus	75	79	52	23-20-13
Tremarctos floridanus (Grassy Cove)	82	85	55	1-1-1
Tremarctos ornatus	70	78	56	30-33-32
Arctodus simus	75	95	63	28-32-21
Arctodus pristinus	78	89	59	4-3-5

Table 2.

Ratio M^2:M^1:P^4 of Various Bears.

Basic data from Kurtén, 1966, except for Grassy Cove.

Species	M^2	M^1	P^4	N
Tremarctos floridanus	1	.66	.48	23-20-13
Tremarctos floridanus (Grassy Cove)	1	.69	.56	1-1-1
Tremarctos ornatus	1	.71	.53	32-33-30
Arctodus simus	1	.69	.60	28-32-31
Arctodus pristinus	1	.65	.52	5-5-2

Table 3.

Dentition of TREMARCTOS FLORIDANUS (Gidley). CM 12611, Grassy Cove Saltpeter Cave, Tennessee. Measurements in mm.

*talonid width

	P^4	M^1	M^2	P_4	M_1	M_3
Length	17.1	21.1	30.3	12.4	—	17.9
Width	14.0	17.9	18.4	6.6	12.7*	14.7

Table 4.

Measurements of Metacarpals, TREMARCTOS FLORIDANUS (Gidley), CM 12611, Grassy Cove Saltpeter Cave, Tennessee.

Measurements in mm.

	1st left	2nd left	2nd right	4th right
Greatest length	59	76.5	75.3	83.4
Anteroposterior diameter, proximal end	18.4	23.0	22.9	24.2
Least width of shaft	10.8	10.0	12.2	12.9
Maximum width, distal end	14.7	16.3	18.0	19.9

Table 5.

Measurements of Metatarsals, TERMARCTOS FLORIDANUS (Gidley), CM 12611, Grassy Cove Saltpeter Cave, Tennessee.

Measurements in mm.

	1st right	2nd right	3rd right	5th right	3rd left	4th left
Greatest length	—	66.5	74.2	82.1	—	83.7
Anteroposterior diameter, proximal end	24.1	22.0	20.9	26.1	25.3	24.6
Least width of shaft	—	11.0	14.0	11.1	—	12.0
Maximum width, distal end	—	14.5	16.0	18.2	—	18.7

Table 6.

Measurements of Phalanges, TREMARCTOS FLORIDANUS (Gidley), CM 12611, Grassy Cove Saltpeter Cave, Tennessee.

Measurements in mm.

	length		minimum width	
	mean	range	mean	range
1st phalanges	38.6	33.1 - 45.6	11.5	9.1 - 13.7
2nd phalanges	27.4	22.4 - 32.8	10.5	10.0 - 11.1
3rd phalanges (greatest width of proximal end without claw sheath)	32.1	25.6 - 36.9	23.4	21.1 - 25.7

Table 7.

Skeletal Measurements, TREMARCTOS FLORIDANUS (Gidley), CM 12611, Grassy Cove Saltpeter Cave, Tennessee.

Humerus	
Transverse diameter of shaft at middle	30.9 (a)
Antero-posterior diameter of shaft at middle	39.4 (a)
Greatest width at distal end	85 (a)
Greatest width of distal articulation	57 (a)
Ulna	
Greatest length	338 (R), 339 (L)
Greatest width of olecranon process	59 (R), 57.4 (L)
Width from posterior border to tip of coronoid process	54.1 (R), 53.2 (L)
Least distance from sigmoid notch to posterior border	32.0 (R), 30.5 (L)
Greatest diameter of distal end	36 (R), 37.6 (L)
Radius	
Greatest length	295 (a)
Greatest diameter of proximal extremity	40
Greatest diameter of distal extremity	56.2
Trapezium	
Length	25.1
Depth	15.7
Width	12.7
Scapholunar	
Greatest antero-posterior diameter	43.8
Greatest transverse diameter	37.9
Unciform	
Proximal-distal diameter	29.1
Greatest transverse diameter	21.5
Transverse diameter, distal end	18.8
Calcaneum	
Greatest length	81 (a)
Width of cuboid facet	26.7 (a)
Astragalus	
Greatest length	48.8
Greatest width	48.6
Least distance across neck	27.4
Cuboid	
Greatest antero-posterior diameter	35
Greatest proximal-distal diameter	23.5
Length of metatarsal facet	23
Width of metatarsal facet	21.5
Navicular	
Antero-posterior diameter	23.1
Transverse diameter	27.7
Ilium	
Least width of neck in front of acetabulum	46 (a)
Acetabulum, transverse diameter	51 (a)
Femur	
Greatest length	399
Antero-posterior diameter of head	42.8
Transverse diameter of shaft at middle	38.9
Antero-posterior diameter of shaft at middle	35.5
Greatest width at distal end	75 (a)
Greatest antero-posterior diameter at distal end	69.8
Tibia	
Greatest width of proximal end	80 (a)

As Kurtên (1966, p. 18) points out, however, variation in both upper and lower P4 is high in *T. floridanus*, and both absolute and relative size aberrations are perhaps to be expected. It is interesting that the same situation prevails in the lower dentition: P_4 is of very large size, M_3 is normal in respect to the southern population of *T. floridanus*. With the exception of the possibly aberrant P4's, however, the dentition agrees quite well with *T. floridanus*.

Widths, of P^4, M^1, M^3, and M_2 appear to bear a positive allometric relationship to length (see figs. 7, 8, 9, 10). No such trend can be observed in P_4. This vestigial tooth is apparently under little selection pressure. In *T. floridanus* it averaged 38.5% as long as M_1; in the modern *T. ornatus* it averages 42.5%. In *Arctodus simus* P_4 is 37% of M_1; in *A. pristinus* it is 39%; and no trends are apparent either chronologically or allometrically.

Despite the massive dentition, the dimensions of the skeleton (see figs. 11, 12, and 13 and Tables 3 through 7) fall well within the range of the Devil's Den population. The Grassy Cove specimen was about the size of a large black bear.

Kurten observed two size classes of adult *T. floridanus* from Devil's Den and attributed this to sex. On that basis, the Grassy Cove specimen was probably a female if the relatively small paws are any indication of sex as they seem to be at Devil's Den. The absence of a baculum (*os penis*) might be attributed to the relatively poor preservation and the later scattering of the skeleton, although bones as small as hyoid elements were recovered and the baculum of a black bear of that size would measure about 170 mm long and 10 mm in diameter.

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A Preliminary Investigation of a Pleistocene Vertebrate Fauna From Crankshaft Pit, Jefferson County, Missouri

By Ronald D. Oesch

ABSTRACT

Crankshaft Pit, Jefferson County, Missouri, has yielded a valuable Pleistocene bone deposit including 73 vertebrate species of which 54 are mammals, making one of the largest Pleistocene deposits found in the mid-American region to date. Seven of the 54 mammals found in the deposit are extinct: *Megalonyx* cf. *M. jeffersoni*, a ground sloth; *Dasypus bellus*, a large armadillo; *Synaptomys* cf. *S. australis*, a bog lemming; *Brachyprotoma* sp., a skunk; *Tapirus* cf. *T. excelsus*, a large tapir; *Equus* sp., a Pleistocene horse; and *Platygonus* cf. *P. compressus*, a peccary. Eleven additional Recent species had not heretofore been reported from Missouri. Studies of the biotic requirements of the species found in the deposit indicate that the climate must have been cooler, but with less severe winters than those experienced in Missouri today. The evidence suggests that the fauna dates from the latter part of the Wisconsin glacial period.

INTRODUCTION

Crankshaft Pit was the object of a search during 1962 by members of the Middle Mississippi Valley Grotto, National Speleological Society. Acting on a lead provided by a local land owner, the group, headed by Donald Stokes and Jim Colvin, located the pit. A skeleton of a black bear, *Euarctos americanus*, was removed and deposited with the Pleistocene vertebrate collection of Central Missouri State College, Warrensburg, Missouri. A quantity of bones of small rodents, rabbits, and the scutes of a large extinct armadillo were also taken from the cave for examination at that time. Data on small Pleistocene mammals were essentially lacking from the Pleistocene of Missouri, and it was soon realized that Crankshaft Pit might be an important fossil site.

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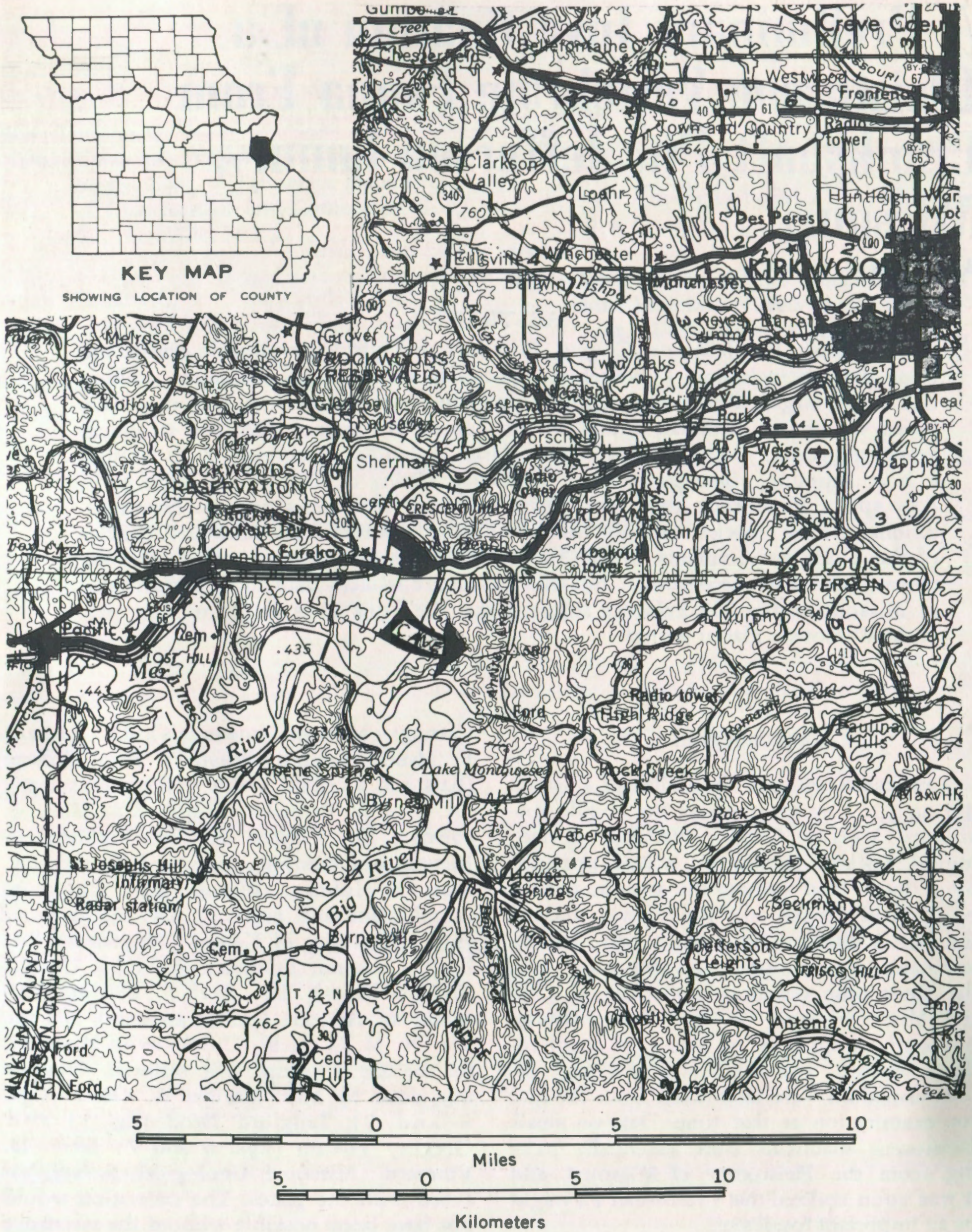

CONTOUR INTERVAL 100 FEET

Figure 1.
Index map showing Jefferson County, Missouri, and Crankshaft Pit in relation to local geographic features. Topography from U. S. Geol. Survey 1:250,000 series, St. Louis, Mo.-Ill.

The work done during the summer of 1962 was supported by a National Science Foundation Summer Institute Fellowship administered by Dr. Sam P. Hewitt, Professor of Botany, Central Missouri State College.

Location and Environment

Crankshaft Pit, northwestern Jefferson County, Missouri, is in the SW¼, SW¼, SE¼, NE¼, NW¼, sec. 9, T. 43 N., R. 5 E., House Springs 7½-minute quadrangle, Missouri (Vineyard, 1964). The region has an average relief of approximately 400 feet. The local minimum elevation of 400 feet is on the Meramec River about three kilometers north of the cave; the local maximum elevation is approximately 960 feet on a hill six kilometers southeast of the cave. The land surface of the area is in the early mature stage of erosion. It is characterized by steep hills and dissected by small streams leading to two major river systems with broad, flat flood plains. A mixed hardwood forest covers the hillsides. Most of the valley bottoms are suitable for light agricultural use. Figures 2 and 3 show typical topography and flora near the cave.

The cave opens on the eastern side of a hill at approximately 620 feet above sea level. The hillside is wooded, rocky and interspersed with small tall-grass glades typical of the deciduous forests of the Ozark region of Missouri (Steyermark, 1963). The average rainfall for the area is about 81 cm per year (U.S. Weather Bureau datum). Crankshaft Pit lies about one kilometer north of Big River, a tributary of the Meramec which flows into the Mississippi 18 kilometers to the northeast. It is in the drainage of Antire Creek, a small intermittent stream which flows north and west into the Meramec.

Geology

Crankshaft Pit is one of many caves developed in the Rockwoods anticlinal fold belt (Brod, 1964) which lies on the northeastern edge of the Ozark dome. The fold trends northwesterly and extends approximately 34 km on both sides of Crankshaft Pit. At least 50 caves are located in this region, almost all of which are joint-determined and are

Figure 2.
View from top of the ridge system in which Crankshaft Pit is located, showing the hills around Antire Creek, Jefferson County, Missouri.

Figure 3.
Hills west of Antire Creek, near Crankshaft Pit, Jefferson County, Missouri.

either pit or modified pit-type caves. Caves in this region are developed in Ordovician rocks, principally the Plattin Limestone which crops out extensively throughout the central and western part of that area. "It is usually found exposed in the valley floors, but in the anticline it crops out on the valley slopes. The thickness of the Plattin formation is 135 feet in the southwest and averages about 140 feet throughout the area." (Bethke, 1965).

The thin-bedded Joachim Dolomite lies below the Plattin formation. Beneath this is the St. Peter Sandstone, which served as an aquifer and may have been important in the genesis of the caves which formed above the sandstone. Above the Plattin is the Decorah Formation (an interbedded limestone and shale), the Kimmswick Limestone and the Maquoketa Shale, the youngest of the Ordovician rocks. Above these lie younger rocks

Figure 4.
The small sinkhole entrance to Crankshaft Pit.

of Mississippian age which are greatly weathered and usually poorly exposed in the fissure cave area.

Caves in this area have developed as a result of artesian circulation of water from a sandstone aquifer (Brod, 1964). Hydraulic pressure, providing the impetus for the movement of the water, was made possible by the simultaneous action of several independent processes. One was an uplift of the Ozark dome which caused tilting of the aquifer and established the pressure head. The others were the erosion of material from the folded area and the jointing which probably occurred as a result of folding. Both the erosion and the jointing gave the water an escape route to the surface, thus reducing the hydrostatic pressure head (Brod, 1964).

When water flow ceased, the caves undoubtedly remained full of water and collected sediments which probably filled them. As erosion continued, some of the caves had a part of this "original red mud fill" (Bretz, 1956) flushed out by vadose water (Brod, 1964). With the cave fill partially removed, such caves (*e.g.* Crankshaft Pit) began to function as natural traps for animals. Bones, surface mud, rock and other debris began to refill them. Remaining to be determined is the depth to which the bone-bearing fill has accumulated. Brod postulates that some of the caves could have had a total depth of nearly 300 feet at one time, however it is unlikely that bone-bearing matrix occurs to these depths.

The cave opening at the surface resembles a shallow sink (fig. 4). The entrance to the cave is 60 by 90 cm. The small shaft which leads down to the floor is approximately 1.5 m in width. Ten meters below the entrance there is a large accumulation of flowstone on the wall which projects out into the shaft, preventing one from descending straight to the floor. The floor of the cave is 20 m below the entrance. Figure 5 is a map of Crankshaft Pit with a cross-sectional view of the entrance shaft. Directly beneath the opening the vertical shaft leads to the cave floor. Interspersed in and lying on the rocks on the floor are the remains of one or more "Model T" automobiles. Surface-derived talus is built up to a depth of about 1.2 m directly beneath the opening of the pit.

On the west side of the talus, there is a narrow, shallow channel in the cave floor leading down to the small room (A) where the bone deposit occurred (fig. 6 The small room is in the lower right hand part of the center drawing). Mud originally filled this room, but it is now being eroded away. This small chamber actually is a part of the entrance room. Figure 6 shows the mud fill as it passes under the "wall line" designation and extends laterally into both rooms A & B Bones occurred in a channel fill between the two rooms and were removed via room on the right hand side. The sediment on the sides of the channel show stratification and contain sorted gravels characteristic of stream deposition.

Even to this day, the cave has acted as a natural trap for animals. It is possible that during a part of the time when the bones were accumulating, the cave had a horizontal "walk in" entrance with a pit in the floor into which animals or their bones fell to what is now the present floor of the cave.

Eventually the filling matrix reached the ceiling of the small room (A) and a layer of calcite formed on top of the mud. Subsequently a stream cut a channel through the mud and later this channel was again filled with mud, bone and rock. A mud flow is suggested as the method of filling because the nature of the fill indicates that, whatever its source, it moved into the channel slowly and not far.

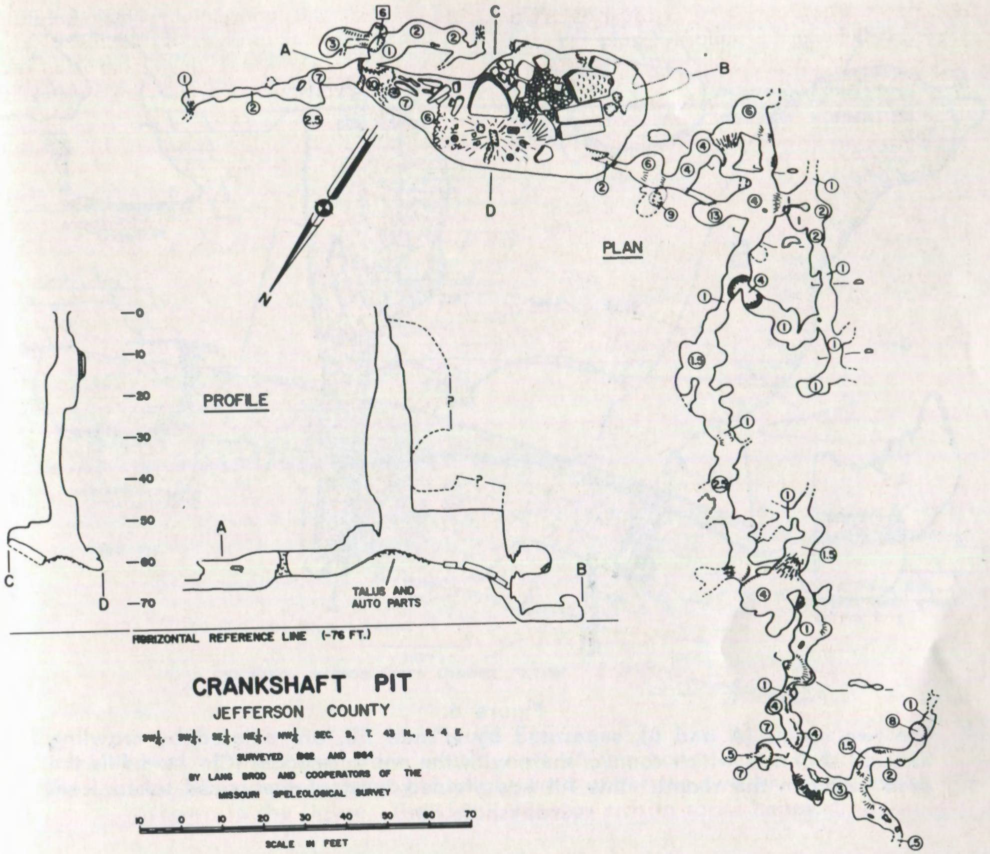

Figure 5.
Map of Crankshaft Pit, Jefferson County, Missouri.

Bones are scattered throughout the fill. In places, downcutting by stream action has removed 1.2 m of the fill from the center of the passage, leaving banks of bone-bearing mud and gravel against the cave walls. Bones are more concentrated in the mud fill close to the entrance of the cave and are seldom seen deep in the cave passage.

Removal of the Bones

Bones in the mud-filled channel were usually excellently preserved except for breakage and there was little mineralization and usually no sign of abrasion. The bones often were as clean as if newly defleshed.

Mud from the fill was sticky and wet. This necessitated the removal of the bones with the mud in which they were found because attempts to separate the bones from the mud inevitably led to breakage. Mud, rock and bones had to be removed from the cave in buckets, limiting the amount of material that could be recovered.

In the entrance room (C) of the cave, where the floor seemed to be undisturbed, a test hole approximately 40 cm square and 1.7 m deep was dug. Ten levels, each approximately 16 cm deep, were established and the remains of animals fróm these levels were analyzed. The data is suggestive of a time-deposited stratigraphic sequence. Results are shown in Table 9.

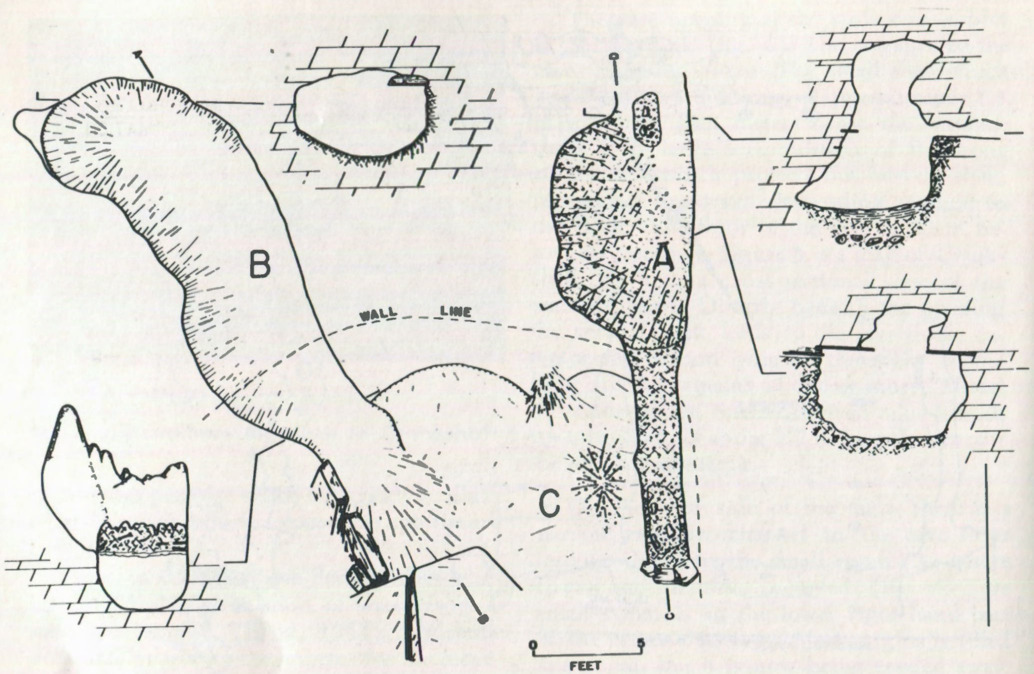

Figure 6.
The two rooms (A and B), separated by a mud fill, are entered by crawling through channels which connect them with the entrance room (C). Mud fills the area between the rooms. This fill has yielded most of the bones taken from Crankshaft Pit.

After removal from the cave, the bone-bearing mud was dried and washed through a fine mesh. Bones were then removed, allowed to dry, and when necessity dictated, dipped into liquid plastic to harden and preserve them.

Table 1.
Faunal List, Crankshaft Pit.

Phylum Mollusca
Class Gastropoda
Family Polygyridae
Polygyra jacksoni (Bland)
Polygyra dorfeuilliana Lea
Stenotreme morodon (Rackett)
Family Zonitidae
Mesomphix sp. Rafinesque
Family Endonotidae
Helicodiscus parallelus (Say)

Phylum Chordata
Class Amphibia
Order Caudata
Family Ambystomidae
Ambystoma maculatum (Shaw) spotted salamander
Order Salientia
Family Ranidae
Rana sp. Linnaeus frog
Class Reptilia
Order Squamata
Family Anguidae
Ophisaurus ventralis (Linnaeus) eastern glass lizard
Family Colubridae
Thamnophis sirtalis (Linnaeus) eastern garter snake
Heterodon platyrhinos Latreille eastern hog-nose snake

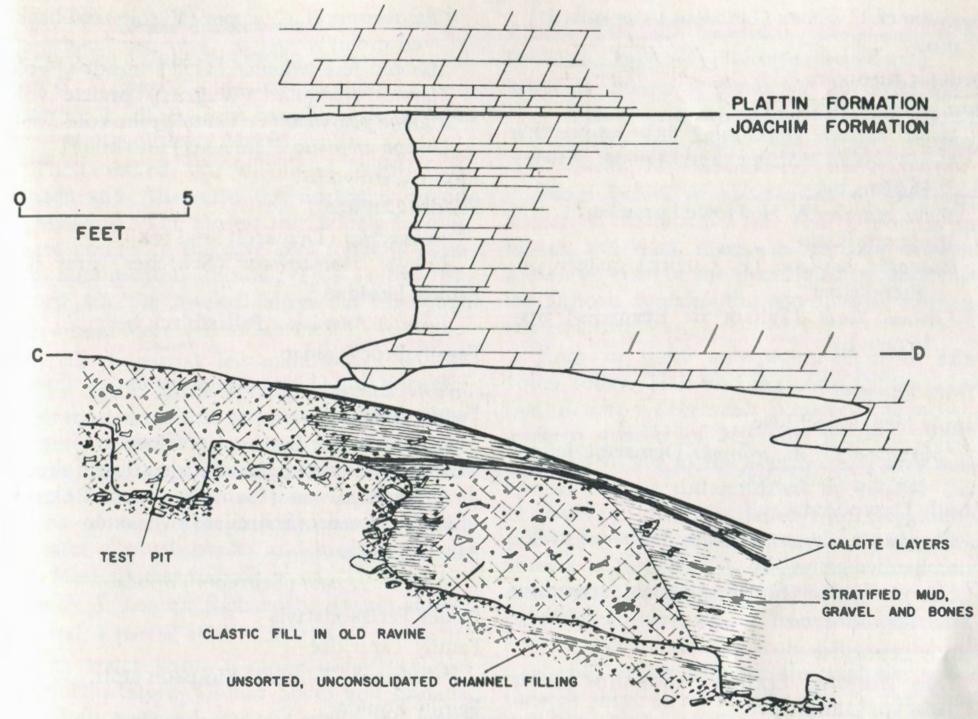

Figure 7.
Cross section of the room from which most of the bones have been taken. The channel fill is represented by the light area under the two layers of calcite shown in the figure. The clastic fill was rich in fossil bones.

Thamnophis cf. *T. proximus* (Say) western ribbon snake
Coluber sp. Linnaeus racer
Elaphe vulpina (Baird and Girard) western fox snake
Elaphe sp. Fitzinger rat snake
Pituophis catenifer (Blainville) bullsnake
Lampropeltis doliata (Linnaeus) eastern milk snake
Family Crotalidae
Crotalus horridus Linnaeus timber rattlesnake
Order Testudinata
Family Testudinidae
Terrapene cf. *T. ornata* (Agassiz) ornate box turtle
Class Aves
Order Galliformes
Family Meleagrididae
Meleagris gallopavo Vieillot wild turkey

Class Mammalia
Order Marsupialia
Family Didelphiidae
Didelphis marsupialis Kerr opossum
Order Insectivora
Family Soricidae
Sorex cf. *S. cinereus* Kerr masked shrew
Sorex arcticus Kerr arctic shrew
Sorex cf. *S. palustris* Richardson water shrew
Sorex sp. Linnaeus
Microsorex sp. Baird pygmy shrew
Blarina brevicauda brevicauda (Say) short-tailed shrew
Blarina brevicauda carolinensis (Bachman) short-tailed shrew
Cryptotis cf. *parva* (Say) least shrew
Family Talpidae
Parascalops cf. *P. breweri* (Bachman) hairy-tailed mole
Scalopus aquaticus (Linnaeus) eastern mole

Condylura cf. *C. cristata* (Linnaeus) star-nosed mole

Order Chiroptera

Family Vespertilionidae

Myotis lucifugus (LeConte) little brown bat

Myotis sodalis (Miller and G. M. Allen) Indiana bat

Myotis grisescens A. H. Howell gray bat

Myotis sp. Kaup

Pipistrellus subflavus (F. Cuvier) eastern pipistrelle bat

Eptesicus fuscus (Palisot de Beauvois) big brown bat

Order Edentata

Family Megalonychidae

**Megalonyx* cf. *M. jeffersoni* Demarest Jefferson's ground sloth

Family Dasypodidae

Dasypus cf. *D. novemcinctus* Linnaeus nine-banded armadillo

**Dasypus bellus* (Simpson) giant armadillo

Order Lagomorpha

Family Leporidae

Lepus americanus Erxleben snowshoe rabbit

Lepus sp. Linnaeus

Sylvilagus floridanus (J. A. Allen) eastern cottontail

Order Rodentia

Family Sciuridae

Marmota monax (Linnaeus) groundhog

Tamias striatus (Linnaeus) eastern chipmunk

Citellus sp. Oken ground squirrel

Tamiasciurus hudsonicus (Erxleben) red squirrel

Glaucomys volans (Linnaeus) southern flying squirrel

Family Geomyidae

Geomys bursarius (Shaw) pocket gopher

Family Heteromyidae

Perognathus hispidus Baird hispid pocket mouse

Family Cricetidae

Reithrodontomys megalotis (Baird) western harvest mouse

Peromyscus sp. Gloger white footed mice

Neotoma floridana (Ord) eastern wood rat

Synaptomys cooperi Baird southern bog lemming

**Synaptomys* cf. *S. australis* Florida bog lemming

Clethrionomys cf. *C. gapperi* (Vigors) red-backed mole

Microtus pennsylvanicus (Ord) meadow vole

Microtus ochrogaster (Wagner) prairie vole

Microtus pinetorum (Le Conte) pine vole

Ondatra zibethicus (Linnaeus) muskrat

Order Carnivora

Family Canidae

Vulpes fulva (Demarest) red fox

Urocyon cinereoargenteus (Schreber) gray fox

Family Ursidae

Euarctos Americanus Pallas black bear

Family Procyonidae

Procyon lotor (Linnaeus) raccoon

Family Mustelidae

Mustela erminea Linnaeus ermine

**Brachyprotoma* sp. Brown short-faced skunk

Spilogale putorius (Linnaeus) spotted skunk

Lutra canadensis (Schreber) river otter

Family Felidae

Lynx cf. *L. rufus* (Schreber) bobcat

Order Perissodactyla

Family Tapiridae

**Tapirus* cf. *T. excelsus* Simpson tapir

Family Equidae

**Equus* sp. Linnaeus horse

Order Artiodactyla

Family Tayassuidae

**Platygonus* cf. *P. compressus* (Leidy) peccary

Family Cervidae

Odocoileus virginianus Zimmerman white-tailed deer

Cervus sp. or *Bison* sp. elk or bison

*extinct form

Discussion of Species

Species indigenous to Missouri are not discussed unless they are important as climatic indicators or provide range extensions. For a discussion of the herpetofauna see Holman (1965). The taxonomy and nomenclature follows Miller and Kellog (1955), and range information is taken from Hall and Nelson (1959).

The bones have been catalogued into the Pleistocene vertebrate collection at Central Missouri State College, Warrensburg, Missouri (CM). Two skeletons have been placed in the Museum of Natural History, University of Kansas, Lawrence, Kansas.

Order Insectivora

Family Soricidae

Sorex cf. *S. cinereus* Kerr (masked shrew)

Material: 2 left, 3 right mandibles, fragments of mandibles. CM 209.

The masked shrew ranges south from Canada and Alaska to the northern border of Missouri. The closest this widely-ranging shrew comes to the cave area today is probably southeastern Illinois. This is the first record for the masked shrew in Missouri.

Sorex arcticus Kerr (Arctic shrew).

Material: 1 partial left mandible. CM 275.

The arctic shrew's range extends northward from southern Minnesota and Wisconsin into most of Canada and all but southeastern Alaska. It has not been reported from Missouri prior to this excavation and is one of many species from this site which indicates a much cooler and moister climate than Missouri has today.

Sorex cf. *S. palustris* Richardson (water shrew)

Material: 1 partial skull. CM 215.

The water shrew's range today occupies the northwestern United States and Canada, extending eastward across Canada and south along the Appalachian chain. The closest that this shrew comes to Missouri at present is south-central Wisconsin, again indicating a cooler, moister climate.

The water shrew's habit of living on the margins of bodies of water makes its presence in the cave deposit difficult to explain unless we consider transportation by predaceous birds.

Sorex sp.

Material: 1 left mandible missing the molar teeth. CM 212.

Due to the paucity of material it is impossible to assign a specific designation to this shrew, but there is no reason to suspect that it represents an additional species.

Microsorex, sp. Coues (Pygmy shrew)

Material: 1 upper left incisor. CM 274.

The pygmy shrew has not previously been reported from Missouri. Its range extends from central Iowa northward throughout most of Canada. An isolated population exists in Alaska and they may be found in the Appalachian Mountains south to approximately 37 degrees latitude.

Blarina brevicauda carolinensis (Say) and *B. b. brevicauda* (Bachman) (short-tailed shrew)

Material: *Blarina b. brevicauda*, 26 mandibles. CM 251. Many partial mandibles, skull parts, and teeth, CM 250. *B.b. carolinensis*, 11 mandibles, CM 249.

Many bones of short-tailed shrews were found in the channel fill. This is one of the most abundant mammals in the deposit. Measurements of the mandibles indicate that the deposit contains the two subspecies mentioned above.

Both of these subspecies occur in Missouri today. Hall and Kelson (1959) show that *Blarina b. brevicauda* occupies the northwestern quarter of Missouri while *B.b. carolinensis* is found in the southwest. These subspecies can be differentiated by relative size of bones. In accordance with Bergman's principle, the northernmost of the two shrews is considerably larger than the southern one. The limiting factor for both is apparently temperature. If bones of both subspecies were recovered from the channel fill, it should reflect climatic fluctuations; unfortunately there is no stratification in the channel fill which would indicate which of the two species occupied the range most recently. However, preliminary examination of bones from the test hole in the entrance room gives evidence of stratification.

Parameters and statistical data of the shrew mandibles from the channel fill and the test zones are given in Table 2; N = sample size, OR = observed range, $\bar{X}$ = sample mean. Note that there is no overlap in the measurements of any of the parameters of the two subspecies.

Table 2.

Statistical data on the linear measurements of mandibles of BLARINA B. BREVICAUDA and BLARINA B. CAROLINENSIS from the channel fill deposit and the test pit zones.

Zone, variate, and subspecies	N	OR	$\bar{X}$
Total length *B. b. b.* from channel fill	23	15.5-17.5	16.160
Zone No. 1	4	16.0-17.4	16.775

Table 2 (Cont.)

Zone No. 2	5	15.1-17.9	16.28
Zone No. 7	3	16.7-17.8	17.20
Zone No. 8	2	16.3-17.8	17.05
Zone No. 9	3	15.3-17.9	16.566
Zone No. 10	3	15.3-16.6	15.80
Total length *B. b. c.* channel	6	12.9-13.6	13.26
Zone No. 4	3	13.2-14.0	13.63
Zone No. 5	2	13.9-14.3	14.1
Width of mandibular condyle *B. b. b.* from channel fill	21	3.6-4.3	4.07
Zone No. 1	12	3.9-4:5	4.141
Zone No. 2	7	3.7-4.7	4.171
Zone No. 7	6	4.2-4.5	4.285
Zone No. 8	5	4.1-4.6	4.340
Zone No. 9	4	4.0-4.3	4.125
Zone No. 10	6	4.0-4.3	4.083
B. b. c. from channel fill	9	3.1-3.4	3.220
Zone No. 4	11	3.1-3.7	3.445
Zone No. 5	3	3.7-3.7	3.700
Width of lower incisor of *B. b. b.* channel fill	25	.8-1.2	1.046
Zone No. 1	6	1.0-1.2	1.10
Zone No. 2	5	1.0-1.2	1.06
Zone No. 7	5	1.0-1.1	1.07
Zone No. 8	4	1.1-1.2	1.11
Zone No. 9	4	1.0-1.1	1.10
Zone No. 10	7	1.0-1.1	1.07
B. b. c. from channel fill	8	.8-1.0	.90
Zone No. 4	4	.8- .9	.875
Zone No. 5	2	.9-1.0	.950
Tooth Row C^1-M^3 *B. b. b.* from channel fill	12	9.5-10.9	10.23
Zone No. 1	2	11.0-11.2	11.1
Zone No. 2	5	10.1-11.4	10.68
Zone No. 9	4	10.1-10.7	10.40
Zone No. 10	5	10.1-11.0	10.50
B. b. c. from channel fill	8	8.1- 9.0	8.56
Zone No. 4	2	8.8- 9.1	8.95

Family Talpidae

Parascalops cf. *P. breweri* (Bachman) Hairy-tailed mole.

Material: 2 left humeri, 1 right and 1 left ulnae, 1 tibia. CM 167.

This is the first record of the hairy-tailed mole either west of the Mississippi River or in Missouri. It ranges from northeastern Kentucky to Maine and west to the northern Great Lakes.

Condylura cf. *C. cristata* (Linnaeus) Star-nosed mole.

Material: 2 left humeri, 2 tibiae, 1 ulna. Zone 10 yielded 1 left humerus. CM 168.

Prior to this excavation, star-nosed moles had not been reported from Missouri. At the present time the star-nosed mole occurs no closer to Missouri that southern Wisconsin and northern Indiana. From these areas it ranges northeastward to the Atlantic seaboard and extends down the Appalachian Mountains as far as South Carolina. The occurrence of this animal in Missouri is an indication of a cooler period than we now experience. In Zone 10 it is associated with coniferous forest animals.

Order Edentata

Family Megalonychidae

Megalonyx cf. *M. jeffersoni* Desmarest Jefferson's ground sloth.

Material: 1 right navicular, 1 left unciform (tentative), 5 large rib fragments tentatively assigned to the species, 1 greater trochanter of the right femur, 1 cheek tooth, 1 distal epiphysis of the right humerus, part of an anterior thoracic vertebra with neural arch and spine. CM 218.

This species was also found in the Herculaneum Crevice fauna, Jefferson County, Missouri. The specimen from Crankshaft Pit probably represents one immature individual.

Dasypus bellus (Simpson) Giant Armadillo.

Material: 1 damaged skull, right and left mandibles, 1 atlas, 1 humerus, 2 ulnae, 1 right radius, 1 cervical vertebra, 1 calcaneum, 1 thoracic vertebra, articulated band and buckler scutes, part of the sternum, numerous ribs and rib fragments, 1 tibia-fibula, numerous phalanges, 1 terminal phalanx. A total of 1214 individual bones including scutes, probably of one individual, have been recovered from the site to date. CM 226.

Dasypus bellus is also known from Cherokee Cave, 17 kilometers northeast of Crankshaft Pit (Simpson, 1949). Prior to these two finds, the northernmost records had been from sites in Oklahoma. A nearly complete skeleton of *D. bellus* was recovered

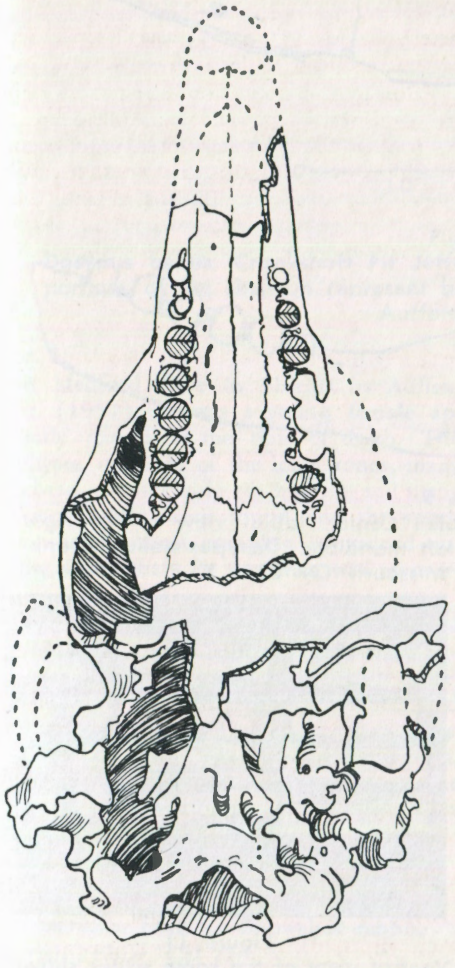

Figure 8.
Ventral view of the skull of **D. bellus** from Crankshaft Pit, Jefferson County, Missouri. CM 226. X .8

Table 3.
Measurements (in millimeters) of the bones and teeth of DASYPUS BELLUS (Simpson) from Crankshaft Pit, Jefferson County, Missouri. CM 226.

Description	
Skull	
distance from top of occipital bone to foramen magnum	35.5
dorsal to ventral greatest width of occipital condyles	11.7
interorbital constriction least width	38.3
mastoid breadth	51.3
alveolar length	42.2
width between alveoli of last molars	21.6
width of the 3rd from last molar	5.1
Mandible	
distance from anterior condylar articulation to anterior alveolus of 1st tooth	106.0
Humerus	
length	112.3
greatest width of proximal end	34.0
greatest width of distal end	38.6
Ulna	
length	134.5
width of proximal articular surface	17.3
width of distal articular surface	20.9
Radius	
length	78.8
width of proximal articular surface	22.6
width of distal articular surface	18.7
Tibia-fibula	
length	137.0
width	64.0
greatest width proximal end	52.0
greatest width distal end	53.5
Calcaneum	
length	74.3
Atlas	
greatest width between lateral margins of anterior zygopophyses	45.3
of posterior zygopophyses	38.2

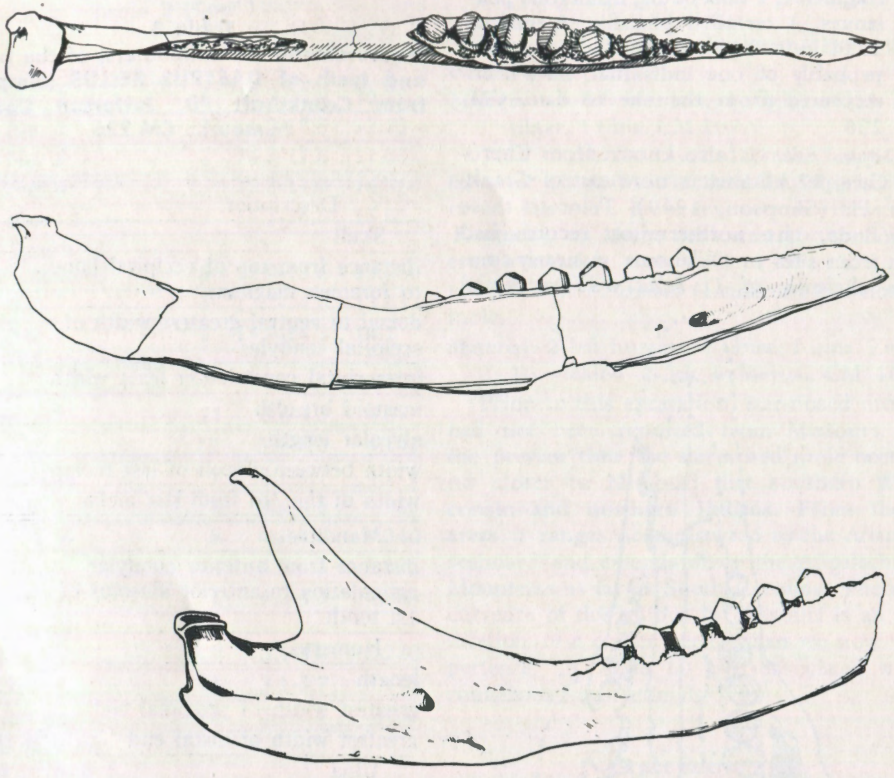

Figure 9.
Top: occlusal view of the right mandible. Center: labial view of the right mandible. Bottom: lingual view of the left mandible. **Dasypus bellus**, Crankshaft Pit, Jefferson County, Missouri. CM 226. X .8

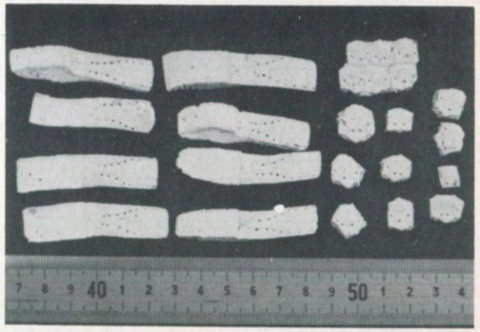

Figure 10.
Dorsal view of band and buckler scutes of the giant armadillo (**Dasypus bellus**). Six articulated buckler scutes are shown. CM 226, Crankshaft Pit, Jefferson County, Missouri.

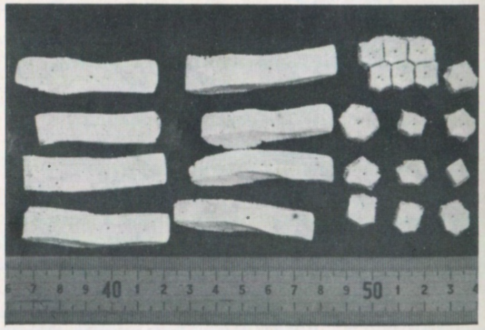

Figure 11.
Ventral view of the same scutes shown in figure 10.

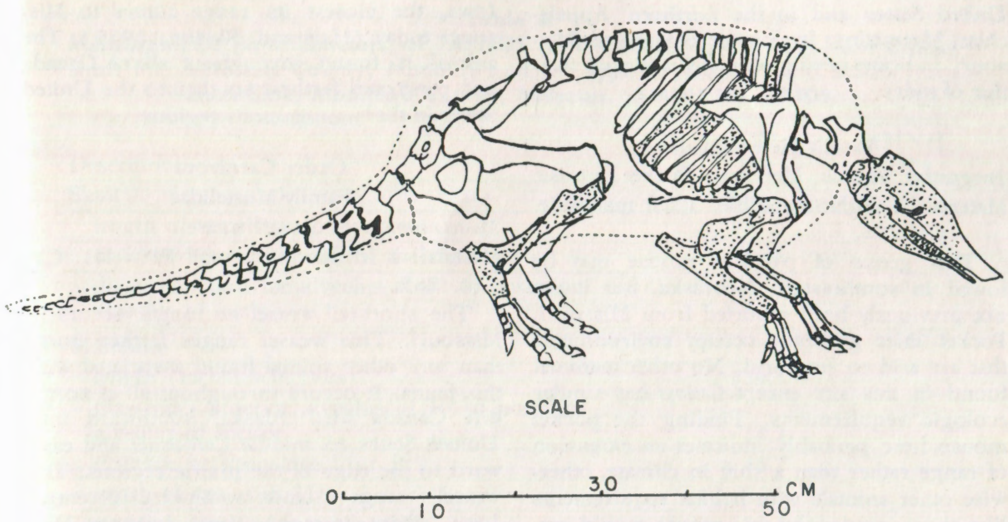

Figure 12.
Dasypus bellus, Crankshaft Pit Jefferson County, Missouri, CM 226. Shaded portions of the skeleton represent bones from the pit. Outline adapted from Auffenberg (1957).

from Medford Cave in Florida by Auffenburg (1957). It was a young female apparently gravid at the time of death. The epiphyses of most of the long bones, many vertebrae, considerable rib material and many carapace scutes were found and the specimen was the most complete on record until the Crankshaft Pit specimen was recovered.

Auffenburg, in examining the bones of the Medford Cave armadillo, says that, except for size, there is no noticeable difference between the Medford Cave specimen and the recent armadillo (*D. novemcinctus*). This is confirmed by the Crankshaft Pit specimen. The skull is shown in figures 8 and 9, the scutes in figures 10 and 11. Measurements of the bones are given in Table 3.

Order Lagomorpha

Family Leporidae

Lepus americanus Erxleben Snowshoe rabbit.
Material: 2 tibiae. CM 228.

This is the third reported occurrence of the snowshoe rabbit from fossil sites in Missouri. This hare no longer occurs in Missouri; its present southern limit is the forest of Minnesota, except for extensions of its range southward in the mountainous regions.

Lepus, sp.
Material: 1 phalanx. CM 286.

Due to the length of this bone the genus *Lepus* is clearly indicated, but no more can be determined. The bone's size rules out the varying hare and places it within the range of the jack rabbit, which occurs only in western Missouri today.

Order Rodentia

Family Sciuridae

Tamiasciurus hudsonicus (Erxleben) Red squirrel.
Material: 1 partial lower left incisor. CM 248.

The red squirrel is the only squirrel in the deposit with definite northern affinities. It ranges north into all of Canada and Alaska except the most northern regions of both. It does not occur in the central prairie regions of Canada or in Missouri. It may be found in the Rocky Mountains almost to the southern border of the

United States and in the northern Appalachian Mountains. Its former presence in Missouri indicates a slightly cooler climate than that of today.

Family Heteromyidae

Perognathus hispidus Merriam. Pocket mouse.

Material: 1 right mandible, 1 left mandible. CM 208.

This genus of pocket mouse may be found in southeastern Nebraska, but it has not previously been reported from Missouri. Pocket mice generally occupy environments that are arid to semi-arid. No other mammal found in this site except *Geomys* has similar ecologic requirements. Finding the pocket mouse here probably indicates an extension of range rather than a shift in climate, otherwise other animals with habitat requirements like those needed by this mouse would certainly have been found in the fauna.

Family Cricetidae

Synaptomys cf. *S. australis* Simpson. Florida bog lemming.

Material: 2 teeth. CM 302.

Synaptomys australis is an extinct Pleistocene lemming closely resembling *S. cooperi* (Simpson, 1928). It was considered larger than the modern lemming; however, *S. cooperi* is known to reach sizes almost comparable to that of the smallest *S. australis*. "Hibbard (1963), has noted a north-south cline in two characters of *S. cooperi*. One is a size cline and is characterized by a progressive increase in size of the subspecies of *S. cooperi* from north to south. The largest *Synaptomys* known, *S. australis*, is found in far southern fossil localities and may represent a continuation of this series" (Patton, 1963). Hence this identification must be considered tentative until more material is found.

Clethrionomys cf. *gapperi* (Vigors) – Northern red-backed mouse.

Material: 4 right, 1 left mandibles, numerous partial mandibles and many isolated teeth. Teeth were also found in the zones of the test pit. CM 211.

Clethrionomys has not heretofore been reported from Missouri. It is one of many animals from this site which inhabits cool northern coniferous forest today. The northern red-backed mouse is found in northern Iowa, the closest its range comes to Missouri today (Hall and Kelson, 1959). The animal is found throughout all of Canada and penetrates farthest south into the United States in the mountainous regions.

Order Carnivora

Family Mustelidae

Mustela erminea Short-tail weasel.

Material: 1 left mandible with P1 – M1. CM 185.

The short-tail weasel no longer occurs in Missouri. This weasel ranges farther north than any other animal found associated with this fauna. It occurs throughout all of northern Canada and Alaska, southward into United States to middle California and eastward to the edge of the prairie regions. The weasel's range extends southward to central Iowa, where its range comes closest to Missouri. Throughout its range this weasel shows no marked preference toward any particular type of habitat.

Brachyprotoma sp. Brown-short-faced skunk.

Material: 1 partial left maxilla, P3 – M1. CM 308.

A fragmentary skull of this extinct skunk was found in the channel fill. This animal is often found in Pleistocene bone deposits in North America. P2 is not present in the genus *Brachyprotoma* although it is found in all modern skunks except the hog-nosed skunk, *Conepatus leuconotus*.

Order Perissodactyla

Family Tapiridae

Tapirus cf. *T. excelsus* Simpson – Pleistocene Tapir.

Material: 1 left maxilla and premaxilla with full dentition, 1 left ramus and part of the right ramus with teeth in place, 1 atlas, 1 axis, several cervical vertebrae, other vertebrae, many ribs, 2 scapulae, 2 humeri, 1 left radius and ulna, 1 left manus minus 1 terminal phalanx, most of right manus. CM 159.

Tapirus excelsus was first found and described from two skeletons recovered from Enon Sink in Moniteau County, Missouri. The tapir recovered from Crankshaft Pit is the third known specimen. Missouri is the only state which has yielded remains of this species to date.

Table 4.
Measurements (in millimeters) of TAPIRUS cf. T. EXCELSUS, CM 159, from Crankshaft Pit, Jefferson County, Missouri and the type of TAPIRUS EXCELSUS from Enon Sink, Moniteau County, Missouri. AMNH No. 39406.

Description	CM 159	AMNH 39406
Skull		
length of maxillary tooth row	211.6	
distance between alveoli of the canines	36.8	
diastema - anterior alveolus of P^1 to posterior alveolus of canine	50.3	
Mandible		
length (includes incisors)	259.5	
diastema - anterior alveolus of P^2 to posterior alveolus of incisor	54.2	
distance between alveoli of P^2's	46.2	
width of ramus at M^1	37.9	
greatest depth of ramus at M^1	53.5	
Post-cranial measurements		
height of atlas	72.0	
length of centrum of axis	80.1	77
width of prezygopophyses of axis	86.4	
maximum width of scapula head	62.0	
maximum width of scapula perpendicular to the long axis	154.7	
least anteroposterior width of the shaft of the scapula	75.5	53
length of the humerus	268.0	251.0
least circumference of humerus	117.00	
least diameter of shaft of humerus	34.0	33.0
length of radius	145.3	
length of metacarpal No. 2	111.7	
length of metacarpal No. 3	135.2	
length of metacarpal No. 4	106.9	
length of metacarpal No. 5	83.4	

T. excelsus is significantly larger in average dental dimensions than any living tapir. The type of *T. excelsus* (Simpson, 1945) was an immature animal with most of the deciduous premolars still in place. The Crankshaft Pit specimen is more mature. All of the permanent cheek teeth are in place except the lower third molars, which in tapirs do not erupt until early to middle adult life. Most of the bones except the thoracic and lumbar vertebrae were well preserved. There was no sign of rodent gnawing.

All of the measurements of the tapir from Crankshaft Pit are greater than those of the type (Table 4), but many of the desirable measurements could not be made because small portions of the bones had been broken off. The measurements of the teeth (Table 5 and fig. 13) except for P1 have much greater transverse dimensions than anterior-posterior dimensions corresponding to the dimensions given for the type, thus differing from all other tapirs. Normally the anterior-posterior dimension is greater than the transverse dimension.

Table 5.
Measurements (in millimeters) of the teeth of TAPIRUS cf. T. EXCELSUS, CM 159, and the type specimen of TAPIRUS EXCELSUS AMNH No. 39406.

Measurements upper tooth row	CM 159				CM 159	AMNH 39406	CM 159	AMNH 39406
	P^1	P^2	P^3	P^4	M^1		M^2	
length	21.2	20.0	20.8	20.0	22.7	25.0	25.3	27.8
width anterior	12.5	23.4	26.3	28.6	27.3	26.4	30.9	30.3
width posterior	18.8	15.0	26.3	27.6	25.0	25.1	27.0	26.6
100 (width) / length	89.	117.	126.	143.	125.	106.	122.	109.
100 (anterior width) / posterior width	66.	156.	100.	103.	109.	—	114.	—
Lower tooth row		P	P	P	M		M	
length	—	24.7	22.3	21.3	28.7	—	26.3	—
Lower tooth row								
width anterior	—	—	16.8	20.4	19.9	—	21.8	—
width posterior	—	16.5	19.3	21.3	19.2	—	21.3	—
100 (width) / length	—	66.	86.	100.	69.	—	83.	—
100 (anterior width) / posterior width	—	—	87	96.	104.	—	104.	—

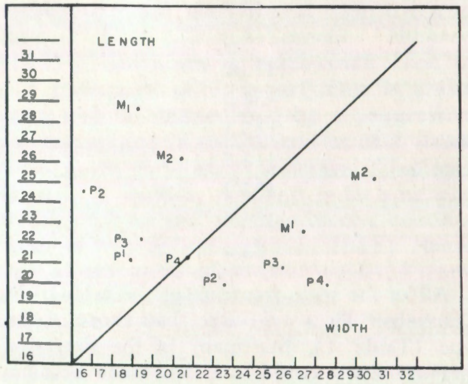

Figure 13.
Graph of the length and width (in millimeters) of the upper and lower cheek teeth of Tapirus cf T. excelsus from Crankshaft Pit, Jefferson County, Missouri. The diagonal line shows where teeth would be found if their length and width were equal.

Family Equidae

Equus sp. – Pleistocene horse.

Material: 1 right astragalus. CM 259.

In Missouri the remains of horses have been found in about one-third of the 114 counties (Mehl, 1962). Horses were probably quite common throughout most of the Pleistocene, at least on the dry, open prairies. All of northern and central Missouri was covered with tall grass prairies when the state was first settled by the pioneers. If these conditions had prevailed during Pleistocene times, grasslands would have been geographically close to the cave.

The astragalus was lying close to the remains of the tapir.

Order Artiodactyla

Family Tayassuidae

Platygonus cf. *P. compressus* – Pleistocene peccary

Material: 1 phalanx. CM 232.

Peccaries were one of the common Pleistocene animals in Missouri. Their remains have been found in at least six counties, often in great abundance, as in Bat Cave in Pulaski County and Cherokee Cave in St. Louis. Brown (1908) considered *Platygonus* a prairie dweller, and the presence of peccary and horse in association with known woodland forms suggests that the woodland-prairie margin may have been close to the cave.

Discussion

A change in climatic conditions is suggested when a comparison is made of the habitat preferences of those species of mammals found in the deposit and those which still inhabit the area. Most of the mammals found in the deposit which are no longer present in Missouri prefer a cooler, moister climate. The following is a list of 11 Recent mammals represented in the Crankshaft Pit fauna but no longer found in the state:

- *Sorex cinereus* (Masked shrew)
- *Sorex arcticus* (Arctic shrew)
- *Sorex palustris* (Water shrew)
- *Microsorex* sp. (Pygmy shrew)
- *Parascalops breweri* (Hairy-tailed mole)
- *Condylura cristata* (Star-nosed mole)
- *Lepus americanus* (Snowshoe hare)
- *Tamiasciurus hudsonicus* (Red squirrel)
- *Perognathus hispidus* (Pocket mouse)
- *Clethrionomys gapperi* (Northern red-backed mouse)
- *Mustela erminea* (ermine)

All of these animals may be found directly north of Missouri today except the hairy-tailed mole and the hispid pocket mouse. The mole is found generally northeast of Wisconsin, the pocket mouse in eastern Kansas and Oklahoma (Hall and Kelson, 1959). Table 6 shows the range limits of some of the animals recovered from the test hole in the entrance room. The mean latitude of the ranges of these species passes through southern Canada. Those forms ranging as far south as Missouri do so only in the high altitudes and cool temperatures of the Rocky Mountains and the Appalachian Mountains. Therefore the mean given in Table 6 may be misleading because the range limits of many of these animals are greatly extended to the south by the cool temperatures of the mountain chains.

The only animals from this site which do not seem to fit into the fauna are *Dasypus bellus*, *Dasypus novemcinctus*, and *Synaptomys australis*. The modern armadillos are incapable of withstanding sudden drops in temperature or prolonged freezing temperatures (Slaughter, 1961). Therefore it is unlikely that armadillos would be able to survive in the present climate of central Missouri, where winter temperatures may fall below freezing and remain there for a few weeks at a time. *Synaptomys australis* is reported from Kansas, Texas and Florida, but it has not been reported north of Missouri.

Table 6.
Modern latitudinal limits of selected species from the Crankshaft Pit local fauna, none of which occur in Missouri today.

	Range in Latitude S. limit	N. limit
Sorex cinereus	32° N.	72° N.
Sorex arcticus	43° N.	72° N.
Sorex palustris	33° N.	64° N.
Microsorex sp.	34° N.	68° N.
Parascalops breweri	35° N.	48° N.
Condylura cristata	34° N.	55° N.
Lepus americanus	35° N.	70° N.
Perognathus hispidus	20° N.	43° N.
Clethrionomys gapperi	35° N.	72° N.
Mustela erminea	35° N.	82° N.
Average range limits	36° N.	65° N.
Mean range*	50° N.	
Lat. of Crankshaft Pit	38° N.	

*passes through Canada just north of Minnesota.

It has been shown that during the Wisconsin glacial period there were advances and recessions of the ice sheet (Flint, 1957). Although none of the Wisconsin advances placed ice in Missouri, they no doubt caused the mean temperature to fluctuate. If the climate had remained cool, we would have difficulty explaining the presence of the armadillo and Simpson's lemming in the fauna, but a warming period would allow southern types of animals to expand their ranges and mingle with northern forms. Such a fluctuation is postulated to have occurred in the area of central Missouri during the period of deposition of the bones in Crankshaft Pit.

It soon became apparent that there had been such a fluctuation of temperature during the time that the bones were accumulating in the cave. The animals found in the upper three zones from the test pit (fig. 7) are similar to a faunal aggregation which one would expect in an area several hundred miles to the north of Missouri. The next three zones contained few of the animals found in the upper three zones which were indicative of a northern fauna, but did contain *Blarina brevicauda carolinensis,* a southern subspecies of *B. brevicauda* (see Table 7).

Table 7.
Zonal distribution of climate-indicator species recovered from the test hole (see text, above).

Zones, depth to right	1	2	3	4	5	6	7	8	9	10
Sorex sp.	1	1	1		1			1		
Sorex arcticus										1
Blarina b. brevicauda	12	6	1		1	2	9	4	4	7
Blarina b. carolinensis			1	10	3	1				
Cryptotis parva	1					1			1	1
Microsorex sp.		1								
Synaptomys australis			1	1						
Condylura cristata					1				1	
Dasypus bellus			1	1	1					
Dasypus novemcinctus			1	1						

Zones six through ten of the test hole yielded approximately the same species of animals that were found in the upper three zones of the test hole and the "warm" temperature shrew, *Blarina b. carolinensis,* was absent.

In Table 7 the minimum number of each of the selected indicator species found in the test hole is shown. The amount of time available for this particular part of the investigation was a limiting factor and the small number of individuals recovered may prejudice my judgment of the facts. However, the evidence does point to a change in climate during the accumulation of the bones. It seems logical to assume that winters were milder than the winters Missouri experiences today. This does not mean that the summers were correspondingly warmer. Summers warmer than those of Missouri today would have prohibited the northern species which are found in the deposit from living this far south. Mean temperatures were probably higher and the winters less severe.

The flora of the state today and that which was contemporaneous with the fauna probably was nearly the same. None of the Recent animals found in the deposit requires a bione significantly different than that found in eastern Missouri today. Pollen analysis was attempted with negative results.

Taking into consideration the temperature requirements of those animals still living today, the number of extinct species found in the deposit, and the number of animals no longer present in the fauna of Missouri today, a span of time extending back not earlier than middle to late Wisconsin is indicated.

Comparison With Other Mid-American Pleistocene Local Faunas

Bat Cave, Pulaski County, Missouri, yielded an interesting but small faunal assemblage (Reynolds, 1962). Bones there like those in Cherokee Cave, Missouri, were in great abundance but represent such a limited number of species (8) that they are of minimal value in evaluating the age of the fauna. The small number of species recovered from the cave may have caused the percentage of extinct species to be unrealistically high. Since Reynolds described this fauna, additional species have been identified; a pocket gopher (*Geomys* sp.), the snowshoe hare (*Lepus* cf. *L. americanus*), the yellow-cheeked vole (*Microtus xanthognathus*), and the cave bear (*Arctodus*). *Arctodus* sp. has also been found in the Hill-Shuler fauna and the Friesenhahn Cave deposits in Texas. The Hill-Shuler local fauna is thought to be Sangamon interglacial (Slaughter, *et al.,* 1961) and the Friesenhahn to be Wisconsin (Pettus, 1956).

Cherokee Cave, in St. Louis, Missouri, yielded a large number of bones, but the fauna consisted of only seven species. Of

Table 8.
Comparison of the Mammalian Fauna from Crankshaft Pit, Missouri with other Pleistocene Faunas of the Mid-American Region.

	Bat Cave (Reynolds, 1962)	Cherokee Cave (Simpson, 1949)	Conard Fissure (Brown, 1908)	Crankshaft Pit	Enon Sink (Simpson, 1945)	Herculaneum Crevice (Olsen, 1940)	Jerry Long Cave (Parmalee & Jacobsen, 1959)	Perry County
Didelphis marsupialis				X				
Sorex cf. *S. cinereus*				X				
Sorex arcticus				X				
Sorex sp.			X	X				
Microsorex sp.			X	X				
Blarina brevicauda			X					
Blarina b. brevicauda				X				
Blarina b. carolinensis				X				
Cryptotis parva				X				
Parascalops breweri				X				
Scalopus aquaticus			X	X			X	
Condylura cristata				X				
Myotis lucifugus				X				
Myotis grisescens				X				
Myotis sodalis				X				
Myotis subulatus			X	X				
Pipistrellus subflavus				X				
Eptesicus fuscus			X	X				
Erethizon dorsatus		X	X					
Canis latrans						X		
*Canis dirus**	X					X		
Canis occidentalis			X					
Canis sp.		X						
Vulpes fulva	X		X	X				
Urocyon cinereoargenteus			X	X		X	X	
Euarctos americanus		X	X	X			X	
*Arctodus pristinus***	X							
Procyon lotor		X	X	X		X	X	
Mustela erminea		X	X					
Mustela sp.						X		
Mustela vison			X				X	

	Bat Cave (Reynolds, 1962)	Cherokee Cave (Simpson, 1949)	Conard Fissure (Brown, 1908)	Crankshaft Pit	Enon Sink (Simpson, 1945)	Herculaneum Crevice (Olsen, 1940)	Jerry Long Cave (Parmalee & Jacobsen, 1959)	Perry County
Mustela pennanti			X					
Brachyprotoma sp.**			X	X				
Spilogale putorius				X				
Spilogale sp.							X	
Spilogale cf. *S. interrupta**			X			X		
Mephitis mephitis				X			X	
Lutra canadensis			X	X				
Felis cf. *F. concolor*						X		
Felis concolor							X	
*Smilodon fatalis***			X					
Lynx rufus			X	X			X	
Mastodon sp.**					X			
*Equus complicatus**						X		
Equus cf. *E. scotti**								X
Equus sp.				X				
Homo sapiens							X	
*Megalonyx jeffersoni***				X		X		
*Mylodon harlani***					X			
Dasypus novemcinctus				X				
*Dasypus bellus**		X		X				
Lepus americanus	X		X	X		X		
Lepus sp.				X				
Sylvilagus floridanus			X	X			X	
Sylvilagus aquaticus						X		
Marmota monax	X	X	X	X			X	
Citellus tridecemlineatus			X					
Tamias striatus			X	X				
Sciurus niger							X	
Sciurus sp.						X		
Tamiasciurus hudsonicus			X	X				
Glaucomys volans				X				
Geomys bursarius	X			X				
Geomys sp.						X		
Perognathus hispidus				X				
Castor canadensis		X	X				X	
Reithrodontomys sp.		X	X					
Peromyscus sp.		X	X				X	
Peromyscus nuttalli						X		
Neotoma floridana	X			X		X	X	
Synaptomys cooperi				X			X	
Synaptomys cf. *S. australis**				X				
Erethizon dorsatus		X	X	X				
Clethrionomys cf. *C. gapperi*				X				
*Microtus xanthognathus****				X				
Microtus ochrogaster				X				
or								
Microtus pinetorum				X				
Ondatra zibethicus				X				
Tapirella cf. *T. bairdii*						X		
*Tapirus excelsus***					X			
Tapirus cf. *T. excelsus***				X				
Mylohyus sp.**			X					
*Platygonus compressus***	X	X				X		X
Platygonus sp.				X				
Cervus canadensis			X					
Odocoileus hemionus			X					
Odocoileus virginianus			X	X			X	
Bison sp.					X	X		X
*Symbos australis***			X					
*Tanupolama parvis***						X		
*Tanupolama macrocephalus***								X

*Denotes extinct species.
**Denotes extinct genus.
Some animals given in the faunal list from the Conard Fissure (Brown, 1908) have been deleted here because some are synonymous with recent forms and several were incorrectly named.
***CM collections

these seven, two *Dasypus bellus* (Simpson) and *Platygonus compressus* Le Conte, are extinct and are found in Crankshaft Pit.

The porcupine, *Erethizon dorsatum* (Linnaeus) was found in Cherokee Cave but was not found in Crankshaft Pit. Since there are so many "northern" animals in this fauna, it is probable that porcupine remains may yet be found.

Simpson considered the Cherokee Cave local fauna to be late Wisconsin to Recent in age.

The first major Pleistocene local fauna to be excavated in the Missouri-Arkansas area was the Conard Fissure deposit (Brown, 1908). This was a limestone fissure in which bones accumulated. The Conard Fissure local fauna was considered to be of late Pleistocene age. Brown (1908) listed two new genera and 22 new species, but recent reviews have shown that at least one genus was assigned incorrectly and probably a dozen of the "new" species are synonomous with Recent animals (Guilday, pers. comm.).

Enon Sink, a filled sinkhole in Moniteau County, Missouri, yielded a number of skeletons, some of which were nearly complete. This is the type locality of *Tapirus excelsus:* unfortunately, the only two individuals known were juveniles recovered from this sink. Since the tapir from Crankshaft Pit is an adult, direct comparison of linear measurements is of little significance. A re-evaluation of the species would now be most desirable. Due to the impossibility of making direct comparisons between these three animals, the tapir from Crankshaft Pit can only be tentatively identified.

Jerry Long Cave, Ralls, County, Missouri, produced a Recent fauna (Parmalee and Jacobson, 1959). Of the 23 species of mammals found in the deposit, only the black bear (*Euarctos americanus*) and the mountain lion (*Felis concolor*) no longer inhabit that part of Missouri. Recent evidence indicates that the black bear may be returning to Missouri, moving northward from Arkansas.

Perry County, in southeastern Missouri, has an extensive karst topography. In this region "sewer type" caves frequently have bones washed into them. Some of these caves have functioned as traps when animals have fallen into them and it is not uncommon to find bones and teeth of large Pleistocene animals in these caves. Bones of small animals do not preserve well in caves of this type because water which often floods the caves destroys them by abrasion. As a result, the animals found here represent only the larger members of the fauna and have limited value for ecological studies.

Despite the relatively large number of Pleistocene cave deposits, the age of none of them has been definitely established and no valid correlations are possible at this state of our knowledge.

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