PHOLEOS

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The Wittenberg University Speleological Society

The Wittenberg University Speleological Soceity is a chartered internal organization of the National Speleological Society, Inc. The Grotto received its charter in April 1980 and is dedicated to the advancement of speleology, to cave conservation and preservation, and to the safety of all persons entering the spelean domain.

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PHOLEOS

THE WITTENBERG UNIVERSITY SPELEOLOGICAL SOCIETY NEWSLETTER

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EXCHANGES
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Cover Photo:

Rimstone Cave
Carter County, Kentucky

EDITORIAL

As the new editor of Pholeos, I would like to welcome all of you to our ninth year of publishing. I will begin this issue with some good news: on Tuesday November 15, Senate Bill 177 (the Cave Protection Bill) was voted out of the Agricultural and Natural Resources Committee, proceeded to the Ohio House of Representatives for a final vote, and was passed on November 17 by a vote of 94-5. Five years of work have payed off—WE NOW HAVE A LAW TO PROTECT OHIO'S CAVES! Congratulations to everyone who worked for this goal.

Our survey of Bat Cave is now complete, and our survey work in Zane's Caverns is almost complete. Maps of both of these caves will be published in our next issue of Pholeos, as well as the second half of Warren Luther's report. We also hope to have information from our new area of concentration—Boone National Forest. We began hiking, camping, and surveying the local caves on November 6. I'm sure that this area will give us plenty to do in the near future.

I would like to thank all those people who contributed to this issue of Pholeos, and those who helped to put it together, especially Sheryl Rowold, Warren Luther, and Teressa Keenan, Susan Crown, and Carol Kneisley.

BAT HIBERNACULA CLOSURES

The summer is over and the Indiana Bats are returning to their caves to hibernate. Caver courtesy (as well as federal and state laws) says we should not risk disturbing our furry friends by avoiding the major hibernacula until next spring (March 31st). The caves that should be considered off limits are: Twin Domes (Harrison County), Ray's Cave (Green), Batwing Cave (Crawford), Jug Hole (Harrison), Grotto Cave (Monroe), Coon Cave (Monroe), Parker's Pit (Harrison), Saltpeter (Crawford), and Clyfty (Green). Some of these caves have physical barriers to prevent entry and all have been posted by the IDNR.

The IKC has been active in promoting protection for the Indiana Bat. Arguably, caver disturbance has often been listed as the leading cause for the *Sodalis's* population decline. As efforts have been made to reduce the "caving factor", the other causes for their decline (pesticides, and loss of summer feeding habitats) are becoming more apparent. These latter causes do not have easy or short term solutions and are beyond the scope of the caving community. But we can continue to reduce the winter visitation problem through the dissemination of information about the importance of sesasonal closures, and by setting examples for others to follow.

For more information, please contact Keith Dunlap, care of Indiana Karst Conservancy, PO Box 461, Plainfield, IN 46146.

A PITTING EXPERIENCE

by Paula Stitzel

On October 7, my husband and I went to Alabama for the eleventh annual TAG Fall Cave-In. We left Springfield, Ohio around 5:30 a.m. Saturday and arrived at the Sequoyah Caverns K.O.A. Campground around 4:30 or 5:00 p.m. The trip was enjoyable because the weather was really warm and the sights were great. We signed up, found a site for our tents, and then went to bed.

The next morning, we woke up very early and started our trip to our cave for the day—Stephen's Gap Cave, about one hour from our campsite. This was to be my first pit, and boy did 143 feet sound scary to me. The closer we came to the pit, the more I wanted to say, "Forget it!" I really must have been a little crazy for telling my husband that I really wanted to do this. Well, we were there, so everyone changed clothes. Then the men fixed the ropes and set everything up. Bill, my husband, who loves caving and enjoys jumping into these pits, went first. When it was my turn, I became a nervous wreck. I was really scared, but I went anyway. I started down the rope; the lip turned out to be a very easy one, but then all of a sudden I was in mid air on this little skinny rope. Now I was wondering why I wanted to do this, because my stomach was very upset and all I could think of was getting down to the bottom real quick. But I went down very, very slowly as I held on for dear life. When I was half way down, the rack suddenly started to eat my gloves and almost my fingers. I struggled to get my fingers out of the glove, and there in mid air I almost panicked. But Howard, my sister Carla, and my friend Janie were on a ledge half way down to take my picture (because it was my first pit), and Howard told me to let the glove feed through the rack and just keep going, which I did.

The trip down the rope was slow and long for me. My husband was waiting for me at the bottom, which made me feel a little better. I got off the rope and climbed up a tree to reach the ledge so I could walk out of the cave. When I was out, I decided to do the pit just one more time. This time it was a breeze and a little more enjoyable since I could now look around and go at my own speed. But that was my first pit and my last one—well, until next time.

P.S. Thanks to all my caving buddies: Bill, Horton, Chris, Howard, Charles, and to the Dogwood City Grotto for a TAG good time.

SLOAN'S—A FIRST EXPERIENCE
by julia l. collins

Having done a bit of "wimp caving" in the Dakotas and New Mexico, and being close friends with two speleophiles, I recently decided to add "real caving" to my list of life experiences. My first adventure was at Sloan's Valley Caves near Burnside, Kentucky. Though it could in no way be termed an unqualified success, it was overall a good experience.

In the future, Sloan's would probably not get my recommendation for a first-ever caver. However, it is a great cave system in terms of diversity. There is plenty of exposure to the ups and downs and ins and outs of caving—lots of rock climbing, mud sliding, pool wading, and a few moderate crawls in the area we covered, nothing being too scary or difficult. My biggest problem was not realizing my limitations, but dealing with the fact that I didn't eat or drink enough beforehand. As a result, I ended up having to take a shorter way out with quite a bit of help.

I am having a difficult time convincing people what a good time I had. They tend to take one look at me and say, "My God, what happened to you?" If I hadn't been a volunteer at a women's center, I'd get a lot more mileage out of telling them that my housemates beat me. Frankly, I look like I jumped out of a car traveling as fast as I drove home. But that is another matter entirely. When I say it happened caving, their faces take on that rather 'knowing' look, and they nod, seemingly understanding. But when I tell them I had a great time, and fully intend to do it again, their eyes glaze over and they shake their heads. Hey, I just bruise easily.

I'm not really a glutton for punishment. Well, perhaps I am, but that has much less to do with my wish to continue spelunking than, say, my decision to spend my life in theatre. I mean, I really have this thing for natural beauty, and caves are chock-full of it. In one trip, I experienced such incredible sights as "The Big Room," an immense space that makes one's humanity and age seem hugely insignificant; a gorgeous waterfall which I passed both at its top and bottom; marvelous stalagmite and stalactite formations; natural pools; and the rich dark mud/clay which eventually became the most visible thing on me. There were no bats on this trip, but I found signs of life—numerous cave crickets (heaven forbid one should call them spiders!) and even a newt, much to the chagrin of my housemate, a veteran caver, who said, "You're so lucky! You saw a newt on your very first trip. I can't believe it!" It puts a certain needed perspective on life, don't you think?

My mother worries, as mothers will, that it's too dangerous. I called to ask her to send my hiking boots, and ended up having to justify my need for them.

"So, you're going to be going down into huge labyrinthine caves and going up and down cliffs on a rope?"

"Well, basically."

"Why do you want to do dangerous things? Are you trying to prove something? Is this for some boy?"

"Look, Mom, these other people are really experienced, and it's not like I'm skydiving, or hang gliding."

"Yet..."

"Mom, okay, I know it can be dangerous. I went this last weekend and found out a lot about my stamina and endurance. To tell you the truth, I pretty much had to be rescued. But now I know."

Somehow, this was not the thing to say. My stepmother's approach had been, "Well, you're certainly not going again, are you?" to which my "yes" had met with reserved approval. My mother, on the other hand, seems to have me as good as dead and would rather disown me first to save herself the grief.

"What should I say?" she asked, after a long, deep sigh.

"About what?"

"To make you not do it. I'll send the boots, so you'll be safer, but I still don't know why you want to do such dangerous things."

(This is the woman who moved me from Florida to Minnesota and then cringes at the thought of my winter camping or downhill skiing. "It's dangerous," she insisted. "It's life," I said. Oh well...)

We all have to start somewhere, I suppose. Now that I've been through Sloan's, I have a better idea of how to prepare for my next cave. And believe me, there will be a next one. Can anyone say, "Oktoberfest?" I'll see you there!

ARTICLE REVIEW
by Monika Palunas

Roberts, David. 1988. "Caving comes into its golden age: a New Mexico marvel." Smithsonian, 19(8):52-60,62,64-65

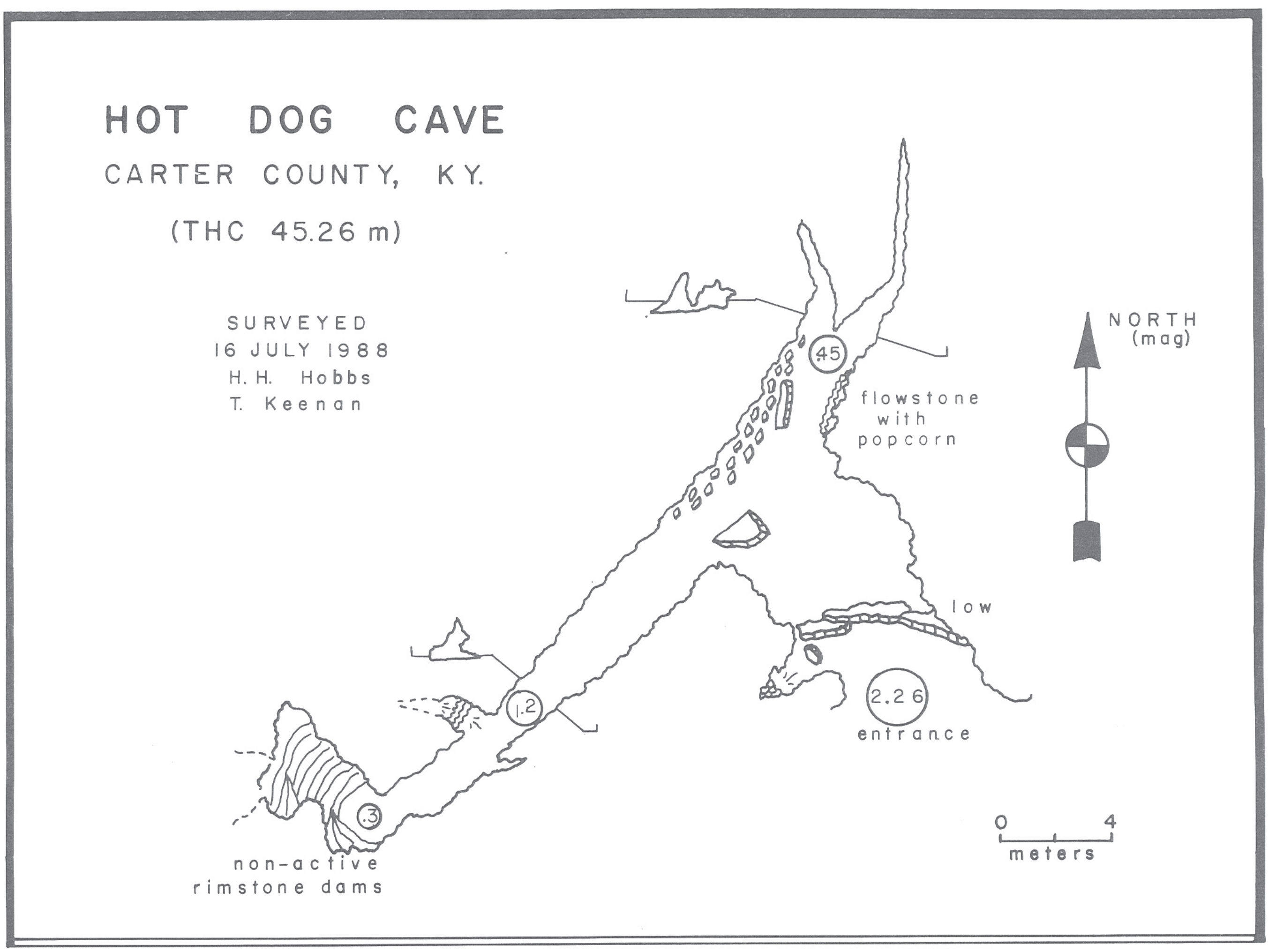
The past year has witnessed a media blitz on caves, "earth's last frontier." Much of the commotion has been directed toward the biggest American find in recent years—Lechuguilla Cave. The November issue of Smithsonian magazine dedicates an eleven page spread to this spectacular cave as well as to the sport of caving. For David Roberts, the author of "Caving comes into its golden age: a New Mexico marvel," Lechuguilla marked his first "wild caving" experience. Exquisite photography first brought my attention to the article. As I flipped from one page to the next my eyes stared in disbelief at the passages and incredible formations pictured before me. I must admit to becoming envious of Roberts and others who have had the good fortune to visit Lechuguilla. Wanting to know more, I began to read. Robert's article was filled with both awe and respect for caves and cavers alike. The account of his nine hour trip, led by Rick Bridges, included personal reflections, colorful descriptions, and a brief history behind the discovery and exploration of Lechuguilla. Much to my pleasure the messages of conservation and safety were well integrated. The article tended to spread itself thin in places as Roberts tried to incorporate too much general information about the caving world. I recommend this article to cavers and non-cavers alike—particularly for the photography.

HOT DOG CAVE

by Teressa Keenan

Hot Dog Cave is a small cave located within Carter Caves Resort Park, Carter County, Kentucky. This solution cave was formed in Mississippian Limestone (Upper St. Louis), a common bedrock type in this area. The entrance is 2.26 meters in height and looks very much like a simple overhanging section of rock. Just to the left of the entrance is a short section which slopes up and ends in a breakdown plug. Along what appears to be the back wall is a very low space which opens up into a small but obvious cave passage. The main passage runs in a north north-west direction for about eight meters. At this point the cave branches out in somewhat of a "T" shape (see map). The right passage soon splits again creating two small passages running almost due north. Both of these dead end very shortly. The left arm of the passage continues on to a low room, the floor of which is covered by non-active teared rimstone dams. There is a small opening in the west wall that has good air flow and suggests that the cave continues further. However, digging will be necessary to go beyond this point.

Hot Dog Cave is generally dry with a fairly large amount of breakdown along the top part of the "T". None of the formations in this cave are active. The rimstone dams are the most significant formations, but, there are also two sections which contain flowstone, and there is some popcorn along the east wall of the right passage. No organisms were found during this survey or any other known trips to the cave. Hot Dog is fairly clean except for the section which is directed due north; here the back part of the passage is almost completely filled with old cans and bottles.



SOME INTERESTING OHIO CAVES IN NONCARBONATE ROCKS

by Warren Phillips Luther

PART I: GENERAL REMARKS

INTRODUCTION:

The caves described in this paper have been chosen to illustrate the variety of cave types found in sandstones and conglomerates throughout the Appalachian Plateaus of Ohio and the different processes that formed them. In the author's opinion, these selected caves are among the most interesting as caves in themselves, or are significant as examples of certain cave-forming processes.

In areas with immense limestone cavern systems, such as Kentucky, features like "fracture" caves in sandstone, or rock shelters, in spite of their archaeological value are generally ignored, considering how little is to be gained in exploring them for sport. In Ohio, however, many of these noncarbonate caves rival those in limestone or dolomite in size as well as in their scenic aspect. Furthermore, their inclusion in a state-wide survey of caves is justified because of their geological and historical importance. Many areas boasting of sandstone or conglomerate caves in abundance are in public parks, hence easily accessible to recreational explorer and scientist alike. Roughly one-half of the caves listed by the Ohio Cave Survey are in noncarbonate strata, and of these, many are nothing but rock shelters without passage, included because of their worth in any of the ways mentioned above. Much archaeological work has been done in them, and the prehistoric peoples who inhabited various parts of Ohio found them more suitable for occupation than limestone caves, since the latter are apt to be wetter, or have entrances either restricted in size or unfavorably exposed. There are, of course, notable exceptions, but these sandstone shelters are more accessible than any other type of cave, and so numerous that a complete inventory of them is not possible. A few of the caves described in this paper are shelters, but the majority of caves are in fact deep ones, usually penetrating the aphotic zone, that is, the zone of total darkness, and are formed in ways suggesting more than one process at work. The potential for great size and length for caves in noncarbonate rock (at least in Ohio) is less than in carbonates, because these caves can be the mere result of the splitting of rock masses, or erosion (perhaps aided by solution) on a small scale, rather than the result of the removal of rock by solution at greater depths under a wider area. Again, notable exceptions can be found in other states, especially on high plateaus (like the Colorado Plateau) or in mountainous areas (like the Adirondacks), where such caves can be enormous; in Ohio they tend to be much smaller, though fairly common.

THE REGIONAL SETTING AND OVERVIEW OF THE CAVES

All of the caves described herein are on the Appalachian Plateaus where most of the sandstones and conglomerates in Ohio occur. These range from Lower Mississippian into Permian in age, and along with interbedded shales, they make up the greatest bulk of strata outcropping in the region. Instead of discussing at length the various rocks involved, they will be mentioned in conjunction with specific caves described below. The nature and composition of these strata are similar enough for similar types of caves to form in them, no matter where the parent rock occurs in the geological column. The sandstones are mainly pure quartz sand (silicon dioxide), at times containing an abundance of rounded quartz pebbles, and are cemented with arkosic or siliceous material, sometimes with limonite--the latter often coloring the rock various shades of brown and red on exposed surfaces. Calcite cement is unfortunately rare in Ohio, in contrast to the Loyalhanna formation (Upper Mississippian) of the Laurel Highlands of western Pennsylvania, which is called a limestone yet is about fifty per cent quartz sand bonded by calcite; some extensive caves in that state are formed in it. Solution has removed the soluble matrix while subterranean erosion is responsible for removing the loosened sand grains; analogous situations are possible in some of the sandstone caves described in this paper, where the cementing material is iron oxide.

The Ohio sandstones are commonly thick and massive, well jointed, and are underlain by much softer, hence easily eroded, shales. They crop out in areas with enough vertical relief to expose an entire stratum to the various processes at work, especially when a particular stratum is devoid of excessive overburden. Glaciation has not had the same effects on these cave areas as it had in some of the limestone areas of western Ohio, at least in its destructive aspects; some evidence is seen in the glaciated northeastern part of Ohio that the presence of ice over certain exposed conglomerates possibly had much to do with the formation of caves in them. Also, certain areas near the glacial boundary, notably in Hocking County (where an abundance of thick sandstones crop out), received meltwater in great volume and force, thus contributing substantially to the formation of several cave types, not to mention the many deep scenic gorges for which the region is famous.

"Fracture" caves in sandstone, in contrast to rock shelters or overhanging ledges, are passageways, sometimes without a roof or partly roofed; in Ohio these can attain lengths surpassed only by a minority of the known limestone caves. These caves are concentrated in certain areas where conditions are favorable, reaching their most spectacular development in the northeast. The term "fracture" implies a tectonic origin, since it means a break or split along joint planes (or a fault) which is further enlarged by gravity and erosion. Caves of this type occur at or near the edge of a sandstone bluff with no other stratum above, though sometimes they are found some distance back from the outcrop itself. In working with some of these caves for several decades the present writer has become convinced that mere "tectonics," or earth movements, does not answer all the questions surrounding their origin, which is certainly more complicated than it seems to be. The apparent splitting and settling of large masses of sandstone often involves several processes, including some thought to be in the exclusive domain of caves in soluble rocks. While most of the caves examined appear to have had a complicated history, a few are clearly tectonic, being simple unaltered fractures or holes under and among piles of boulders.

Noncarbonate caves in Ohio fall into three main categories; this classification is based on their general form and appearance and is not necessarily indicative of the processes that formed them. Listed in order of their abundance, they are:

1) Rock shelters, overhangs, and recesses, which are predictably shallow, though they may have some passage at floor level along their inner walls, often along bedding planes.

2) "Fracture" caves or caves developed along a joint plane, with several types of ceiling: a real ceiling (with bedrock in place), or a false ceiling (one rock mass resting against another, or with boulders and other debris wedged in the crevice); these caves, no matter how they originated, have some lateral extent.

3) Caves in talus, or under boulders, which are entirely tectonic, and in Ohio having very little lateral extent. These are called "purgatories" in New England, where they are common.

In addition, other features are associated with these caves. Their setting is often along a bluff or escarpment where the rock has been broken and split into various passageways, more often without roof than with one. In Ohio places like these are called "ledges;" elsewhere "rock city" is a common term. Springs are numerous at the base of a sandstone bluff and contribute to the process of cave-formation either by eroding the sandstone bluff or its underlying stratum, or both. Solution has not been ruled out as a cause, since the residue of this process—stalactites and flowstone (usually semiconsolidated) of limonite or goethite—can be found in some of the caves, resulting from the solution of the iron oxide matrix or derived from overlying strata, especially those bearing coals and iron ores. "Pseudokarst" abounds on uplands underlain directly by certain massive sandstones, in particular the Sharon Conglomerate of northeastern Ohio; this consists of any combination of phenomena, including sinkholes, natural bridges and tunnels, "solution" tubes, stream piracy, and large collapsed areas. The caves may exist singly as an isolated feature, or they may be part of an integrated (though perhaps not completely explorable) network of fissures, collapses, and true cave passages, which can carry pirated surface water.

Natural bridges sometimes represent the destruction of a longer natural "tunnel." These are not too common in Ohio. In any case, their appearance in sandstone is the result of several converging processes: 1) headwater erosion on a narrow sandstone-capped divide or ridge; 2) stream piracy through crevices behind receding waterfalls; and 3) collapse of cave passages. A few natural bridges in Ohio will be discussed in this paper.

The above considerations in no way exhaust the types of caves formed in noncarbonate rocks outside of Ohio. For one thing, these rock types in Ohio are basically the same—clastics (sandstones, conglomerates, siltstones, shales, and their various gradations) which are essentially horizontal and metamorphosed only to the extent that they have become indurated and locally fractured. Conspicuously absent from Ohio are, of course, littoral (or sea) caves and lava tubes, not to mention the fissure systems or boulder complexes alluded to in earlier paragraphs which are on a grand scale elsewhere, and are formed in a great variety of rocks—igneous as well as clastic. Nor are such cave types as enumerated above confined solely to noncarbonate rocks in Ohio and elsewhere; shelters and overhangs are common in the resistant dolomites of southwestern Ohio, and much less common are simple "fracture" caves in these dolomites. A few have been found which resemble their sandstone counterparts so much that they must have been formed in the same manner—the splitting of rock masses aided by solution along joint planes from surface waters. Seneca Caverns is perhaps the largest collapse feature in Ohio, yet it is in solid limestone; its origin seems to be from the solution and removal of underlying gypsiferous beds, perhaps halite (rock salt) also, leading to massive widespread regional collapse of the overlying Columbus Limestone which contains the cave. The limestone caves so far examined in that area rarely show any solutional features. Nelson Ledges, which will be discussed later, has a similar collapse feature, but the stratum removed is the soft shale beneath the Sharon Conglomerate.

The present writer hopes that this tangential discourse on the nature of these noncarbonate caves, and the cave descriptions which follow, will encourage further research. The problem is deceivingly more complicated than it appears to be, and old conceptions need to be re-examined after careful study is made of the caves and their environment.

PART II: CAVES IN NORTHEASTERN OHIO

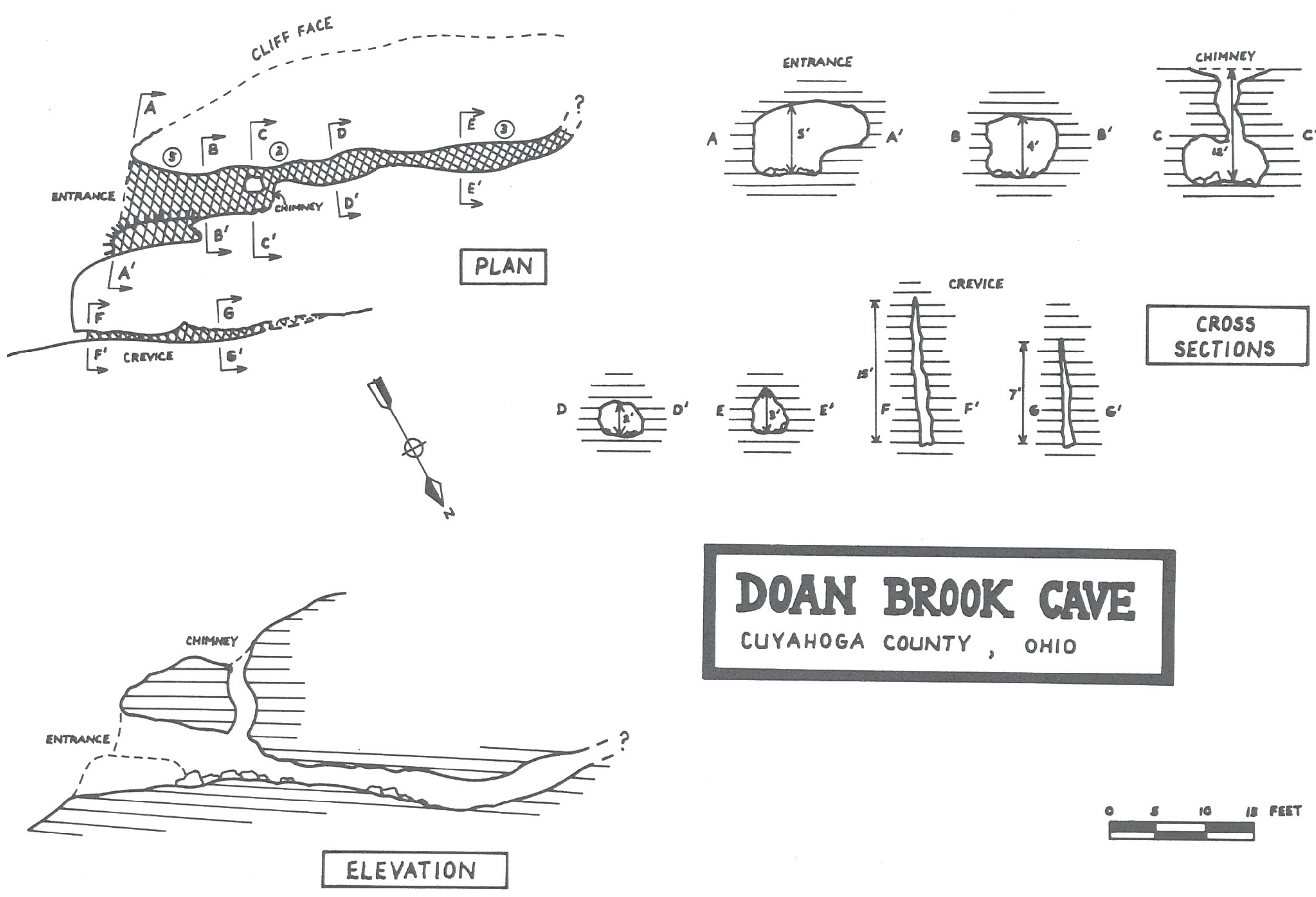
ASHTABULA COUNTY:

The Berea Sandstone, of Mississippian age, is well developed in northeastern Ohio, thickening westward to over 200 feet in Lorain County. Its occurrence is limited to the lower elevations, and around Cleveland and farther east it is seen in the numerous gorges cut into the edge of the Appalachian Plateau. In one such gorge called Warner's Hollow is Fox Hole, which is interesting for its strict adherence to two sets of joints, and for its ceiling heights (to 40 feet) along about 100 feet of narrow passageways. It is clearly a "separation" cave, formed with the aid of gravity and erosion.

CUYAHOGA COUNTY:

Deerlick Cave, also in the Berea Sandstone, is along marked trails in Brecksville Reservation, a part of the Cleveland Metropolitan Park System. At first inspection, it is nothing more than a shallow recess, or re-entrant, behind a small waterfall, measuring about 25 feet wide, 12 feet deep, and up to 5 feet high. On the right, though, a crawlway 3 feet high begins, turns to the left, rises slightly, and becomes one foot high. After a dozen feet it ends in a pool of dripwater. Here is the surprise: this little grotto is adorned with colorful mineral-stained flowstone and stalagmites, with some pure white and even reddish stalactites, likely of calcium carbonate. If so, what is its source? The Berea Sandstone is generally not bonded with calcite—though such a case could be a local occurrence. The present writer suggests that the overlying glacial drift, which can be calcareous, supplies the trickle of water coming through the cave's ceiling with calcium carbonate in solution, and that the source of this mineral is farther to the north, in the Lower Paleozoic carbonates of southern Ontario, pulverized by the advancing ice sheets, and dumped on what is now northern Ohio. If this is true, it might be the only documented instance of the bedrock of one country forming speleothems in a cave in another country!

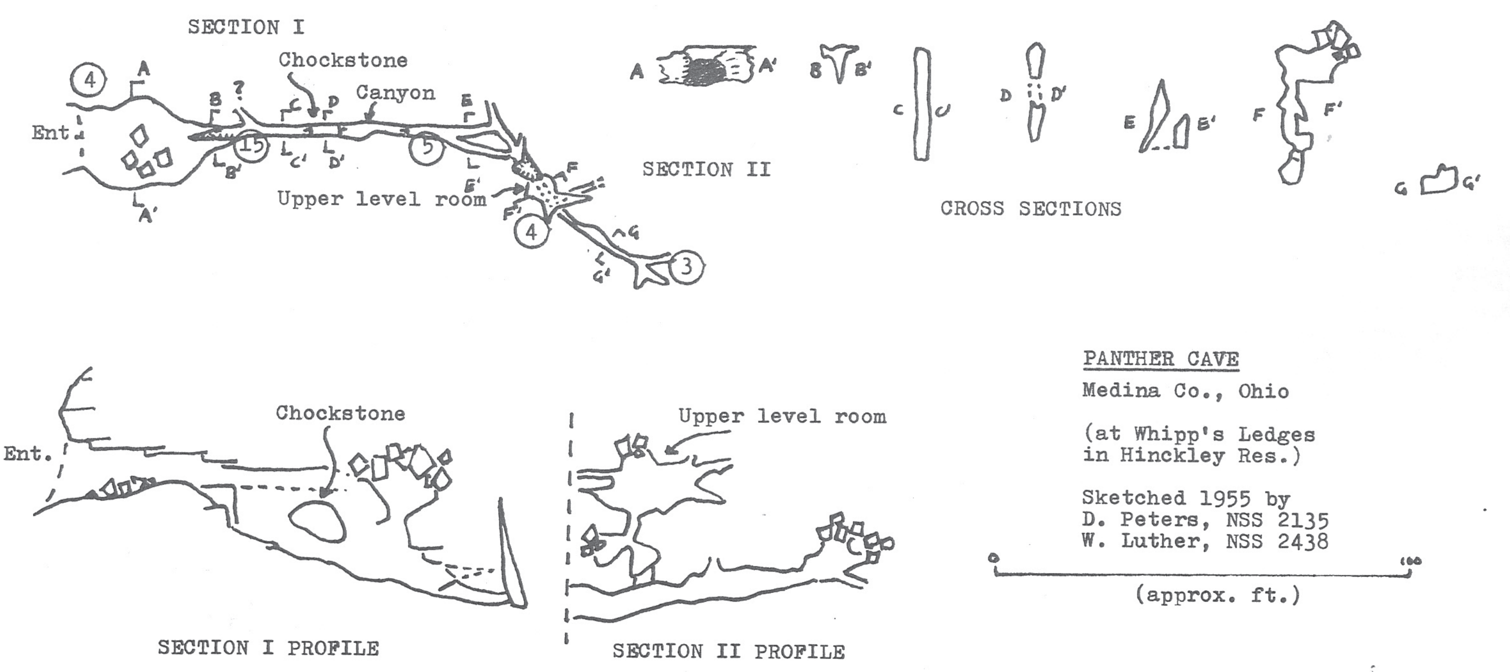
On the east side of Cleveland, Doan Brook drains the Shaker Lakes and cuts a deep gorge through the Berea Sandstone into the underlying Cleveland Shale. This is on the so-called Portage Escarpment, the first step of the Appalachian Plateau, where the Berea supports a broad, rather flat upland. In the gorge the sandstone forms cliffs and several small caves, giving the area the name "Caveland" to local children. The largest of these, called Doan Brook Cave for want of a better name, is in the



north wall of the gorge; its imposing entrance is in a low ledge of crossbedded sandstone, completely devoid of vegetation, jutting out several yards from the bluff. The cave nearly occupies the whole interior of this ledge, making it appear somehow artificial, but it is presumably natural. Inside is a room about 15 feet long and 5 feet high; a hole in the ceiling towards the back serves as a convenient chimney for the often-used fireplace beneath it. Beyond the chimney a low crawlway over broken rocks extends perhaps 30 feet slightly downward and parallel to the bluff face. The cave's origin seems to be connected with the gradual separation of the ledge from the bluff, as seen in the narrow crevice to the right of the cave (see map), as well as in the trend of the crawlway itself. The single room, though, is not so easily explained, nor is the hole to the surface. This could be a circumstance like the Hocking County caves, that is, of the gradual disintegration of a friable zone in the sandstone by various agents, aeolian erosion included—perhaps here also aided by man's ingenuity. The entrance to Doan Brook Cave is certainly among the prettiest in Ohio.[1]

MEDINA COUNTY:

Above the Berea Sandstone, and separated from it by a thick sequence of shales and siltstones, the Sharon Conglomerate of Pennsylvanian age (the basal member of the Pottsville formation) is a conspicuous cliff-former; and whereas the Berea is confined to the lower elevations in the Cleveland area, the Sharon crops out in all positions—atop the highest hills and ridges in some areas, or at base level in the gorges of certain rivers. This is due not only to its higher stratigraphic situation, but to the uneven surface upon which the Sharon was deposited and to the general regional dip of all strata to the southeast. In Medina County it stands at an elevation of approximately 1,300 feet in a few localities, notably at Whipp's Ledges in Hinckley Metropolitan Park. The bold escarpment of the Sharon (which is here mainly a sandstone) has been broken up into typical "rock city" structures where joints have separated and large blocks of the sandstone have moved from their former positions, aided by the continual erosion of the weaker sandstones and shales beneath them, and of course by gravity. Among the several caves found, one in particular is interesting because it seems to be at once a simple fracture in which a joint has separated to form smooth straight walls, and something entirely different. Panther Cave (also knownas Wildcat Cave) begins as something else, like Doan Brook Cave; an arched entrance leads into a small room (in this cave wider than the entrance) with a true ceiling, that is, a ceiling which is part of the parent rock, neither debris nor a shifted slab. Immediately past the first room the nature of the cave changes. The floor drops into a narrow slot, or crevice, descending some 15 or 20 feet, while above, the original level of the entrance is preserved in a ledge rather like a catwalk along both sides of the crevice. The ceiling is now of debris, and halfway into the crevice a large chockstone necessitates ducking under it to continue. At the bottom acrossing joint intersects the passage; to the left it cannot be followed, but to the right (beyond a tight squeeze) it enters a jumbled area of breakdown in which rocks have fallen into the crevice, creating several rooms on two levels among the debris. It is this part of the cave which resembles a cave under talus, like Broken Rock Falls Cave, which will be discussed under Hocking County. The total amount of passageway is about 120 feet (see map). The writer noticed, in the lowest level where the two joints meet, a condition of the cave walls not unlike incipient botryoid formations seen in limestone caves, caused by standing water depositing calcite in knobby profusion. In Panther Cave this is perhaps a negative rather than a positive



condition, meaning that some of the rock may have been removed, leaving the original wall surface in relief. In any case, though no standing water was observed during several visits, the floor is always damp here, and water must stand from time to time which has either deposited something on the walls, or dissolved something from them. Again, water can be the cause for some features in sandstone caves, though in this cave, like Deerlick Cave, these features are secondary and perhaps not connected with the cave's origin. In other caves to be discussed later, the water, whether trickling, running, or standing, can be assumed to be responsible in an important way to their growth. Besides this minor dilemma at Panther Cave, the other question is: how could a cave room like the entrance chamber, which is seemingly a water-carved enlargement of weak bedding planes along one joint, suddenly give way to a passage clearly tectonic in origin? And which was formed first, the room or the fissure? Would not tectonic movements destroy the entrance room, if they antedated it? It is perhaps not so complicated; one suggestion is that the entrance room is simply an enlargement along these friable beds where they are exposed to surface weathering, and below them, in the fissure or crevice itself, the rock is more massive and thickly bedded, therefore more resistant to weathering.

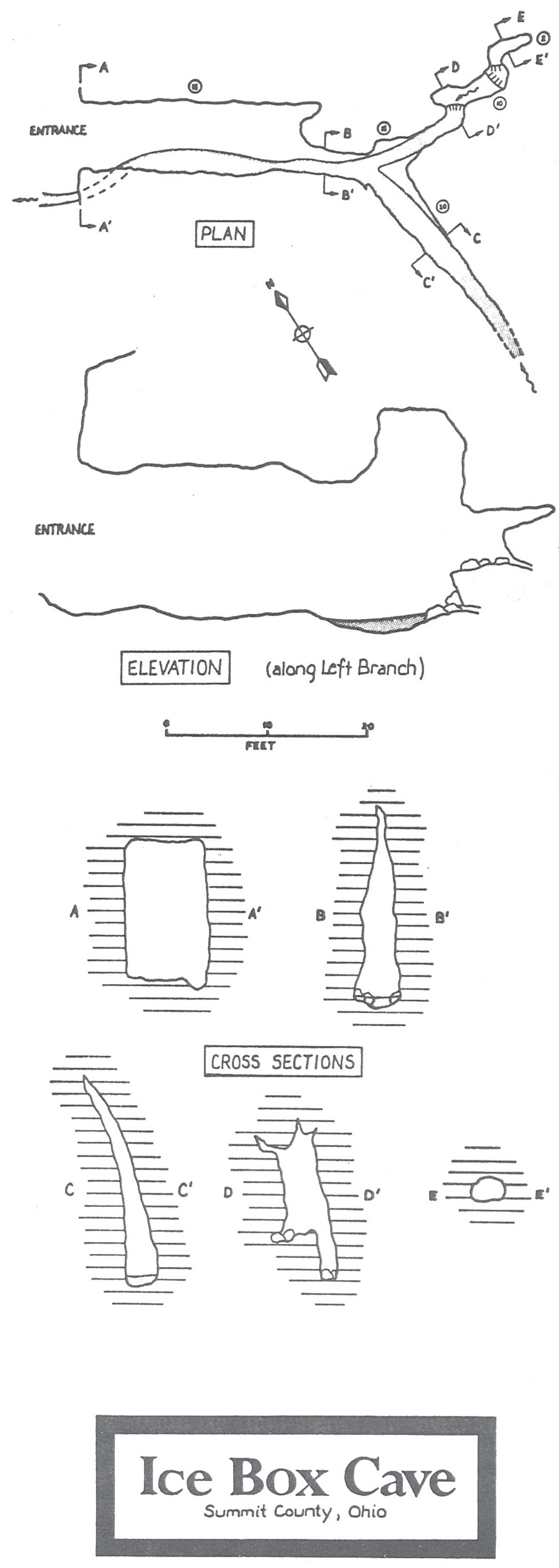
SUMMIT COUNTY:

At and below Cuyahoga Falls, the Cuyahoga River enters a deep gorge in the Sharon Conglomerate after flowing through a much shallower notch for several miles. Along the walls of the gorge are various caves and overhangs, the most famous of which is Mary Campbell's Cave in Gorge Metropolitan Park. More elusive, however, is the following cave, which has not been located by the Ohio Cave Survey:

> "On the north bank of the Cuyahoga, below the village {of Cuyahoga Falls}, is a remarkable cavern. I discovered it in 1826, when the country was a wilderness. It is on the very brink of the chasm cut by the river, and the small opening, but just large enough to admit a person's body, was on a level with the ground. A few leaves or a rotten log will easily conceal it. ... I entered it, and found it about ten feet in height, and divided into two rooms with a small passage between, barely sufficient for a person to pass. There was no opening except at the place where I entered, from which I was let down by my companions. It being totally dark in the cavern, I could make but few examinations; and, fearing some chasm in the bottom, I did not let my curiosity tempt me far in my explorations.... From the length of time intervening, and change of appearances, ... I cannot now find it,—but some future explorer will bring it again to light."[2]

This sounds like a separated joint, perhaps roofed by soil and other debris; this "lost cavern" is included in the Survey files as Bierce's Cave in honor of its discoverer and describer.

Downstream from Cuyahoga Falls the river enters a valley about 400 feet deep with several large bluffs of Sharon Conglomerate appearing on the highest elevations along the way. One of these, Kendall Ledges in Virginia Kendall Metropolitan



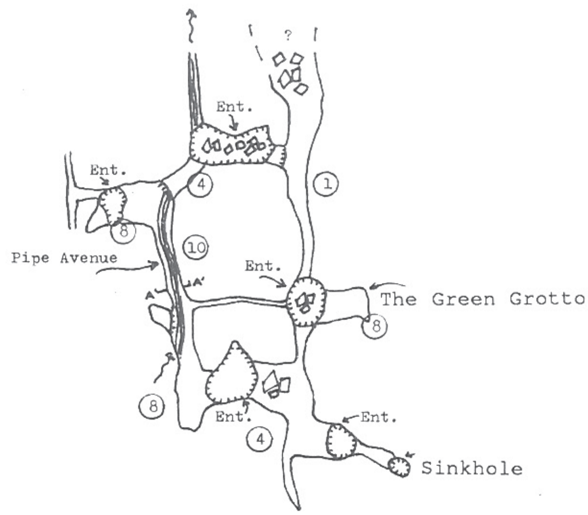
Park, contains Ice Box Cave (see map), a short walk from the main picnic area. This cave, aside from the Devil's Den at Nelson Ledges, boasts of the most imposing (if not most forboding) entrance to a northeastern Ohio cave. Its main room is a rectangular chamber about 20 feet long, 10 feet wide, and 15 feet high, and its ceiling looks suspiciously "shifted," that is, it seems to be a large slab of conglomerate held in place over the separated joint and saved from collapse by its own strength, any other fallen debris in this room having long since been removed by erosion. A constant stream, which cannot be followed beyond 30 or 40 feet, issues from a high crevice to the right of a short passage beyond the entrance room. The left-hand branch rises in several steps and ends under a breakdown ceiling. Water can be heard gurgling under this passage, and the cave's two streams meet at the fork; the water then sinks at the entrance to disappear under a considerable pile of surface rubble. Not seen from the trail which passes the entrance is another cave opening in the talus pile, which leads into a roomy little cave under the boulders. The water from Ice Box Cave can be seen in its lowest level, in a tiny room among the boulders, where is also the tiniest waterfall the author has ever seen in these sandstone caves. It is well worth the tight squeeze to see it. This talus cave is referred to as Sand Cave in the Survey files, from the composition of its floor.

GEAUGA COUNTY:

The Sharon Conglomerate caps the higher elevations in Geauga County as erosional remnants of an older plateau surface. These uplands contain many interesting groups of caves, two of which were popular recreational sites in the nineteenth century—the Chesterland Caves and Little Mountain Caverns. The latter even went so far as to offer "underground" boat rides, so it was, in a way, the only true "show cave" in Ohio in sandstone. Both Lynch and the present author have studied the Geauga County caves, and Lynch's paper, describing ten caves, is the first such study ever published. While his paper is short, one hopes for some future elaboration on his hypotheses, which, in the present writer's opinion, seem to be hitting at the heart of the matter. To assume that all such caves in dissoluble rock are tectonic puts too much emphasis on one aspect alone, that is, of movement. It is rather the cause, or causes, of this movement which is (or are) problematical. And in some cases, as Lynch notes, material has been removed from the bedrock to form certain caves and passageways, which is much different from separation. Lynch observes that running water must have had considerable effect on the formation of these caves, especially since many caves in northeastern Ohio contain either large springs or active streams, and in certain caves there is evidence of past water action. One would expect purely tectonic caves to show only angular or "fractured" surfaces; indeed, this is true of some of them, as the reader has already seen. But other caves have well-rounded contours, even tubes extending for many feet (resembling solution tubes in limestone caves), so that it is obvious that running, falling, or circulating water played a large part in sculpturing these passages. What is needed is, of course, an aquifer, and the Sharon Conglomerate functions superbly as one. It is conspicuously jointed along its outcrop (which Lynch surmises is the result of the weight of glacial ice), of a rather porous or open texture (especially in its pebbly phase), and lies above an impermeable shale which also happens to be easily eroded. And where the Sharon is exposed, it is usually the highest rock in this area, covered mainly with glacial drift. The region receives ample rainfall and snow cover, so the source of groundwater is continually guaranteed. The effects of glacial meltwaters can be seen (so states Lynch) in the "box canyons" often found on Sharon Conglomerate uplands; the present writer also cites the base-level gorges of the Cuyahoga and Grand (or Geauga) Rivers as examples of this postglacial erosive force as they reach the level of the Sharon. Some of these "box canyons" will be described later in the discussion of Sand Hill's caves. The point is, though, that something has removed large quantities of sand from the Sharon—running water, perhaps, or stationary or slowly circulating groundwater. Some of the features Lynch mentions or the present writer noted while examining these places could have no other explanation. Lynch points out that the variable lithology of the Sharon Conglomerate at specific sites likely has an effect on cave formation also, as it does in the Black Hand Sandstone of Hocking County. The zones in the Sharon which are highly conglomeratic, although massive, contain very little cementing matrix, hence are easily crumbled, and other zones can be of soft friable sandstone, leading to what is called "differential weathering" on cliff faces, where the rock is exposed to the elements. When such things occur, material from the weaker zones will be removed at a much quicker rate, leaving recessed grottoes, overhanging ledges, or in the caves proper, irregular walls, in these zones. However, when cave passages in sandstone—passages with a "true" ceiling—exhibit the same features, it is evident some other process is at work besides superficial weathering. The discussion of a few of Geauga County's caves which follows is equally applicable to all other northeastern Ohio caves in the Sharon Songlomerate.

On a small outlier of Sharon Songlomerate between Sand Hill and Gildersleeve Mountain is a group of caves known collectively as Card's Caves. The largest and most interesting one is known singly as Card's Cave; it is clearly the result of the settling of large blocks of the conglomerate over a weakened and removed substratum. The present writer, in his unpublished article on northeastern Ohio caves, has given it the following laconic description:

"...From the entrance, a 10-foot shaft near the edge of the low bluff, one descends into a series of narrow passages with a total length of about 150 feet. At several places are holes or roof collapses where one may exit. The cave is well decorated by mosses which grow profusely along the walls or in alcoves. Sunlight coming in through the various entrances illuminates the moss, creating some rare effects of color and shadow. ..."[3]



CARD'S CAVE

Geauga Co., Ohio

Sketched 1954 by
W. Luther, NSS 2438

0 10 20
(approx. ft.)

A glance at the map will show that the Sharon Conglomerate is broken up into rectangular masses, and that a small stream emerges in the main passage, sinks beneath breakdown, then enters a narrow slot, eventually supplying the nearby summer cottages with a constant source of potable water. A pipe laid along the floor to this effect is the reason for the name "Pipe Avenue." The "Green Grotto" is, aside from the formation-filled grotto in Deerlick Cave, the prettiest underground sight in northeastern Ohio, and the formations in this case are mosses and ferns, lit by sunlight.

Little Mountain is a "monadnock"—an erosional remnant of the Sharon Conglomerate Plateau of Geauga County standing at the very edge of the Portage Escarpment, which, at an elevation of about 1,280 feet, commands a spectacular view of the surrounding hills and flat Lake Erie plain. Other similar outliers in the area have produced caves, such as Gildersleeve Mountain in Lake County, where the view is equally fine—making up for the small size of its caves. Little Mountain is unique in that its "caves" had been developed as a tourist attraction when the site, with its cooler climate, clear water, and rare stand of virgin white pine forest (which is still there), served as a summer retreat for the better-situated Clevelanders a century ago. Little Mountain Caverns has been described briefly by Lynch; the present writer visited the place once, during unfavorable high water conditions, that is, heavy rain on top of deep snow, and could not enter the "caverns" proper. Lynch got in and produced a map showing 430 feet of passage, though some of it may be open to the surface. He relates that:

> "... the caves were dammed up, impounding the water to a maximum depth of 3 feet. From a small block building over the entrance visitors were taken on boat rides in the passages. Other than this entrance and two large sinkholes there are two floor-level entrances. The entire area near the caverns is cut with fissures, but none are [sic] as continuous as the caverns. The uppermost 3 feet of the caves did not break away as evenly as the lower walls and the overhang created makes up the ceiling of the caves. No surface streams pour directly into the caverns, but there is water in every passage except [in] the one which joins from the north. In the very back of one passage water can be heard gurgling, probably from a spring ..."[4]

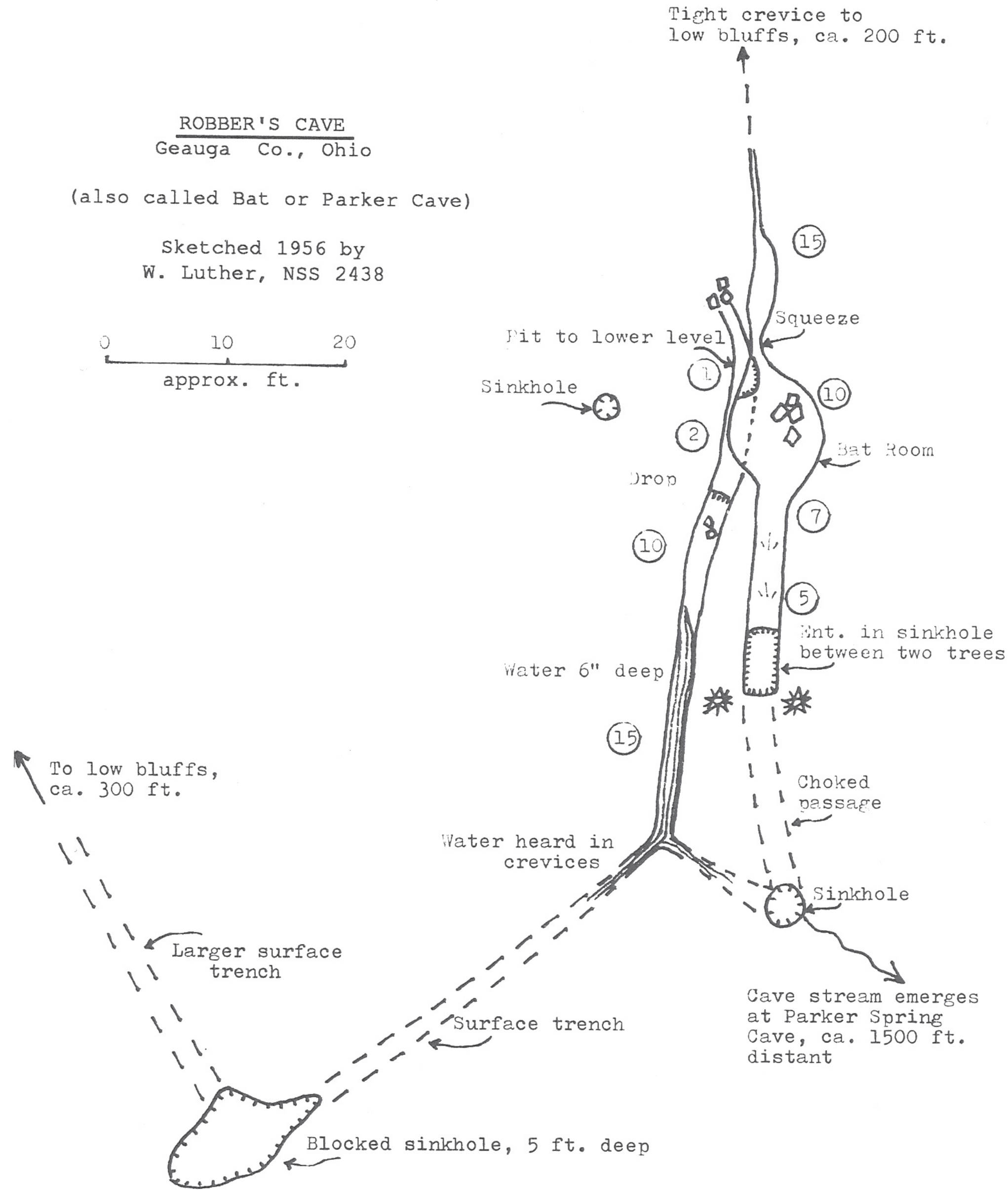
The observation regarding the ceiling is interesting. Several types of ceiling occur in these Sharon Conglomerate caves, and by studying them carefully one might postulate a theory about a certain cave's origin.

Sand Hill itself is a large upland of Sharon Conglomerate with its southern base near the town of Fowler's Mill. It is overlain by some younger strata and considerable glacial drift; two localities on it are worth describing in some detail. Dart's and Merkle's Caves (a collective group name) are found in one of three parallel gorges, or box canyons, cut presumably by glacial meltwater, or at least by a much greater volume of water than now occupies these gorges. The Sharon is here generally without pebbles and appears as a massive sandstone, which no doubt has influenced some of the configurations seen in the gorges, since it is less likely to disintegrate as readily as the poorly-cemented pebbly phase. The three gorges are called (from south to north) Fern Gorge, Twin Falls, and Dart's-Merkle's Caves. Visiting them in that order, as the present writer first did, sets up one surprise after another, culminating in the largest natural bridge or tunnel in northeastern Ohio. Pseudokarst features abound in this area, as they do also at the group of caves a mile to the south (Robber's Cave, which will be described later). Fern Gorge is simply that: a gorge, a scenic prelude of what is to come. Twin Falls is a rather spectacular box canyon in crossbedded sandstone, with a gigantic "pillar" at the back which divides a small creek into two high waterfalls. The present writer noticed something odd about the left-hand falls, since the water came out of a small hole several feet beneath the precipice. Upon investigating, it turned out that a hole, or crack, several yards upstream from the lip of the falls has captured some of the water—a condition essential for the formation of one type of natural bridge, perhaps the same condition to be seen at Merkle's Caves later in this paragraph. The final gorge is Dart's Cave[5] (or caves), another box canyon, but with a better surprise. Stream piracy has progressed much further here, since the stream responsible for the gorge no longer flows down the high-gradient slot at the back of the box canyon, but comes directly out of a nearby cave entrance. A hole in the cave's ceiling has captured the stream just before it is destined to take the surface course, and it plunges to the cave floor about 30 feet below. The cave itself is a large dark room with sheer walls, entered along the stream resurgence up a short rapids in a passage about 15 feet long and 7 feet high. This part of the cave is entirely roofed. Immediately inside and to the left is an upper level shelf which may be reached by a difficult climb, or from the outside, since it leads to an entrance along the former steep bed of the stream. Several high narrow fissures extend from the back of the cave's one large room, on both sides of the waterfall. Aside from a few other holes and fracture caves, this interesting cave constitutes the Dart's Cave portion of the gorge, the upstream remainder being Merkle's Caves. Above Dart's Cave and the abandoned watercourse are the final surprises. The stream has cut a rectangular, though much shallower, gorge, for perhaps a quarter of a mile, following two sets of joint planes in the Sharon Conglomerate. Along this channel are numerous slots and holes, some resembling solution tubes in limestone; they are certainly not "horizontal potholes," as some writers have surmised, and their origin is problematical. They do appear to have been carved by water along joints, as seen in one small cave along the way, which has a short straight main passage and a parallel crevice, all in well-rounded sandstone. The largest cave of the group, which barely attains total darkness, once carried water, since a notch has been cut in the floor at its entrance, now several feet above the floor of the gorge. Porter was quick to notice these features, and reports that "other passages meander, have an oval cross-section, and have potholes developed in their floors. Several small stalagmites were found. The most notable feature of this 'cave' is that its walls crumble off upon being rubbed."[6] It is unclear which cave he means, since the present writer looked into at least four along this stream channel, but does concur with him that "some of the fissures resemble deep-phreatic limestone solutional passages..."[7] In fact, the whole channel looks like an unroofed limestone cave with various short side passages (still covered), until the biggest surprise of all, farther upstream—a true natural tunnel, spanning the channel for about 30 feet. Under this arch the stream flows between walls which are an extension of the gorge at both ends, maintaining undiminished width underground. It is possible that this is a feature carved by a receding waterfall like Rock Bridge in Hocking County (to be described later), except for one important difference: the waterfall supposedly responsible is some distance upstream, at the upper end of the gorge, and if it is responsible, it attests to the speed of postglacial erosion. While Rock Bridge is nothing more than a "bridge" with its parent waterfall adjacent, Merkle's "tunnel" is—and there is no better way to put it—a section of cave passage in sandstone, in the most unlikely place, an anomaly unlike anything else in the region.

South of the series of gorges which make up Dart's-Merkle's Caves, and on the same plateau, is Robber's Cave (also called Bat Cave), unusual in that it is entered through a sinkhole in a flat wooded area a few hundred feet away from a low bluff of Sharon Conglomerate. This "sinkhole" is one of several in the immediate vicinity (see map) which are the result of soil washing into roofless crevices once covered by surface matter. In fact, the whole tract of woodland here resembles the Niagara Escarpment karst of Wisconsin and Ontario, where the bare Silurian Dolomites are exposed at the surface, with very little soil cover, and the rectangular pattern of enlarged joint planes is clearly seen. Robber's Cave is distinctive because it has a true ceiling along its short length. A narrow passage about 20 feet long leads down into a room about 10 feet long and high, formed in friable cross-bedded sandstone. The same joint then narrows, becoming too tight for further progress. The total length of this "upper level" is about 50 feet. Lynch visited this cave, not suspecting a lower level reached through a constricted hole in the floor towards the back of the main room.[8] It appears to be a second fracture, nearly parallel to the upper cave, and it meets the perched water table which is responsible for undermining the whole area. It is the "key," perhaps, to this system of fractures, which includes several springs along the bluffs; dye-tracing from the cave and from other water-filled fissures might be an interesting project for the future. Unfortunately, one cannot "follow the water" in Robber's Cave, because the stream met in the lower level trickles into crevices too narrow to negotiate beyond about 25 feet. On the surface, debris-filled trenches, intercepted by sinkholes when they meet crossing joints, extend in various directions, some reaching the low bluff about 250 feet away. In times of prolonged rainfall or snow-melt water may be heard gurgling at the bottom of these filled crevices. The flow in the cave is apparently away from the nearest points on the bluff, which is why the present writer suspects it may emerge from the Parker Spring over 1,000 feet away, in a different direction.

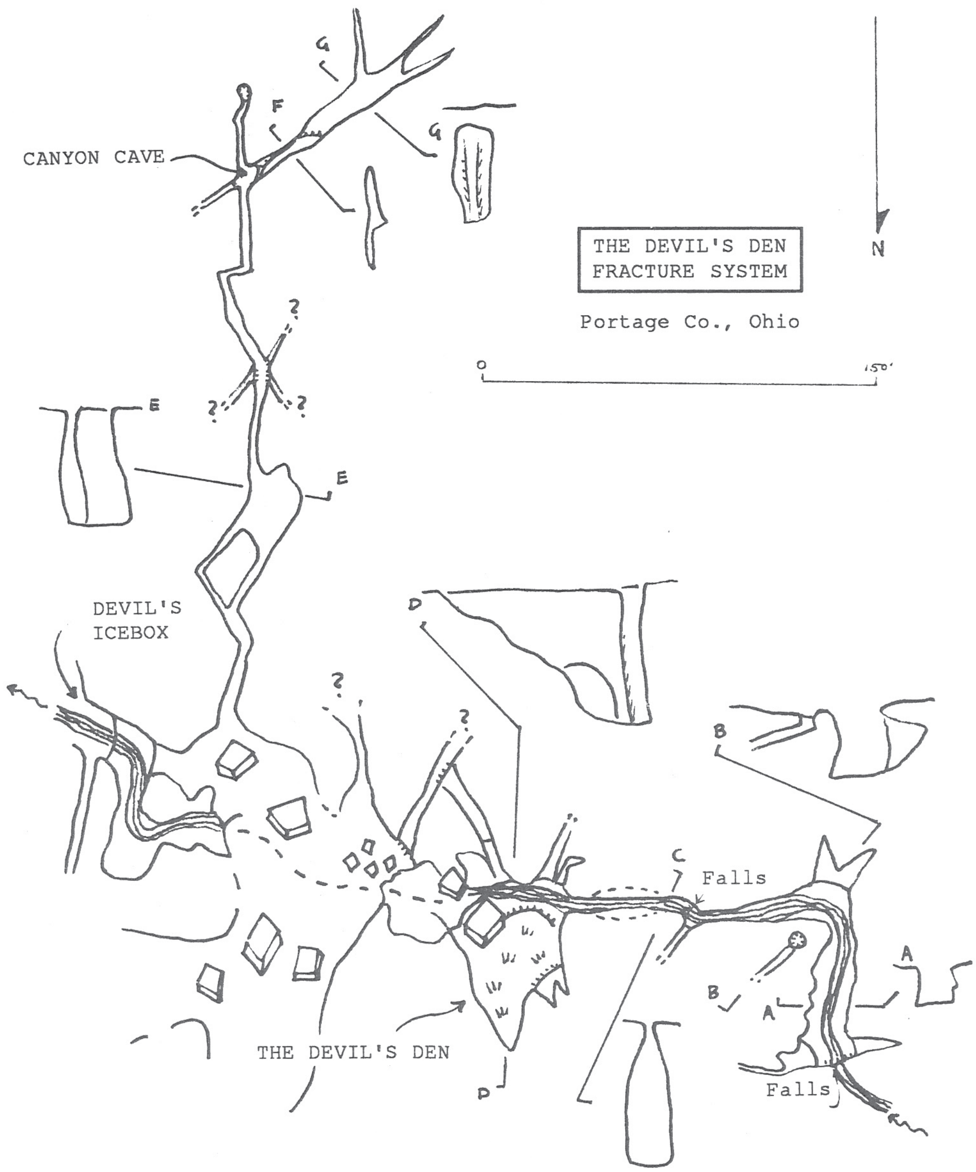
PORTAGE COUNTY:

No other site in Ohio, except for the Seven Caves in Highland County, offers so many interesting caves in such a small area as does Nelson Ledges.



Like its counterpart in the Silurian Dolomites of southern Ohio, most of the caves are accessible by marked trails, but unlike the Seven Caves, are "undeveloped" and unlit. Nelson Ledges are a part of Nelson-Kennedy Ledges State Park, and have received descriptive treatment from VerSteeg, Pettit, and Farnsworth. The present writer, who has made numerous excursions to the park, is convinced he has not even found all its caves yet, since the smaller entrances can be elusive and often ephemeral—that is, they come and go over the years. The low bluff of Sharon Conglomerate extends north and south along Route 282, reaching its greatest height at the park. Trails lead into a confusing "rock city" labyrinth of passages, mostly open to the surface, which runs parallel to the bluff face. It is hardly possible to see it all in a day's visit; even the true caves themselves are deceptive, once found, since inner passages and rooms are entered often only by squeezing or chimneying into seemingly improbable places, and a few caves can be entered only by rope-work or difficult rock-climbs. The notorious "Great Cheddar" Squeeze[9] in the cave of that name is one of those deceptions, and because of it traffic to its interior is so slight that the cave can support a few bats unmolested by the usual amount of daily visitors to the park.

Aside from the maze of partly-open corridors at or near the bluff face, one small creek atop the plateau has been captured by a joint plane to form the Devil's Den Fracture System, perhaps the most spectacular single feature in the park. Here the sapping action of running water is apparent, notably in the tilt of the narrow deep slot the creek occupies just before it enters the Den, and in the jumbled complex of boulders immediately downstream from the Den. The stream leaves the

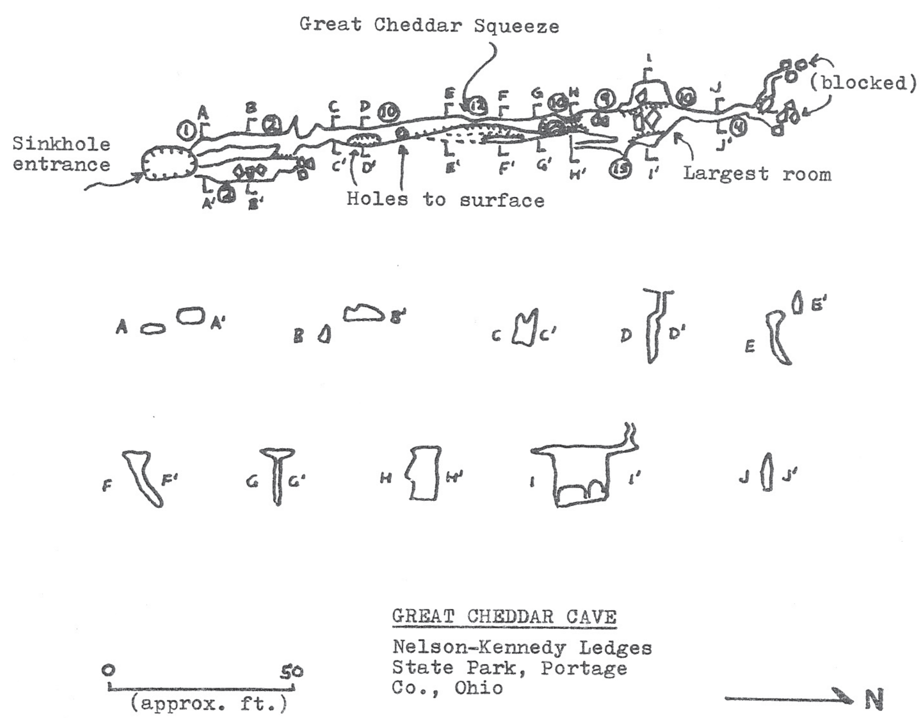


plateau through the Devil's Icebox, a true boulder or talus cave. An open passage leads from the back of its inner room south to Canyon Cave, where chimneying up is necessary to avoid a tight crack at its entrance. The Devil's Den (see map) is the center of this system; it is a triangular pit about 65 feet deep with its apex pointing north; all three sides are vertical, but a steep rubble pile in the apex facilitates descent (though a hand-line is advisable, especially during wet weather). From the bottom one can enter the narrow slot mentioned above and follow the water upstream to a waterfall. The remainder of the upstream section must be entered at the first waterfall, from the surface. At every bend in the passage, and at both waterfalls, are shallow water-cut caves, sometimes on two levels. Downstream from the Den is another cave under the boulders, consisting of one dark room; from here the stream sinks into the rubble to appear in the rear room of the Devil's Icebox. Other cave passages may be seen high on the walls of the various fissures radiating from this complex—caves so far unentered by the author.

A second creek enters the park to the north of this complex but does not sink, reaching the edge of the bluff to plunge over a large cave of the recess type—in which the underlying Meadville Shale was removed by great volumes of falling and swirling water at some time in the past, leaving a roof at the base of the Sharon Conglomerate. This cave, called Gold Hunter's Cave, perhaps does receive some water seeping down from the creek above, because several springs issue from the rear of the cave at the contact of the shale and conglomerate. Soft limonite stalactites and "flowstone" are forming here, along the rear wall. One spring comes out of a low wide bedding-plane crawlway which connects with an "upper level" through a barely negotiable squeeze in fallen rock; this is really a separate cave, and it may be entered better from the side of the bluff to the right of and above Gold Hunter's Cave. This cave is a covered fissure, that is, a true cave; its several rooms are connected by crawls or narrow fissures. Everywhere is evidence of the work of running water and the gradual disintegration of the conglomerate. These two caves have been mapped as a unit. Great Cheddar Cave (see map), about 200 feet north of this, is entered through a shallow sinkhole near the edge of the bluff. It is likely a part of the same fracture or joint system containing the "upper" cave at Gold Hunter's Cave. From its obscure entrance, which may or may not be open at the time of this writing,[10] two parallel crawlways merge in a tight fissure through which the explorer must pass sideways and supine, keeping high in the slot. Soon a real floor develops, the passage widens, and by dropping to the floor the explorer enters a small room about 10 feet high with some standing water in it; beyond that is a much larger room with a large block of conglomerate sitting in the middle. The passage continues and narrows, ending in breakdown about 150 feet from the entrance. Also near Gold Hunter's Cave is the Old Maid's Kitchen, which has a natural tunnel, open at both ends, with a real ceiling—that is, the passageway beneath it has been hollowed out from the rock. In this respect it resembles the famous Rock House in Hocking County, with its joint plane clearly visible in the ceiling along the length of the passage, and in general aspect not unlike trunk passages in limestone caves. Therefore, the cave passage itself has been unaffected by rock movements, in contrast to passages in other caves which are roofed by debris fallen in from above and wedged firmly in the fissures.

The whole area behind the Devil's Den complex of fissures appears to have been undermined. Sunken blocks of conglomerate are bordered by miniscule "fault scarps" set at various angles where one block rests against another. The tendency is, of course, for blocks like these to creep away from the main mass at the edge of the bluff, as can be seen along the entire outcrop; here, back in the woods, they cannot move far laterally, only downward, as their bases are continually eroded by running water. Many opened joints appear at the surface, but most of these are either choked by debris or too narrow to enter. The present writer believes that considerable cave passage lies beneath this part of the plateau, judging from the extent of the crevices, some of which may be peered into but not entered. One sinkhole cave in the middle of all this seems to lead into the system, but the present writer, who can get through an 8-inch crawlway, could not fit into a very tight crevice to gain access to its lower levels.

Various theories have been put forth regarding the origin of Nelson Ledges and places like it, including direct deposition of the boulders by glaciers, and by earthquakes. No doubt each is possible, in a small way, but closer inspection of this confusion of jumbled boulders reveals something more deliberate and orderly, a process or processes still at work. Responsible for it are water action on the top of impermeable stratum (the Meadville Shale) at the base of the Sharon Conglomerate, surface water captured by fissures and joints, disintegration (both chemical and mechanical) of rock surfaces in weaker zones or



GREAT CHEDDAR CAVE

Nelson-Kennedy Ledges
State Park, Portage
Co., Ohio

Sketched 1956 by
W. Luther, NSS 2438
D. Peters, NSS 2135

on favorably exposed places, ice wedging, the growth of tree roots, collapse, and of course enormous human traffic. The three authors cited above have advanced their own theories, which all contain some of the above causes. VerSteeg notes that the slumped area described above is undermined; Farnsworth notes the role of water (among other agents) in "attacking" the widened joints; and Pettit, who made repeated visits to study and to map the intricate series of passages, suggests that ice and frost, along with solution, might be responsible for the removal of material from certain weaker zones in the rock, especially in the limonitic concretions known as "bee rock" or "box work" elsewhere. It is clear to the reader already that no one theory can alone explain the great diversity of features associated with these sandstones. It will be clear also that in some cases there is no evidence of movement, so tectonics must be ruled out. This is now in the domain of "pseudokarst," or karst-like features in supposedly dissoluble rocks. But if karst is the surface expression of groundwater action, this is indeed karst; perhaps the author's neologism "allokarst" might better describe it—that is, karst of a different kind. Movement may be seen as the reason for the settling of sections of the plateau, but the distinctive features within the caves, even the cause of the settling, might prove to be entirely the work of water running both horizontally and vertically. The latter might explain the rounded contours of cave walls, especially where there is no longer any evidence that the walls had separated to form the cave. One is forced to conclude, in the absence of more compelling data, that trickling surface water caused the rounded contours, which is analogous to karst in limestone. Such observations could lead to a general theory which would incorporate all the different cave types and take into consideration the enormous effects of several continental glaciations. Even the age of the present Nelson Ledges is problematical, since parts of it (that is, detached boulders) lay buried or partly covered by thick till and alluvium on the un-rejuvenated broad valley to the east, which was once probably 300 feet deep—like the present-day Cuyahoga River Valley.

From this rather elaborate discussion of some of the many known caves in northeastern Ohio, the reader will be shown some isolated caves and shelters farther south, where different strata are exposed and somewhat different conditions prevail, and with caves of other types needing other explanations regarding their origin.

[TO BE CONTINUED]

ENDNOTES

1) This little cave was the first cave ever seen by the present writer, who spent his school years in its environs. It led, among other things, to his continual interest in the Ohio Cave Survey from its beginning in 1953.

2) Bierce, L.V., 1854. Historical reminiscences of Summit County. Akron: T. and H.G. Canfield, p. 66-67. (Quoted also in: Perrin, W.H., ed., 1881. History of Summit County, with an outline of Ohio. Chicago: Baskin and Battey.)

3) Luther (1973), p. 5.

4) Lynch (1974), p. 56.

5) Dart's Cave is mentioned by Lynch (1974), p. 56; also by Porter, C.O., 1965, "Sandstone 'caves' of northeastern Ohio," The NEOG Log, 1 (5), p. 52; and by Madigan, T. J. and B. L. O'Sickey, 1982, "Chesterland Caves area report," Pholeos, 3 (1), p. 3-4. In the latter article, Dart's Cave is described and mapped under a mistaken name, since the authors assumed they were visiting the Chesterland Caves, which are several miles to the east of the caves on Sand Hill.

6) Porter, op. cit., p. 52.

7) Idem.

8) Not one of the several independently-made maps in the Survey files shows this lower passage except the present writer's, which was made in 1956, before the others were made. Perhaps it is no longer accessible.

9) Similar to the Gun Barrel in Knox Cave, N.Y., or the Bardangi Hole in Sullivan's Cave, Ind.

10) The present writer found it filled with soil during his last visit, in 1983.

ANNOTATED BIBLIOGRAPHY [FOR THE FIRST INSTALLMENT]

(Note: this bibliography contains mainly works of a general interest on the region's geology, and a few works describe related noncarbonate cave processes in other areas. An occasional reference to a cave in a single work is cited in full in the endnotes, and will not be repeated here.)

Alexander, E. C., Jr., 1980. An introduction to caves of Minnesota, Iowa, and Wisconsin. Nat. Spel. Soc. Conv. Guidebook 21. (Caves in the Ordovician St. Peter Sandstone are described, and a process known as "piping" is proposed to explain their origin. In sandstones with little or no cementing matrix, or from which the matrix has been removed by solution, groundwater under pressure can carve winding tube-like passages. This theory might be applicable to the horizontal tubes seen along gorge walls in northeastern Ohio and elsewhere in the state.)

Banks, P. O., and R. M. Feldmann, eds., 1977. Guide to the geology of northeastern Ohio. N. Ohio Geol. Soc. (This symposium includes several papers of interest to the present study: Szmuc, E. J., "The Mississippian system; " Rau, J. L., "Pennsylvanian system of northeastern Ohio;" Heimlich, R. A., J. V. Mrakovich, and G. W. Frank, "The Sharon Conglomerate; " and Miller, B. P., "The Quaternary period.")

Cushing, H. P., F. Leverett, and F. R. Van Horn, 1931. Geology and mineral resources of the Cleveland district, Ohio. U.S. Geol. Surv. Bull. 818. (No cave data, but a thorough general geology.)

Farnsworth, C., 1957. Geology of Nelson and Kennedy Ledges. O. Cons. Bull., 21 (10). (A sketchy introduction; see Pettit [1954] and VerSteeg [1932] for more reliable information.)

Geyer, A. R., and W. H. Bolles, 1979. Outstanding scenic geological features of Pennsylvania. Pa. Geol. Surv. Env. Geol. Rep. 7. (The Sharon Conglomerate, named for the city on the Ohio-Pennsylvania boundary, extends across northwestern Pennsylvania and into New York, producing along the way a number of interesting "rock cities" similar to those in Ohio, but larger. Some of the accessible ones are discussed briefly, as well as other ones in non-carbonate strata other than the Sharon Conglomerate.)

Hansen, M. C., 1988. Natural bridges in Ohio. O. Geol, Sum. 1988. (An interesting survey of bridges in both limestone and sandstone, several of which are given detailed treatment. A photograph of one in the Sharon Conglomerate in Geauga County—not mentioned in the present paper—is on p. 1.)

Harris, S. E., et al., 1976. Exploring the land and rocks of southern Illinois. Carbondale: S. Ill. Univ. Press. (The basal Pennsylvanian Sandstones and Conglomerates have also produced some "rock cities," natural bridges, and assorted caves in southern Illinois. The effects of glaciation are stressed as well as differential weathering along weaker zones in the rock. Well illustrated.)

Luther, W. P., 1973. The caves of northeastern Ohio. unpub. MS. (A brief general geology is followed by short descriptions of every cave or group of caves known to the Ohio Cave Survey at that time, though it is now obsolete considering how many additional caves have come to the author's attention.)

Lynch, L., 1974. The formation of caves in the Sharon Conglomerate in Geauga County, Ohio. Cleve-O-Grotto News, 20 (6). (The role of running water, and the possible role of standing and melting glacial ice, are discussed in relation to the formation of caves; included are brief descriptions and sketchy maps of each of the ten sites examined.)

Pettit, L. 1954. Nelson Ledges; a visitor's guide. Hiram College. (An excellent, somewhat speculative, pamphlet based on numerous visits and careful observation. A partial map of the various open passages and trails is included, as well as a redrawn road map taken from the old Garrettsville 15-min. quadrangle, annotated for places of geological interest.)

Pettit, L. 1958. The effects of weathering and other changes at Nelson Ledges State Park. O. J. Sci., 58 (3). (Various kinds of weathering are discussed; several old photographs of the Sharon Conglomerate in place had been examined pebble by pebble for any evidence of change since they were taken. Except for one fallen slab shown in one piece in an old photo, and now split, the only substantial changes in the park have been due to human erosion.)

Prosser, C. S., 1912. The Devonian and Mississippian formations of northeastern Ohio. O. Geol. Surv., 4th Ser., Bull. 15. (A general, detailed regional geology. A few cave sites in the Sharon Conglomerate in Geauga County are described incidentally, including Little Mountain Caverns.)

Stout, W. E., 1944. Sandstones and conglomerates in Ohio. O. J. Sci., 44 (2). (Brief lithologies and distribution of the important sandstones of eastern Ohio.)

VerSteeg, K., 1932. Nelson Ledges State Park. O. J. Sci., 32 (3). (A useful though short discussion of various processes, including the cause and role of jointing, and the action of running surface water and ground water.)

White, W. B., 1976. Caves of western Pennsylvania. Pa. Geol. Surv., 4th Ser., Gen. Geol. Rep. 67. (Although the majority of caves described are in limestone, some interesting ones in Pennsylvanian Sandstones are included, most of which seem to be simple fractures, but large and deep. Also interesting is his discussion of cave formation in the Loyalhanna Siliceous Limestone [or calcareous sandstone]—perhaps somewhat applicable to certain Ohio sandstones with locally higher than usual amounts of soluble matrix.)

Williams, A. B., 1940. Geology of the Cleveland region. Cleve. Mus. Nat. Hist., Geol. Ser. 1, Pocket Nat. Hist. 9. (A speculative and thoughtful brief introduction, with mention of several Sharon Conglomerate cave sites—Whipp's Ledges, Gildersleeve Mountain, and Little Mountain.)

SUGGESTIONS FOR BUILDING BAT HOUSES AND ATTRACTING BATS

from Cog Squeaks

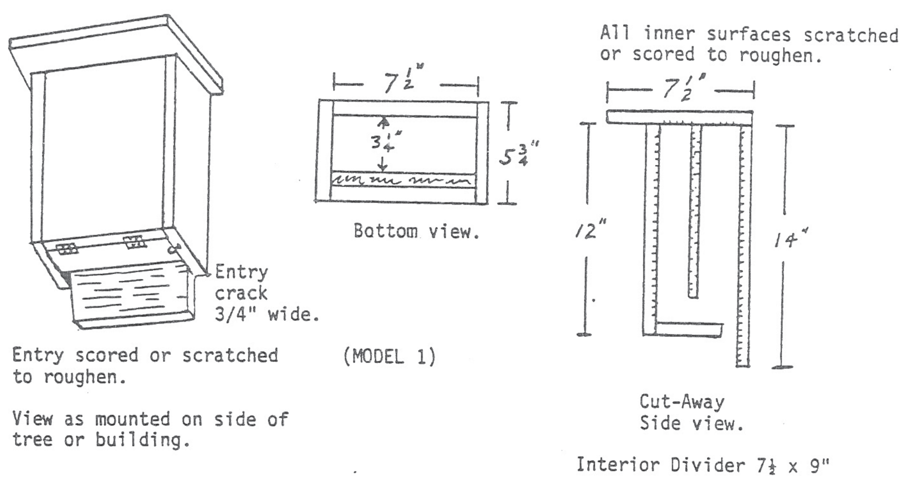
Bat houses of the designs illustrated for models 1 and 2 have been used successfully for a variety of bat species in Europe. Their exact size and shape probably are not important except for the width of the entry space. This should not exceed one inch, with the ideal width being only 3/4 of an inch. Regardless of the kind of house built, all inner surfaces must be rough enough to permit the bats to climb on them with ease, and rough outer surfaces are preferred.

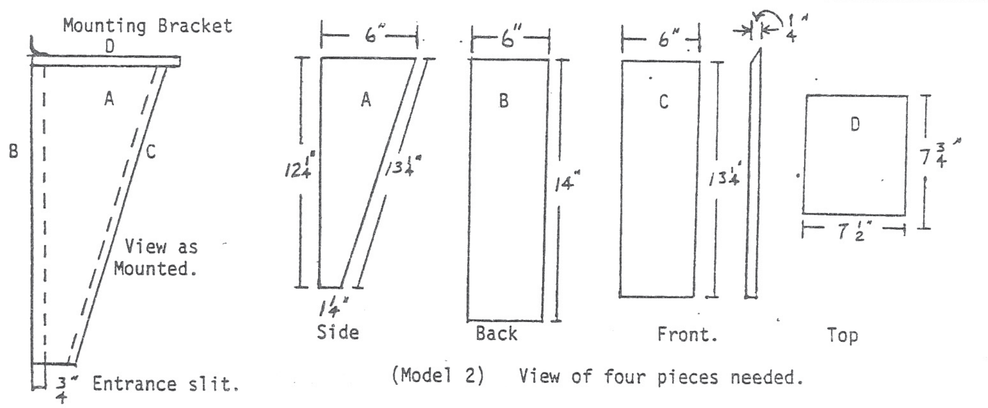
Young bats grow best where daytime temperatures are in the 80-90 degrees F. range. For this reason maternity colonies are most likely to use bat houses that either provide temperatures in this range or that are so well insulated that body warmth is easily trapped. Europeans often cover their bat houses on top and for an inch or two down the sides with two or more pieces of tar paper. The dark covering absorbs heat from the sun by day and provides added insulation by night, in addition to protecting the bats from rain.

Several means of insulating or providing a range of temperatures in bat houses are available but as yet largely untested. One involves covering bat houses with styrofoam on top and on all four sides. An additional covering of dark colored shingles or tar paper might prove helpful, especially in northern areas where the bats may need higher temperatures. Also making bat house model 1 two feet tall, with only the upper six inches and top covered with dark material might provide a better range of temperature. By moving up and down and from front to back, bats could find roost temperatures more continuously to their liking. Paint or varnish reportedly is somewhat repellent to bats, at least until well cured.

Bat houses should be fastened securely to a tree trunk or the side of a building roughly 12-15 feet above ground, preferably where they will receive morning sun but will be shaded during the afternoon. Inside temperatures above 90 degrees F. generally are intolerable. For this reason, a well insulated bat house that receives only morning sun should prove most suitable. Male bats do not live with the females while young are being reared, and these bachelor colonies may be attracted to sheltered, cooler locations. Additionally, most bats seem to prefer sites that are relatively protected from wind.

It is important to note that bats can live only where local food supplies are adequate. For this reason most colonial bats are found near places such as rivers, lakes, bogs, or marshes where insect populations are high. The closer bat houses are to such places the greater the probability of being used. Those located more than a half mile from these habitats have greatly reduced probability of being occupied unless alternate food sources are available.





Bat House Plans courtesy of Bat Conservation International c/o the Milwaukee Public Museum, Milwaukee, Wisconsin 53233 USA

Sometimes bats occupy a bat house within a few weeks. Often, however, bats require a year or two to find the new house. Chances of early occupancy probably are increased if houses are hung before or by early April and also if bats already live in barns or attics in adjacent areas.

Since use of bat houses is very new in the United States, we have much to learn about local bat preferences. Your reporting of successes and failures in building houses for bats could contribute measurably to our knowledge of how to attract bats. Write to Bat Conservation International, c/o Milwaukee Public Museum, Milwaukee, WI 53233.

Green Trail Chasm
Carter Co., KY
Carter Caves Park

VESPERTILIONIDAE: AN INTRODUCTION TO THE BAT SPECIES OF OHIO

by Teressa Keenan

Bats may be one of the most misunderstood animals in Ohio (and perhaps the entire world). They have acquired a bad public image because of misconceptions and superstitions. Many people believe that bats are blind or that they enjoy getting tangled in women's hair. On the contrary, bats can see very well, especially at night, and they have no interest in getting in one's hair (Harvey 1986). Since a bat can detect an insect less than 1/3 of an inch long from more than six feet away, he's not likely to accidentally fly into one's hair. Also, bats are not flying mice, as some seem to think. In fact, they are not even remotely related to mice. Bats are part of a completely distinct mammalian order—Chiroptera —which is derived from the Greek word for "hand-wing" (Gottschang 1981). Bats are no dirtier than any other mammal, nor do they carry more parasites. In fact, bats are beneficial and intelligent organisms that play an important role in the environment. The intent of this paper is to provide the reader with a general understanding of bats and an introduction to those species found in Ohio.

Bats are mammals; they have hair, mammary glands, and give birth to live young just as humans do. Their sizes vary from less than 1/10 oz. to over 2 lbs. Those found in the U.S. are typically small, with a wingspan averaging between 15 and 46 cm. Worldwide, bats have a broad variety of diets from fruit and nectar to insects and blood. All of the species in the United States are insectivorous except for three that feed on nectar.

Bats are more important to the world than most people realize. Not only do they provide a major source of food for the cave ecosystem, but they also have many commercial and scientific values. For example, your grocery store would not be the same without the aid of bats; many valuable wild fruits, nuts, and spices are dependent on fruit- and nectar-eating bats for seed dispersal and pollination. Bananas, peaches, dates, figs, cashews, and cloves are just a few of these bat-dependent plants. Other items that rely on bats include plant fibers for surgical bandages, life preservers, rope, and timber for furniture. In fact, bat-dependent timber sales have provided West Africa with annual revenues up to 100 million dollars (Anonymous no date). Bats are the only major predator of night flying insects, and their guano is often used as a fertilizer—yet another way in which bats help farmers. Studying bats has contributed to the development of navigational aids for the blind, vaccine development, artificial insemination, and speech pathology (Anonymous no date).

Bats live in caves, cliff faces, trees, and other vegetation as well as man-made buildings. Bats are the only mammals that have adapted to achieve true flight; the bones of their forelimbs are elongated and tubular in shape. A thin double layer of skin (the flight membrane) is supported by the fingers and joins the hind legs, extending between them to enclose all or most of the tail. The only forelimb digit that possesses a claw is the thumb; this claw is often used while climbing. Because the primary means of locomotion is flight, bats have lost the ability to "walk"; however some species can move quite well by hopping or by pulling themselves along the ground with their wings.

Bats have the unique ability of echolocation. This is similar to our use of sonar; they emit pulses of high frequency sound (15,000 -100,000 cycles per second) and then listen for the echoes to be reflected back. The rate of their sound pulses varies from just a few to over 500 pulses per second. Their echolocation technique is so precise that they are able to avoid obstacles no wider than a thread (Harvey 1986).

Females generally give birth to one offspring per year. The ovaries of the females are quiescent during fall and winter and the sperm that is introduced into the reproductive tract in the fall remain active and alive until the next spring when actual fertilization takes place (Gottschang 1981).

Bats are primarily nocturnal and/or crepuscular. Also unique to bats is their feeding behavior. Unlike birds which catch insects in their beaks, bats scoop them into their tail or wing membrane and then reach down and pick the insect up with their mouths. This probably accounts for much of the erratic-looking flight that people see (Harvey 1986). Bats are also seen flying just above the surface of a pond or lake; although a few species catch fishes for food, most are actually drinking the water as they skim across the surface (Rausce 1946).

As most people know, bats rest and sleep in a peculiar upside down position; this is mostly due to the fact that the small bones can not support the bat's entire body weight in an upright position (Tipton 1980). While sleeping, the bat's metabolism is reduced 70 to 80 percent; that is quite different from man, whose metabolic rate merely drops 10 percent. During the winter months when there is a lack of available food, some bats hibernate. At this time their metabolic rate is reduced to a point where the bats seem to be in a state of suspended animation. In the spring they leave the hibernaculum and fly to summer roosting locations, where females give birth to their young.

An interesting and poorly understood behavior of bats is swarming. The term was first introduced by Wayne Davis in 1964 to describe the night flights into, out of, and around certain caves during late summer and early fall (Tipton 1982). It has been suggested that swarming activities help bats locate hibernating sites (Davis and Hitchcock 1965) and/or reunites the sexes for mating. Fenton (1969) suggested the latter because males and females roost separately during the summer and mating was observed during swarming activity.

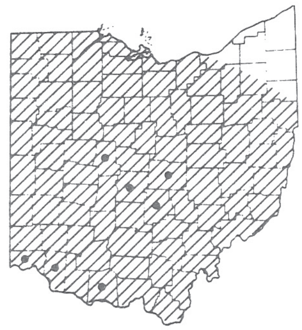
There are 17 families and over 1000 species of bats worldwide. Only 40 species are native to the U.S., 12 of which are found in Ohio. All 12 of these bats are vespertilionids; this family has a worldwide distribution with the exception of a few oceanic islands. Two of the bat species common to Ohio are included on the Federal Endangered Species List (*M. sodalis* and *M. grisescens*) and two others are considered to be rare (*Myotis leibii* and *Plecotus rafinesquii*) (Case 1985).

There have been no large roosting colonies found in Ohio. However, bats are common here (see fig 2 for species distribution). These bats are often arbitrarily divided into two groups: non-migratory and migratory. Most all of the smaller species are non-migratory, preferring to remain in the state all year. The migratory bats, on the other hand, stay in Ohio during the warmer months and then move south as colder weather approaches and their food source diminishes. The exact location of most of these bats' wintering grounds remains uncertain. There have been banding studies that have shown migration from Ohio to specific locations in northeastern and central Kentucky. Individuals from large colonies of *M. sodalis* in Bat Cave, Carter Caves State Park, and Mammoth Cave have been recaptured throughout the southern and western parts of Ohio (Barbour and Davis 1969). The majority of *M. lucifigus* that reside in southern Ohio during the summer have also been found to migrate to the many caves in Carter Caves State Park. The winter location of Little Brown Bats in northern Ohio is still unknown (Barbour and Davis 1969).

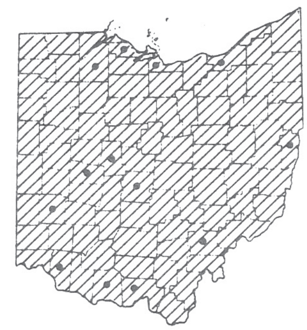
Ohio is not known for having lots of caves suitable for hibernation and nursery colonies of bats, thus many species have adapted by primarily roosting in man-made buildings. This has increased the possibilities of confrontations between men and bats which often leads to a greater concern for problems such as rabies.

Because bats are often encountered by people and the rabies virus is carried by some bats, they should not be handled without gloves. Any bat found lying on the ground should not be picked up or touched; these may be sick or injured and are more likely to bite. Although rabies is a serious disease, we need to keep our fear of it in perspective. I think that a quote from Dr. Robert Martin (1975) says it all: "Although rabies is found in bats, my calculations indicate that your chances of being killed by being run over by a blue-painted Mack pulp truck driven by a pipe-smoking 65-year old woman who owns six beagles are greater than your chances of dying from rabies contracted a bat. "Identification of different bat species can be very difficult for most people. The following general description and taxonomic key (modified from Gottschang 1981,

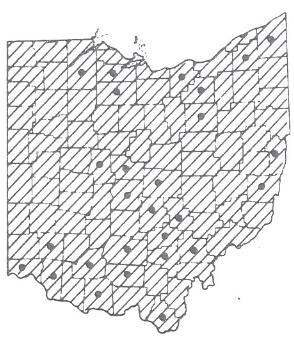
Plecotus rafinesquii Lesson



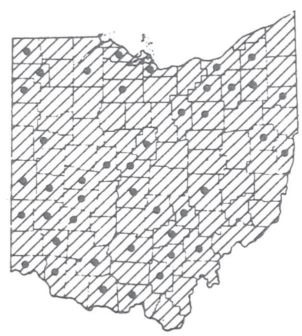
Nycticeius humeralis (Rafinesque)



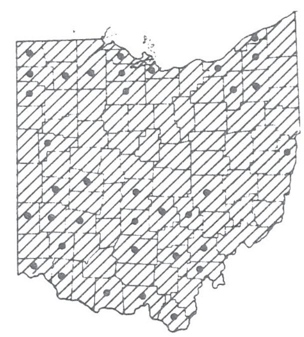
Lasionycteris noctivagans (LeConte)



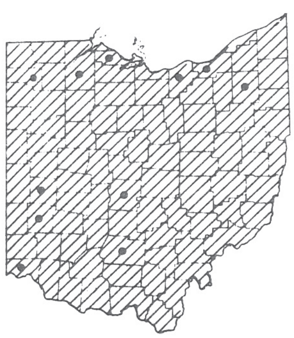
Pipistrellus subflavus (F. Cuvier)



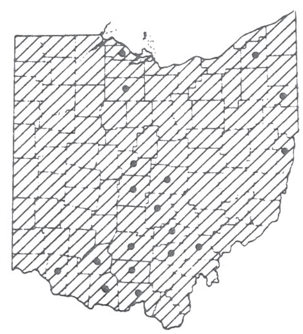
Eptesicus fuscus (Palisot de Beauvois)



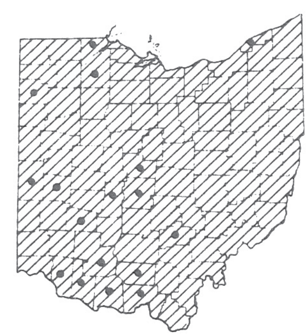
Lasiurus borealis Müller)



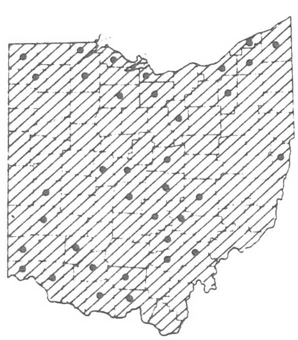
Lasiurus cinereus Beauvois



Myotis keenii Merriam



Myotis sodalis Miller and Allen



Myotis lucifugus LeConte

Myotis leibii (Audubon and Bachman)

Figure 2 Distribution data for specific bat species (Gottschang 1981)

Known range in Ohio

Actual capture or sighting

Barbour and Davis 1967) to Ohio bats may be a helpful aid in identification of local bat species.

A Description of Ohio Bats (refer to Figure 1 and Illustrations)

Plecotus rafinesquii Lesson

Common name: Rafinesquii's Big-Eared Bat, Eastern Big-Eared Bat.
Description: A medium sized grayish brown bat with two large lumps on the nose, long toe hairs, and whitish ventral fur. Ears are usually more than an inch in length.
Distribution: This species may not be a regular member of the mammalian fauna of Ohio, but it has been occasionally found in southern Ohio.
Habitat: Caves and buildings.
Habits: The word plecotus means "twisted ear" and was derived from the bat's habit of resting with its ears curled close to its face.
Hibernation: These bats are almost always found just beyond the twilight zone. They awaken frequently and often move around during the winter.
Reproduction: Breeding occurs in the fall and winter and the offspring are born in late May to early June.
Care of Young: The young remain clinging to their mother even while she forages for food. When they become too heavy, she then leaves them hanging alone in the roost.

Lasionycteris noctivagans (LeConte)

Common name: Silver-Haired Bat.
Description: The long, silky fur is dark brown or black. Almost every hair has a prominent silver-white tip and the tail membrane is heavily furred on the upper surface of the basal half. The ears are naked, short, and rounded and the tragus is also short and rounded.
Distribution: Most commonly found in the northeastern part of the state.
Habitat: Woodland areas.
Habits: These bats are solitary, hunting and roosting alone. They are thought to migrate south for the winter, but a few have been found hibernating in buildings and trees as far north as New York.
Reproduction: These bats usually give birth to two young in late June or July.

Lasiurus borealis (Muller)

Common name: Red Bat
Description: These bats have soft and fluffy body fur. Males are always bright red, rusty, or yellow-ish brown; females are usually blond or yellowish red. Both sexes have a conspicuous patch of white fur on each shoulder just in front of the wing. Ears are short, broad, and rounded. The tragus is short, rounded, and curved slightly foward.
Distribution: Found throughout the entire state.
Habitat: Trees, bushes, or clusters of weeds.
Habits: These are solitary animals. Some remain in Ohio all year but most migrate south in the winter. Litter sizes range from 1 to 4 offspring.
Food and Feeding: This bat commonly feeds beneath street lights, catching flies, beetles, crickets, moths, cicadas, and other insects. The presence of crickets in their diet suggests that they occasionally take food from the ground.
Reproduction: Red Bats usually breed in August and September. Fertilization then occurs in the spring with a gestation period around 80 - 90 days. Copulation is often initiated in flight.

Lasiurus cinereus Beauvois

Common name: Hoary Bat
Description: This is the largest bat in Ohio. It has a heavily furred interfemoral membrane. Ears are short and rounded; the tragus is short and blunt and the calcar is keeled. General color is a heavily frosted dark brown or gray. A small cream colored spot of fur on the forearm just behind the thumb and another immediately in front of the elbow distinguish this bat from other Ohio species.
Distribution: This bat has been recorded in less than 12 counties but probably has a statewide distribution.
Habitat: Forested areas.
Habits: These bats are considered solitary and migratory. Their flight is swift and more direct than most smaller bats. They emerge late in the evening and except for *E. fuscus*, this is the only vespertilionid to chatter audibly during flight.
Reproduction: Litter size is generally two.
Care of Young: They cling to the mother during the day and are left in the roost while she forages.

Eptesicus fucus (Palisot de Beauvois)

Common name: Big Brown Bat, Barn Bat, House Bat.
Description: A large bat with long silky hair that

is chocolate brown in color. The calcar is keeled. Wing membranes and ears are dark or black. The nose is broad and ears are short and broad with a straight tragus directed forward. The tragus is also wider in the middle than it is at either end.
Distribution: One of the most common species in Ohio. Found all over the state.
Habitat: Buildings and caves.
Habits: Likes to rest in cooler places than *M. lucifigus* and is not tolerable of high temperatures. If the temperature becomes greater than 33 - 35 deg. c they will move or abandon the roost.
Food and Feeding: *E. fuscus* emerge at dusk; they have nearly straight steady flight between 20 and 30 feet above the ground. Individuals generally use the same feeding ground every night. They search for food in cleared meadows, and among scattered trees in pastures. Most of the insects caught by Big Brown Bats include beetles, wasps and bees, flying ants, and various flies.
Hibernation: They become extremely fat during the late summer. They retreat to caves, mines, storm sewers, etc. but choose a site close to the entrance. A low temperature and a relative humidity below 100 % is desired. Big Brown Bats will hibernate either singly or in small groups and will never become beaded with moisture like Pipistrelles.
Reproduction: Spermatogenesis occurs in the summer. The females ovulate around the first week of April and then give birth in early June. Maternity colonies (consisting almost exclusively of females) are formed approximately two to three weeks before the young are born and they consist of anywhere between 20 - 300 individuals.
Care of the Young: During the day the young cling tightly to the mother, but are left behind when the mother goes out to forage for food. Upon their return the mother crawls about apparently searching for her own young. When she has found them she licks them around the face and lips before allowing them to nurse. Occasionally mothers have been known to rescue babies that have fallen from the roost to the floor.
Predators: Most commonly rat snakes and hawks.

Nycticeus humeralis (Rafinesque)

Common name: Evening Bat
Description: This bat closely resembles the larger big brown bat and the slightly smaller little brown bat. Fur is dull brown but shorter and less dense. The tail extends well beyond the interfemoral membrane. Ears are short, thick, and rounded. The tragus is short and rounded (barely 1/4 as long as the ear) and the calcar may or may not be keeled.
Distribution: Believed to be a summer resident only; found in central and southwestern Ohio.
Habitat: Trees and buildings in the summer. Their winter habitat is unknown.
Habits: They are thought to be colonial and migratory. They emerge early in the evening and generally fly a slow steady course.
Reproduction: Females form nursery colonies; sometimes consisting of 100's of individuals. Litter size is two.

Pipistrellus subflavus (F. Cuvier)

Common name: Eastern Pipistrille, Pipistrille, Pip, Pygmy Bat.
Description: A small bat with distinctly tricolored fur. Grey at the base, then banded with yellow-ish brown followed by a dark tip. The ear is longer than it is wide, and the tragus is straight and slightly less than half the total ear length. Pale reddish forearms contrast with dark wing membrane. This is the smallest bat in Ohio.
Distribution: Has statewide distribution but has been reported more often from the eastern part of the state.
Habitat: Caves, trees.
Habits: Hibernate singly or in pairs, never numerous in any single location. Not common to see body covered with water droplets. They emerge early and are weak erratic fliers. These bats are often mistaken for large moths.
Food and Feeding: Little is known but they have been seen eating moths.
Reproduction: Litter size is often two.

Myotis sodalis Miller and Allen

Common name: Indiana Bat, Pink Bat
Description: Dorsal hair is brownish and may have chestnut or pinkish cast, and the calcar is keeled. This bat may easily be confused with other species of Myotis. A pale colored nose, usually pink to pale brown and short inconspicuous foot hairs distinguish *M. sodalis* from similar species.
Distribution: Scattered throughout the western part of the state.
Habitat: Caves in the winter, under bark and hollow trees in summer.
Habits: Extremely colonial; may form clusters of 500 to 1000 bats. No large colonies have been found in Ohio. Individuals tend to return to the same caves year after year.
Hibernation: They form large clusters usually in the same spots of the cave as the year before. They prefer a temperature range of

37-43 deg. F and an average relative humidity of 87%.

Reproduction: *M. sodalis* breed early in October and then give birth to a single young late in June.

Myotis leibii (Audubon and Bachman)

Common name: Small-Footed Myotis, Least Brown Bat, Masked Bat.

Description: A small brownish bat with dark wing and tail membranes, black ears and a distinct black mask on its face. The body fur tends to be light tan or golden brown. The calcar is keeled.

Distribution: The only occurrence of this bat in Ohio was reported in 1842 along the northern border of the state.

Habitat: Caves in the winter, summer habitat is poorly understood.

Habits: The Masked Bat's slow flight and small size make it easy to identify in flight. It is one of the most hearty species of bat in North America; it is among the last to move into hibernacula for the winter and is usually found in drafty open mines and caves, often hanging near the entrance where temperatures fall below freezing.

Reproduction: Little is known about their reproductive behavior. However, some nursery colonies containing 12-20 individuals have been found in a few buildings.

Myotis lucifugus LeConte

Common name: Little Brown Bat

Description: Dorsal fur is bicolored (dark at the base) glossy brown; ventral fur is lighter in color. Hairs extend beyond the tips of the claws. This species can be distinguished from *M. keenii* by its shorter ears, from *M. sodalis* by the long toe hairs and its lack of a keeled calcar, from *M. leibii* by its larger foot and larger size, and from M. *grisescens* by its smaller size.

Distribution: This bat is found throughout the entire state and is probably the most common of all the bats of the genus *Myotis*.

Habitat: Caves and mines in the winter; buildings, and hollow trees during the summer. Nurseries are seldom located in caves and are usually near a source of water.

Food and Feeding: Little brown bats begin to emerge at late dusk after which they begin repeating the same flight pattern while searching for food. Their diet apparently consists of a wide variety of insects. Individuals usually feed a few feet above the surface of a body of water; however, if there is no water nearby, they will feed among trees and over lawns or in streets near the roost. In such cases they generally remain about 10 - 20 feet above the ground.

Hibernation: They are colonial, hibernating in caves which are usually totally dark with high humidity. They form clusters of 5 - 50 individuals. However, some have been known to hibernate singly, as well as forming a linear arrangement along cave walls. *M. lucifigus* does not form as tightly packed clusters as does *M. sodalis*. Individuals have a tendency to return to the same roost year after year. Often droplets of water become condensed on the bat's fur.

Reproduction: Breeding takes place in the fall while fertilization does not occur until the spring. There is a 50 - 60 day gestation period before the young are born. *M. lucifigus* forms maternity colonies which range in size from a few individuals to over 1000. A single young is produced each year. During birth the female hangs head upward (opposite of normal resting position) and uses the tail and interfemoral membranes to form a cup to catch the emerging baby. The young emerge feet first and actively participate in their own delivery by grasping and pulling with their feet and legs. The whole process takes about 15 - 30 minutes to complete.

Growth and Development: While resting, the mother keeps the young beneath her wing. After the baby is about half grown it begins to hang next to its mother. The young are born blind and only weigh between one and two grams, but they are soon capable of flying in about three weeks.

Predators: Consist of house cats, mink, racoons, hawks and rat snakes.

Myotis grisescens (Howell)

Common name: Grey Bat, Cave Bat

Description: This is a large big footed bat, and the calcar is not keeled. They have dull greyish-brown dorsal fur that is not bicolored and can be distinguished from other species by its unicolored fur and its unique attachment of wing membrane at the upper part of the ankle rather than at the lower base of the toe.

Distribution: Most common in the southern part of the state along the border of Ohio and Kentucky.

Habitat: Caves both during summer and winter.

Habits: They are extremely colonial. Females form large maternity colonies. During hibernation they form dense clusters which are sometimes layered.

Hibernation: They tend to hold their forearms out at right angles rather than parallel like most other species. They prefer temperatures between 45 and 50 deg. F.

Reproduction: Mating occurs in late fall.

ing usually takes place in June. Like most species, the grey bat only has one off-spring per year.

***Myotis keenii* Merriam**

Common name: Keen's Bat, Keenii, Acadian Bat
Description: A medium sized bat with long ears. Brown fur is not glossy and the calcar is not keeled. It could be confused with *M. lucifugus* which has shorter ears.
Distribution: A woodland species found most commonly in the south central part of the state.
Habitat: Caves in the winter and behind loose bark and in hollow trees in the summer.
Habits: The bats are never abundant in any one cave and are usually found singly or in small groups of five to six.

In closing, I would like to emphasize that bat populations have declined over recent years. This is due to our misunderstanding and carelessness. As cavers, it is our responsibility to try to educate the general public about bats and to preserve both the bats and their environment. While caving, please keep the following in mind:

The three most common threats to bat populations are (1) Human disturbance, (2) Habitat loss and (3) Pesticide poisoning. During hibernation, bats need to conserve their fat storage in order to survive the winter; once awakened, a bat uses up to three weeks worth of energy before returning to its hibernating state. If this happens too often, a bat will starve to death. Nursery colonies are also easily disturbed; often a mother will drop or abandon her young. Because most species bear only one offspring per year, disturbance of a major colony can be detrimental to the population. Habitat loss due to modification of summer habitat through stream channelization, flooding, commercialization of caves, and excessive traffic of cavers, have chased many bats away from their optimal habitat and to an early death. Pesticide poisoning is most often from organochlorine residues such as DDE or PCB's.

Cavers can help protect bats by always trying to avoid nursery caves from April to late July, avoiding passages which contain nursery colonies and only passing through sensitive areas at night while adults are out feeding. Passages which contain hibernating bats should be avoided during the months of October through May. Finally all sensitive areas should be marked on cave maps so that others will know to avoid them.

For further information about bats and their conservation, contact Bat Conservation International, P.O. Box 162603 Austin, Texas 78716, (512) 327-9721.

KEY TO THE SPECIES OF BATS FOUND IN OHIO

1. a. Ears extremely large, much larger than head....................*Plecotus rafinesquii*, (Rafinesque's Big-eared Bat)

   b. Ears not larger than head................................ 2

2. a. Dorsal surface of interfemoral membrane completely or partially covered with dense growth of fur; hairs on body may be tipped with silver.. 3

   b. Dorsal surface of interfemoral membrane naked or not densely furred; hairs on body not tipped with silver....................................... 5

3. a. Only basal half of interfemoral membrane furred; hairs on body tipped with silver white; first premolar in upper jaw not minute.......... *Lasionycteris noctivagans*, (Silver-haired Bat)

   b. Interfemoral membrane completely furred; over-all color not silver, but hairs on body may have silver tips; first premolar in upper jaw minute and easily overlooked.... .... Lasirus 4

4. a. Forearm less than 44 mm long; general coloration redish or yellowish red........... ....*L. borealis*, (Red Bat)

   b. Forearm more than 44 mm long; general coloration heavily frosted dark brown or grey.........................*L. cinereus*, (Hoary Bat)

5. a. Premolars 1 above and 2 below on each side.. 6

   b. Premolars not 1 above and 2 below on each side.. 7

6. a. Incisors 2 above and 3 below on each side; total number of teeth 32; interfemoral membrane scantily furred near base; tail not extending beyond edge of interfemoral membrane (fig. 2a); color chocolate brown with long silky hair............*Eptesicus fuscus*, (Big Brown Bat)

   b. Incisors 1 above and 3 below on each side; total number of teeth 30; interfemoral membrane without hair except at base; tail definitely extending beyond interfemoral membrane (fig. 2b); color brown with hair not long and silky................*Nycticeius humeralis*, (Evening Bat).

7. a. Premolars 2 above and 3 below on each side; total number of teeth 34; color light brown to yellow; hairs distinctly tricolored, grey at the base, yellow in the middle, and tipped with brown .... *Pipistrellus subflavus*, (Eastern Pipistrelle)

b. Premolars 3 above and 3 below on each side; total number of teeth 38; color brown or grey; hairs usually not distinctly tricolored, or, if tri-colored lacking a definite yellow band ....*Myotis* 8

8. a. Calcar with a small but usually evident keel (fig. 2a) sagittal crest on skull evident 9

b. Calcar not keeled (fig. 2b) sagittal crest on skull not evident 10

9. a. Fur pinkish-grey in color; on back obviously tricolored; no black facial mask....................... .... *M. sodalis*, (Indiana Myotis)

b. Fur brown with golden sheen; distinct black facial mask.................... *M. lemibii*, (Small-footed Myotis)

10.a. Ear when laid foward extends beyond tip of muzzle; tragus long (equal to or more than 1/2 the length of ear), narrow and pointed (fig. 2d); hairs on toes do not extend beyond tips of claws .... *M. keenii*, (Keen's Myotis)

b. Ear when laid back does not extend beyond tip of muzzle; tragus short and rounded (fig. 2c); some hairs on toes extent to or beyond tips of claws.................*M. lucifugus*, (Little Brown Myotis)

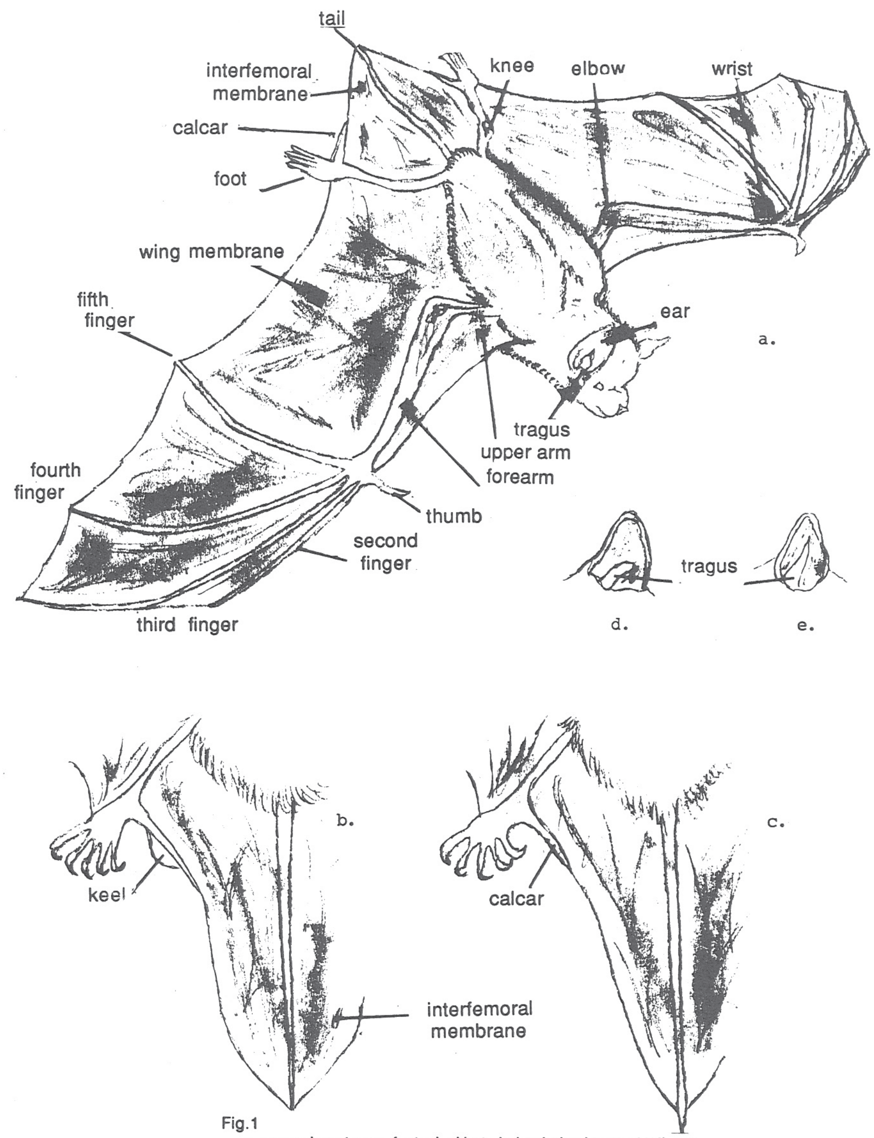


Fig.1
a. general anatomy of a typical bat; b. keeled calcar and tail not extending beyond interfemoral membrane; c. calcor not keeled and tail extending past membrane; d. short round tragus; e. long pointed tragus

Pictures redrawn from Harvey (1986) and Gottschang (1981)

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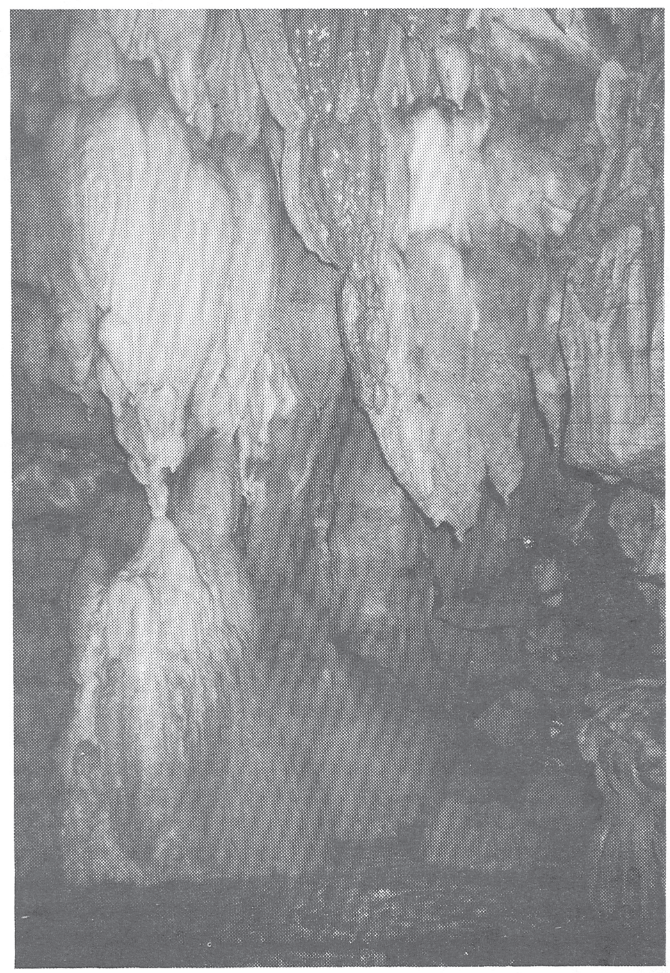

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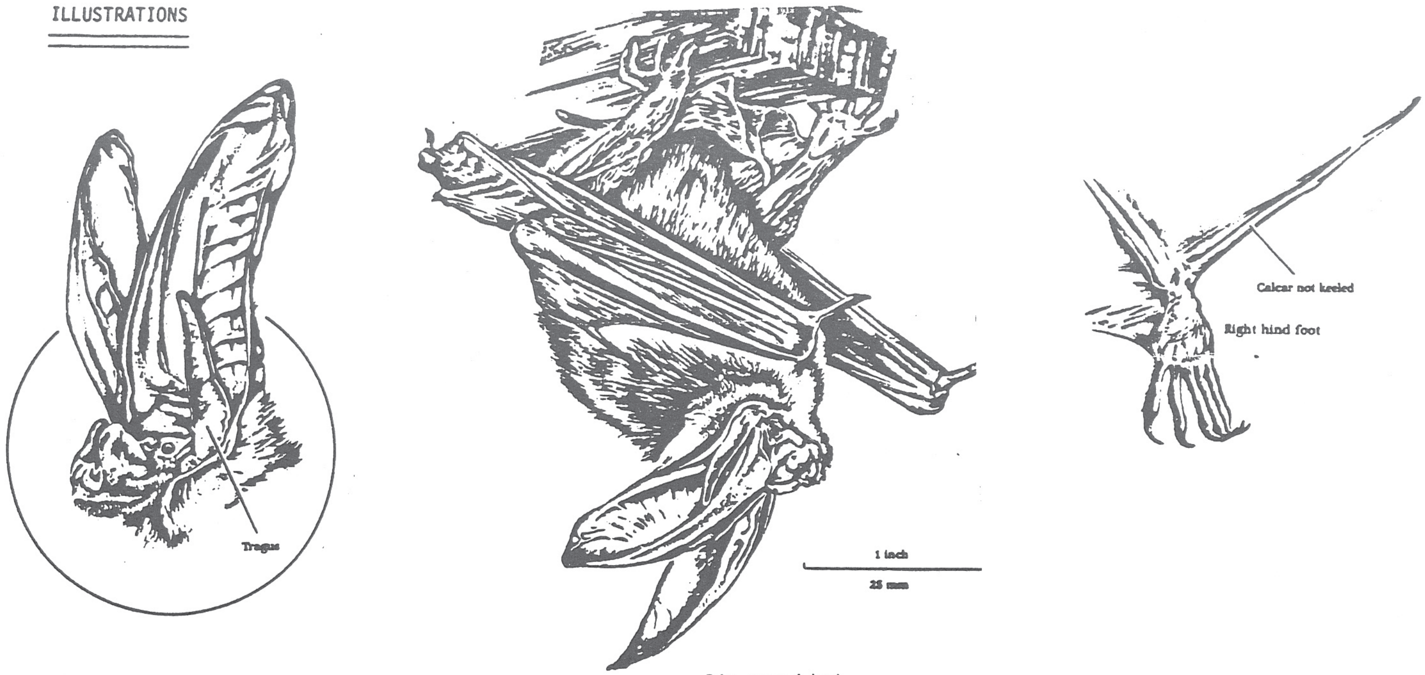
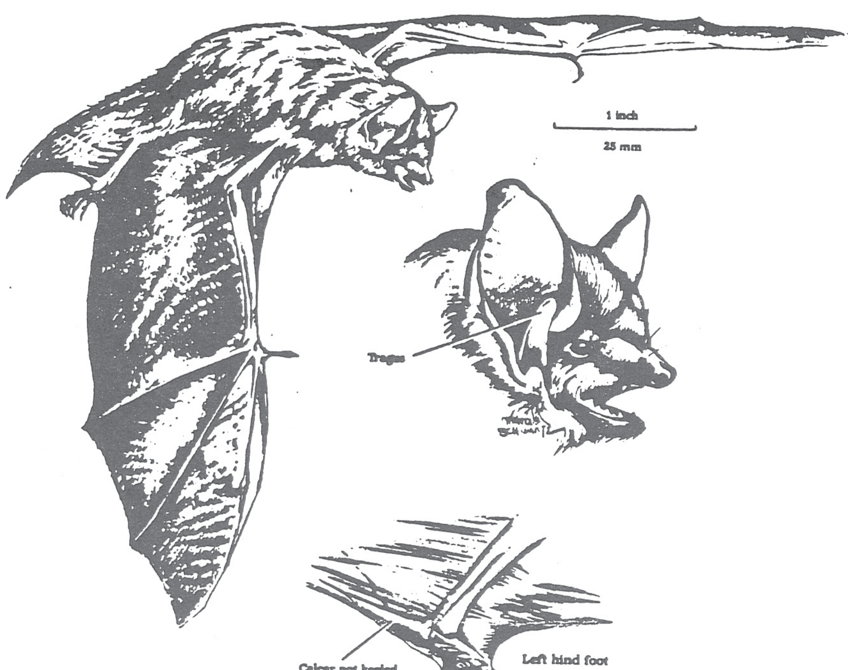
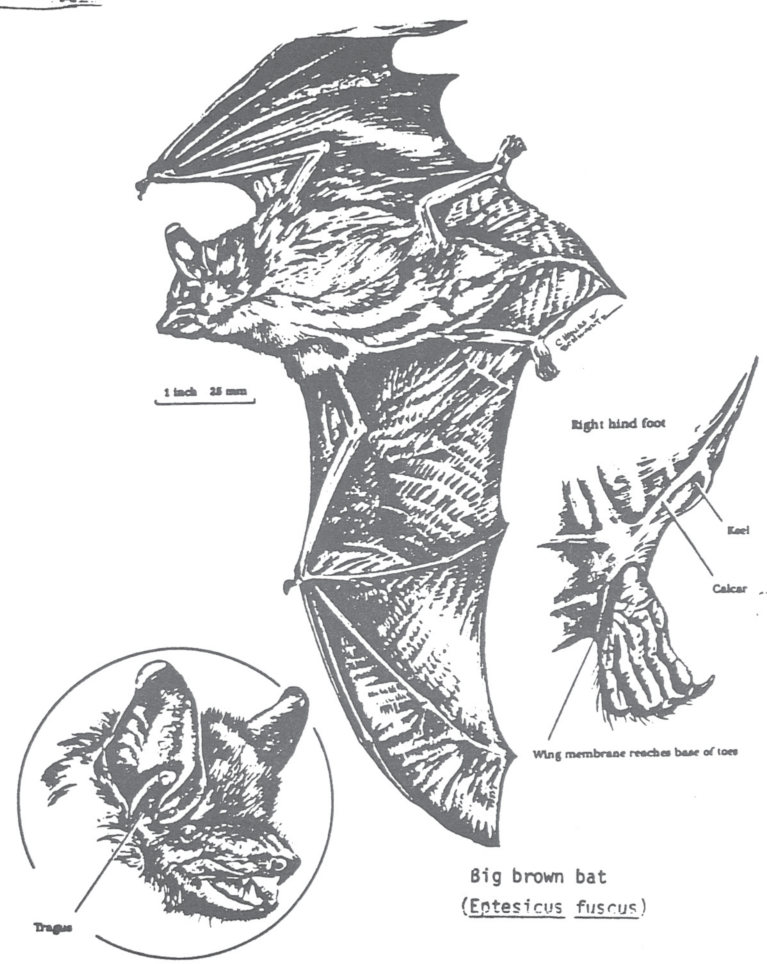


Big-eared bat
(Plecotus)

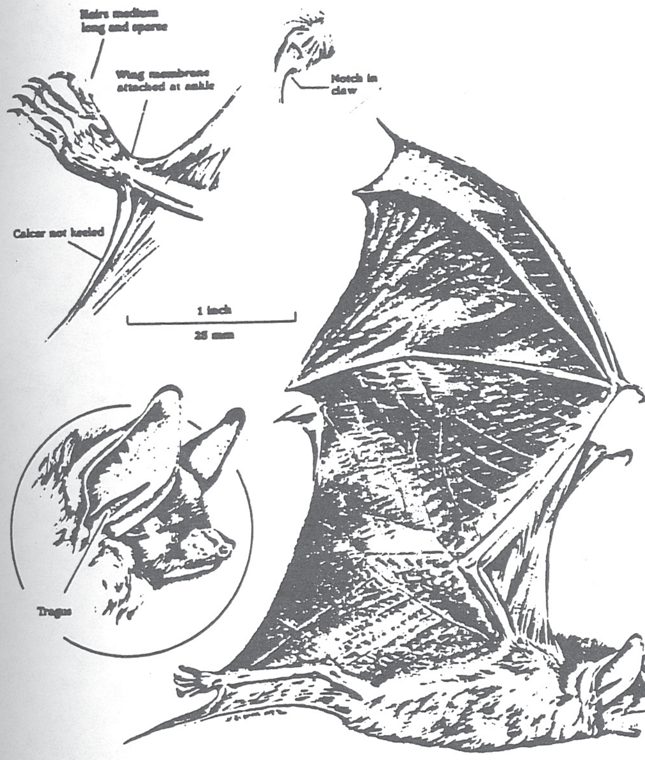


Eastern pipistrelle
(Pipistrellus subflavus)

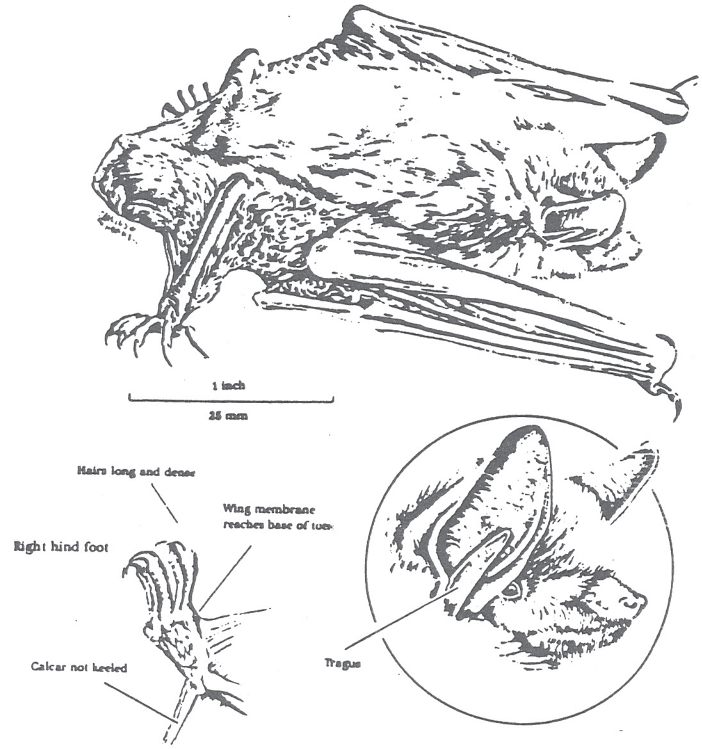


Big brown bat
(Eptesicus fuscus)

Illustrations coppied from the September issue of COG Squeaks 1985

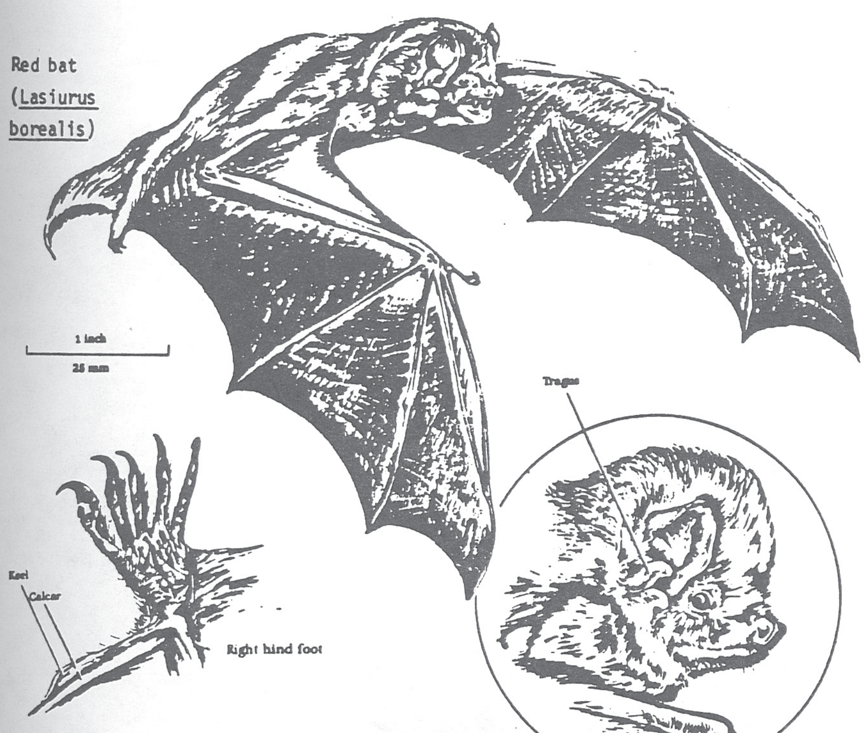


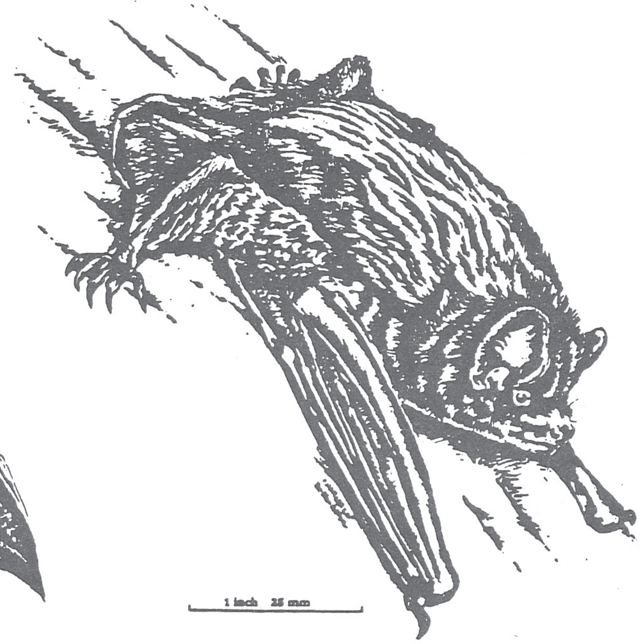
Gray bat
(Myotis grisescens)



Little brown bat
(Myotis lucifugus)

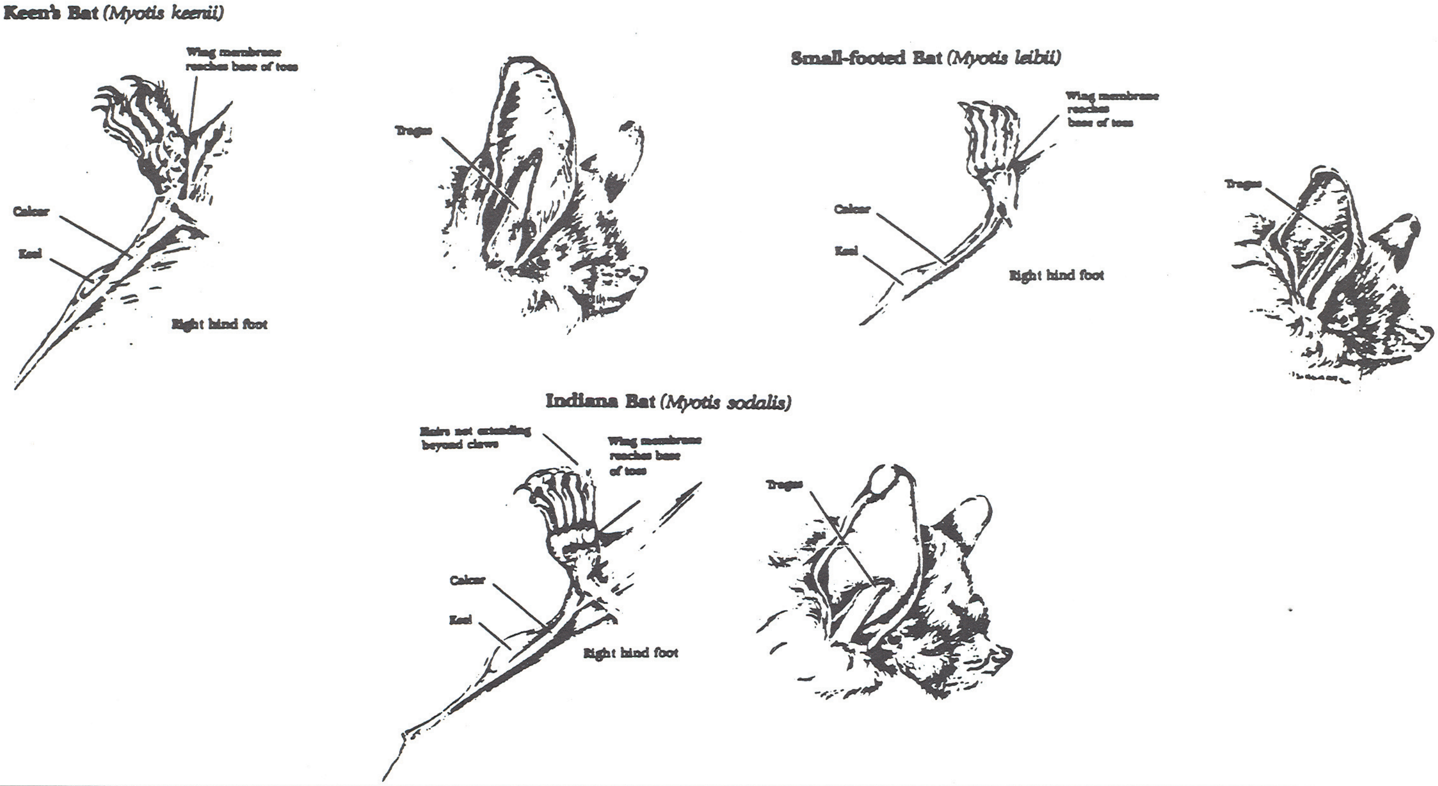
Red bat
(Lasiurus borealis)



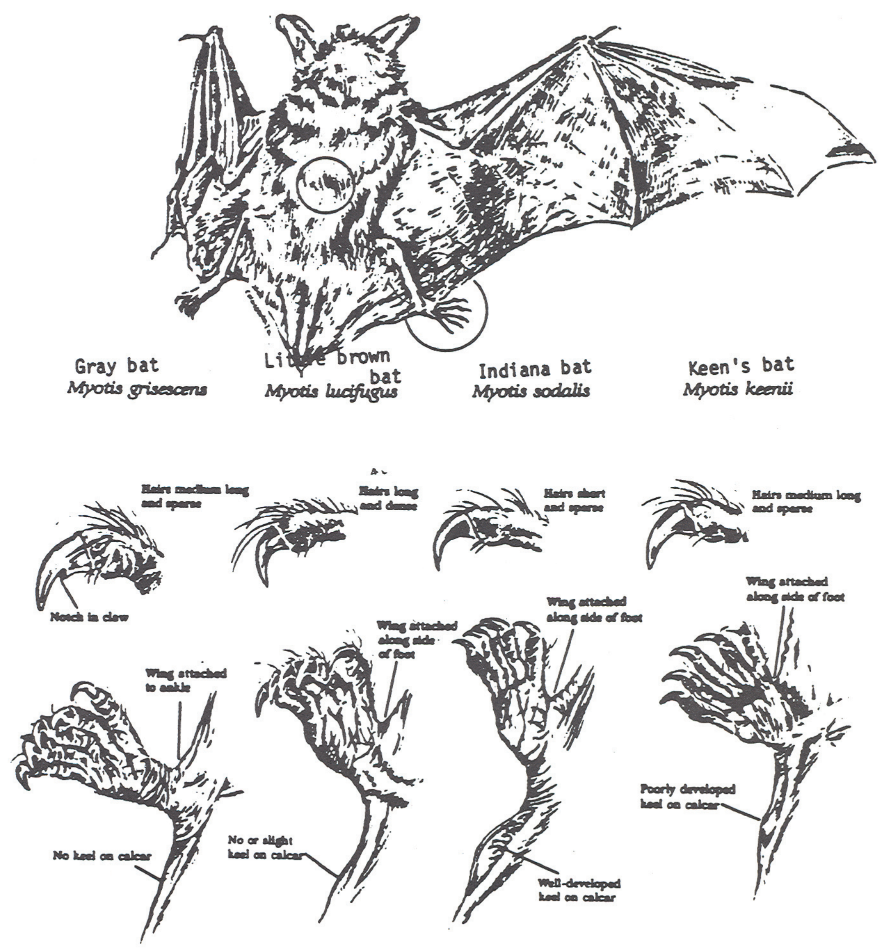


Silver-haired bat
(Lasionycteris noctivagans)

Heads and hind feet of three species of Myotis



Hind foot characteristics of several species of bats of the genus Myotis



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