

CAVE LIFE
OF CARTER CAVES STATE PARK

David Bruce Conn

"A cave is more than just a dark hole in the ground; in its dark recesses there abounds a rich and fascinating array of life."

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PREFACE

I first became aware of the unique nature of cave life at Carter Caves State Park while conducting research on the beetles inhabiting Bat Cave. Through an extensive search of biological literature, I found that the caves in the park harbor many unusual creatures -- ~~are~~ ^{creatures} that are known to few people, including many biologists. The Indiana Bats which hibernate in Bat Cave every winter are the only animals most people associate with the park's caves. Although these bats are interesting, they are by no means the only unique living creatures making the caves their home.

A search of available scientific literature revealed that a large number of visits to Carter Caves has been made by various biologists through the years. Their scholarly approaches followed a similar pattern. They each made a few observations, wrote a short report, and let it go at that. Several small papers were published but soon became lost in the mounds of biological studies published in other areas. In addition, works concerned with the cave life in Carter Caves were overshadowed by the attention diverted to the large Mammoth Cave system just across the state. As early as 1874, A. S. Packard, the great biologist, visited Carter Caves and reported finding several unique animals. Biologists who came after him did likewise but, until now, none has ever put it all together in such a way that anyone visiting the park can share in the excitement of this unusual feature.

Cave Life of Carter Caves State Park was written in an effort to compile information about the park's cave life into a structure that is meaningful to both the biologist and non-biologist. In no sense should this book be regarded as a primer on biospeleology. However, an effort has been made to include enough

technical terminology to maintain scientific clarity. Adequate explanations of specific terms and concepts have been provided so that persons with no biological background can understand the material.

It is important for the reader to realize that all of the animals living in the park's caves may not be included here. A reasonable expectation is that future studies of the caves will uncover more species. In fact, several animals are reported in this book for the first time from Carter Caves as a result of my own recent studies.

David Bruce Conn, ¹⁹⁸¹~~1980~~

INTRODUCTION

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Carter Caves State Park has long been known as an area of fascinating geologic formations and beautiful scenery. Visitors to the park often comment on the rich variety of wildlife present at the park, from songbirds to chipmunks and White-tailed Deer. With all of this excitement out in the open, it is interesting that most people are unaware of some of the park's unique wildlife -- the animals that actually live in the caves. These cavernicolous ("cavern dwelling") animals are very interesting and are frequently studied by biologists. Since speleology is the scientific study of caves, biologists who study cave life are called biospeleologists. This book is a brief introduction to the biospeleology of Carter Caves. Perhaps by reading it, more people will become aware of a natural treasure that is often overlooked. A cave is more than just a dark hole in the ground; in its dark recesses there abounds a rich and fascinating array of life.

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"What in the world could ever live in a cave?" The question is often asked by visitors to Carter Caves State Park; and at first thought it seems to be an easy one to answer. Most people familiar with the area would quickly reply that bats frequently live in caves, and that, in fact, Carter Caves is widely known for its bat population. Well, that is certainly true, but actually the bats are only a small part of the total animal life in the caves, albeit a very important part. In fact, caves serve as a home for many different kinds of animals, from cave crickets to salamanders. Some, such as the bats, may live both inside and outside of the caves, but many cave animals are restricted to the total darkness of the cave for their entire lives. Because of this, cave animals are often

divided into three main groups. A trogloxene is an animal which lives most of its life in the cave, but must occasionally come outside for some reason, usually to find food. Bats belong to this group. A troglophile is an animal which may live comfortably in a cave, but would be equally at home under a rock or log in the forest. A troglobite is an animal which must spend its entire life in the aphotic (totally dark) zone of a cave; it may rarely venture into the crepuscular zone (or "twilight" zone), where some light enters the cave from the outside. Troglobites usually do not have eyes; but that does not bother them since there is no light to see with anyway. Instead, they usually have well-developed senses of touch and smell. In addition, troglobites are usually very light in color. Ordinarily, dark coloration protects animals from solar radiation and serves as camouflage; both factors are unimportant in the aphotic zone of a cave.

A logical second question might be, "Why would any animal want to live in a dark damp cave when it could be outside?" Well, there are several possible answers to that. First of all, living in a cave may offer protection from predators. Probably, of more importance is the fact that caves offer a relatively stable environment. The temperature in a cave stays constant throughout the year. Whether it is January and ten degrees Fahrenheit outside, or August and 95 degrees, the interior of a cave will always be around 55 degrees. The temperature in a cave usually approximates the average annual temperature of the locality where the cave is located. While animals outside are busy preparing for either cold or hot weather, the animals in the cave do not have to worry about it.

Even the dampness of a cave is important. Unlike their relatives outside, cave animals are rarely in danger of drying out. For example, most salamanders have to stay close to water during the day or search for food only at night when the sun will not dry them out. On the other hand, cave salamanders can remain active at all hours.

Another advantage to living in a cave involves avoiding competition for food. When an animal becomes adapted to finding food in the total darkness of a cave, it can use a food supply that is unavailable to non-adapted animals outside. Although this seems to be a sparse food supply, the abundance and variety of animal life that it supports is amazing.

CAVE ECOLOGY

bF Ecology is the study of how living organisms relate to their environment and to each other. It is impossible to fully understand an animal or plant unless one has some knowledge of how it is affected by its surroundings and its neighbors. With this in mind, ecologists generally speak of an ecosystem as being a complex bF natural unit comprising all of the living organisms in a given area and all of the physical factors (geology, climate, etc.) which characterize that area.

In an ecological context, anything above ground level is referred to as epigeal, while anything in underground cavities or caves is spoken of as hypogean. bF Hypogean ecosystems are similar to those of epigeal environments in many respects. This is especially true with regard to such things as competition between different animals for food and predation by some animals on others. However, probably the most important single aspect of any ecosystem is the source of food energy available to animals in that system. It is in this respect that epigeal and hypogean ecosystems are very different from one another.

The sun provides virtually all of the energy required for life on earth. Through the process of photosynthesis, green plants trap the sun's energy and store it in their leaves and stems. That energy is passed on to herbivores (plant-eating animals) when they feed on vegetation. In turn, carnivores (flesh-eating animals) obtain the energy by eating other animals. This food energy relationship is often bF illustrated in a food pyramid; food pyramids for aquatic and terrestrial cave communities are shown in the accompanying diagram.

Obviously, green plants cannot grow in the aphotic zone of a cave since they need sunlight for photosynthesis. As a result, all food in a cave must ultimately come from the outside. There are two major ways that food material may be brought

into a cave. In caves with a stream, leaves and twigs may be washed in. Aquatic cave animals can feed on the materials which remain in the water, while terrestrial animals feed on the materials which are deposited on the stream banks. Epigean animals are frequently washed into a cave as well and may die and become food for cavernicoles. Fungi need no light to grow and can therefore take energy directly from the stream-deposited detritus. In turn, many cave animals such as spring-tails and beetles can feed on the fungi. Cavernicolous predators may then prey on the fungus feeders. Such an animal community associated with plant detritus is called a xylophagous community.

Many of the caves in Carter Caves State Park have streams passing through them, at least in wet weather. Cave Branch, the main stream in the park, flows through Bat Cave and Cave Branch Cave. During flooding, Cave Branch deposits large quantities of plant detritus in Bat Cave, the park's largest cave. These large piles of plant material provide food for a large and varied community of cavernicolous animals.

The second way that food may be brought into a cave from the outside is through the activity of troglomenes such as bats and cave crickets. These animals normally live in the cave by day and move outside to feed at night. While they are in the cave they leave guano deposits (digestive wastes) on the cave floor. Like the stream-deposited materials, guano provides enough energy for the growth of fungi. Many cavernicoles may feed on the fungi or rarely on the guano itself. Once again, predators may become involved in these guanobic communities. In addition, many cavernicoles may feed on the bodies of troglomenes that die in the cave.

All of the caves in the park are inhabited by cave crickets which often occur in large numbers. In some spots, cricket guano may become thick and provide food for cave animals throughout the summer when the crickets are very active.

Bats are unquestionably the most important troglodytes in providing food for the caves of Carter Caves State Park. The effect of bat activity is evident primarily in Bat Cave where bats occur by the hundreds during the summer and by the thousands during the winter. In Bat Cave, many cavernicoles are entirely dependent on bat guano for food. It is the tremendously large bat population that makes Bat Cave one of the most unique cave ecosystems in eastern North America.

Actually, biospeleologists who have studied the cave life of Carter Caves have done little research on cave ecology. Instead they have spent most of their time trying to discover all of the different animals that live in the caves. But, there are some interesting and complex ecological relationships which influence the distribution of cavernicoles in Bat Cave, the only cave in Carter County which thus far has received significant attention from cave ecologists.

Bat Cave comprises two main levels. The lower level serves as an underground passage for Cave Branch and is subject to periodic flooding. As a result, the major food supply in the lower level consists of plant materials which have been washed in from the outside. The upper level of Bat Cave is well above Cave Branch and is never supplied with plant detritus from stream flooding. However, bat activity is generally greater in the upper level where large piles of guano are often deposited; the hibernating bats in the lower level deposit little guano. Cave ecologists who study the insects in Bat Cave have found that the xylophagous insects in the lower level have little overlap with the guanobitic insects in the upper level. By using different food sources, these two groups of insects avoid competition for the small amount of food available in Bat Cave. Future research in other caves in the park may reveal similar phenomena.

ANIMAL GROUPS

Biologists commonly divide animals into groups based on their natural relationship to one another. In the following discussion, the arrangement used by most biologists is followed, beginning with the simplest and progressing through the most advanced animals. Animals that live in caves belong to the same groups as those living outside and are usually similar to their epigeal relatives. Some, however, differ in many respects; these differences are related to the cave animal's ability to survive in a world of sparse food and total darkness.

Only those animals which commonly occur in Carter Caves are mentioned here. When possible, both the common and scientific names of each animal are given. However, some uncommon animals do not have common names since they are little known to the general public. In those cases, only the scientific name will be used.

FLATWORMS

Phylum Platyhelminthes; Class Turbellaria

Anyone who has ever turned over rocks in a small stream to look for "creek critters" is probably familiar with flatworms. Even though the aspiring naturalist may not have known what they were or paid them a great deal of attention, most likely he noticed the flattened small brown worms clinging to the rocks that were pulled from the water. These worms, often called planarians, have two small "eyes" at the front of their bodies. Actually, they are not true eyes since they cannot form images, but merely detect the presence of light; therefore, a better term for them is eyespots.

Cave flatworms look similar to ordinary flatworms in their general shape and size. They differ, however, in two important respects. First of all, cave flatworms are completely white. Their long white bodies stand out readily

against the dark mud bottoms of the cave pools and streams which they inhabit. Secondly, most cave flatworms lack the eyespots so characteristic of epigean forms. Because of these differences, cave flatworms are restricted to living in caves and are, thus, true troglobites.

Cave flatworms feed by preying on small aquatic organisms and sometimes may eat dead animal matter. They glide quietly along the bottom of their home pool or stream in search of food. When a prey animal is encountered, it is tangled in slimy mucus from the flatworm's body. A long muscular pharynx is then protruded from the worm and pulls the food into the digestive cavity.

Young flatworms are similar to adults in habit and appearance but are much smaller. The young hatch from cocoons which are deposited by the parent at the bottom of the pool or stream. Each mature worm contains both male and female sex organs, thus allowing every worm to produce cocoons. During dry seasons most of the small pools which contain flatworms become dry in the caves of Carter County. When that occurs, the flatworms disappear. It is not known exactly what happens to the worms during these dry spells, but it is likely that they simply burrow into the mud and become inactive. As soon as wet weather brings water back into the caves the flatworms seem to reappear from nowhere.

At least three different species of cave flatworms are known to occur in Carter Caves. The most common of these belongs to the genus Sphalloplana (subgenus Speophila). This species is found most frequently in small quiet pools and is especially common to Bat Cave. It also occurs occasionally in Cave Branch. A closely related species, Sphalloplana percoeca (subgenus Sphalloplana) has been reported to be seen occasionally in small streams and pools in Cascade and Saltpeter caves, but is not very common to any of the park's caves.

Both species are generally less than an inch in length. In 1874, A. S. Packard collected a tiny cave flatworm from a trickle in X Cave. He recognized it as a previously unknown species and named it Vortex cavicolens, a name which is probably incorrect since no other Vortex are known from this country. Even Packard himself expressed doubt as to the accuracy of the name but still considered it a new species. Unfortunately, no one has ever found a worm matching his description since that time. Packard was a reputable biologist however, and his mysterious flatworm is probably legitimate, but rare.

ROUNDWORMS AND HAIRWORMS

Phyla Nematoda and Nematomorpha

Though scarcely known to the non-biologist, roundworms are among the most abundant of all animals. They are found both on land and in water and frequently occur in tremendous numbers. In fact, it has been estimated that a single acre of good farm soil may contain as many as several billion microscopic roundworms. Although less abundant in caves, roundworms may occur in large numbers in those with sufficient food material. Little research has been done on cave roundworms, but most biospeleologists feel that the worms in caves are troglomorphic and may be found outside as well. However, in many cases this may be ~~hard~~ ^{difficult} to determine since all roundworms are eyeless and most lack color even in epigeal situations. Since many roundworms live in deep soil, it is easy to see how they might survive well in caves. Some nematodes have been found in decaying plant material in the caves of Carter County, but none have yet been identified as to species.

↑ Hairworms, sometimes called horsehair worms, are relatives of the roundworms. They get their name from the long hairlike shape of their bodies and the old fable that they develop from horse hairs that fall into ponds or water troughs. Actually, the life cycles of these worms are very complex and present a real problem to biologists. The adult worms do not feed but simply mate and lay eggs in the water where they live. After laying her eggs the female hairworm dies; the male dies shortly after mating. The eggs hatch into microscopic larvae which may encyst on objects in the water. If eaten by an insect, usually a grasshopper or cricket, the larva burrows from the intestine into the blood cavity of the host. There it lives a parasitic life and eventually develops into an immature worm which resembles the parent. After development is complete, the young hairworm crawls out of the insect when it is near water. Upon entering the water, the hairworm matures and begins the cycle all over again.

Several hairworms of the genus Gordius have been found in pools in Bat Cave. The worms there are generally several inches long and are completely white. It is unlikely that these worms are strictly cavernicolous since many white species can be found in pools outside. It is possible that the hairworms in Bat Cave use cave crickets as hosts, but this has never been verified. If this is true, the crickets may transport them both inside and outside of the cave.

SPIDERS AND THEIR RELATIVES

Phylum Arthropoda; Class Arachnida

Spiders and their kin, the mites and harvestmen (daddy longlegs), are common inhabitants of most caves including those of Carter Caves State Park. In fact, the park is a real "hot spot" for these creatures. After his trip to the area in 1874, A. S. Packard reported in American Naturalist, Volume 9, concerning the cave spiders:

"It is in the small caverns of Carter County, Kentucky, and the two Weyer's caves (Virginia) . . . , that the variation and number of species is greatest. In each set of caves there are three species, to one in Mammoth and Wyandotte caves."

Perhaps Packard made this statement with particular excitement because the three spider species and three harvestmen species which he found in Bat Cave were previously unknown to science.

Spiders are among the most noticeable of all cave animals to the casual visitor. This is especially true of the Cave Orb Weaver, Meta menardi, a fairly large spider which is a common troglodrome throughout the eastern United States and an inhabitant of most of the caves in Carter County. The orb weaver may be found anywhere in a cave, but usually spins its web in rock crevices fairly close to the entrance. A smaller species, Nesticus carteri, is a common troglodrome in many parts of Kentucky, Virginia and Tennessee. It builds its web near cave streams where flies which serve as prey are more plentiful. Though common over a wide geographic range, Nesticus carteri was first discovered over a century ago in Carter Caves and was named for this location.

rare we element The ~~two~~ other spider species which are common in the park's caves are considered troglodromic since both are widespread in caves throughout the eastern United States, but neither has ever been found outside of a cave. These spiders, Phanetta subterranea and Porhomma cavernicola, have light body coloration and generally light colored eyes. Both are found most often near cave

streams and are usually associated with decaying plant matter where they prey on tiny insects. As with so many of their relatives, these two spiders first became known to science upon their discovery in the caves of Carter County.

The spider-like harvestmen inhabiting the park's caves are also of unique interest with regard to their original discovery. Sabacon cavicolens, a common troglodene in many Appalachian caves, is locally abundant near cave streams throughout the park. In fact, its initial discovery was made on the banks of Cave Branch in Bat Cave. Another harvestman, Erebomaster flavescens coecus, has been found nowhere in the world other than in the caves of the park, where it lives near plant debris. There is some disagreement among biologists as to whether this form is an individual species or merely a subspecies of Erebomaster flavescens flavescens, an inhabitant of Wyandotte Cave, Indiana. Perhaps the most intriguing of the cave harvestmen at Carter Caves is Hesperonemastoma inops, a species which is known only from two specimens collected in Bat Cave over a century ago. Until more specimens are encountered, little can be said about the life of this rare species.

Leiobunum longipes is a troglodene harvestman which is familiar to most people as a typical daddy longlegs. This species, although common near the entrances of caves, is more frequently seen in damp basements and woodlots. However, several dozen individuals may be seen clumped together just inside the park's larger stream caves during the winter months. This habit does not represent an adaptation to true cave life, but rather a means of escaping the cold weather outside; the species is ~~never~~ ^{rarely} found in the aphotic zone.

Tiny mites, another group of spider kin, are also common cave inhabitants. A single handful of plant debris or bat guano taken from a cave will almost always contain hundreds or even thousands of these minute creatures. Mites live a wide range of life styles, from predator to parasite to plant feeder.

This high diversity, along with their tremendous numbers, makes them an extremely important component of soil communities in both epigean and hypogean environments. Although several species of mites are known to occur in the caves of the park, little attention has been given to them by biospeleologists. Future studies on these interesting animals may prove to be of vital importance to our understanding of cave ecology.

CRUSTACEANS

Phylum Arthropoda; Class Crustacea

Crustaceans are very common and the larger forms are known by everyone. Probably the best known crustaceans are the crayfish or crawdads which are ~~very~~ common in streams. In some caves, such as Mammoth Cave, there live certain species of white blind crayfish which are true troglobites. There are no true cave crayfish known to occur in Carter Caves, but several species of common surface crayfish may be washed into the caves which have streams passing through them. The most common crayfish in the park's caves is Cambarus tenebrosus. This species is common in Cave Branch throughout Bat Cave where it is an important predator and scavenger. It is found in Cascade Cave and Cave Branch Cave in smaller numbers. This species has dark coloration and well-developed eyes; it is the only crayfish in ~~the~~ Carter Caves which regularly inhabits caves. The individuals in the caves are often larger than those outside, probably because there are fewer animals to prey on them.

Other crustaceans inhabiting the park's caves are smaller and more likely to go unnoticed, even though some are quite common. The most abundant crustaceans in caves are amphipods (more commonly called scuds) which are aquatic in habit. One species, Gammarus minus, has dark coloration and well-developed eyes and is usually found in surface streams. However, some of these may occasionally wander deep into Bat Cave where they are generally confined to Cave Branch. This species has also been observed in Laurel Cave and Cascade Cave; it probably occurs in all of the caves in the park which have a sufficient water supply. Other amphipod species in the caves of the park are completely blind and colorless. These troglobitic amphipods include Crangonyx packardii and one or more species of Stygobromus. They live

primarily in quiet mud-bottomed pools in Bat, Saltpeter, Cascade and X caves but are occasionally encountered in side pools of Cave Branch in Bat Cave. They are generally less than half an inch long and are important in the aquatic food pyramid described earlier -- feeding chiefly on small bits of organic material.

Another group of crustaceans, the isopods, is less common in the park's caves. Both terrestrial and aquatic forms of this group may be found in small numbers. The terrestrial forms are commonly known as pill bugs and are familiar to almost everyone. The species living in the caves of Carter County have well-developed eyes and dark coloration; they are troglomorphic in nature and may be found throughout the park, above and below ground.

Aquatic isopods belonging to the genus Caecidotea have been found nowhere in the park except Bat Cave. These are relatively rare in the cave and have been found both in quiet pools and in Cave Branch. They are true troglobites, lacking eyes as well as pigmentation. These tiny animals have habits very similar to their amphipod relatives. Further research on the cavernicolous crustaceans of Carter Caves may uncover several ^(additional) ~~other~~ species from both of these groups.

CENTIPEDES AND MILLIPEDES

Phylum Arthropoda; Classes Chilopoda and Diplopoda

Centipedes (also called hundred-leggers) and millipedes (also called thousand-leggers) are very common animals which are related to insects. Both have long bodies which are divided into numerous segments and both are found most frequently in forested areas. Externally, centipedes differ from millipedes in that the former have only one pair of legs on each body segment, whereas the latter have two pairs per segment.

In habit, centipedes are predaceous on insects and other small animals. They are generally fast runners, a characteristic which helps them in chasing down their prey. Another special adaptation that helps make centipedes successful predators is the pair of poison claws at the front of the body; these claws are used to paralyze their victims. Few centipedes are found in the caves of Carter County. Occasionally one or more may be found under rocks or logs which have been deposited by the flood waters of underground streams. Since centipedes normally occur in similar situations outside the caves and have little need for light anyway, many species are able to cope with life in the total darkness of the aphotic zone and thus may be considered troglophilic.

Millipedes are herbivorous and feed on a wide range of plant materials. They travel slowly with graceful wavelike motions moving down their long rows of legs. Millipedes are common cave inhabitants throughout the eastern United States. In fact, many species of cave millipedes have adapted so well as cavernicoles that they are rarely found outside of caves. Such is the case for Pseudotremia carterensis, the Carter Caves Millipede. Until recently, this species was reported to occur only in Carter County caves; the range has now been extended to include Tar Kiln Cave in neighboring Elliott County.

Pseudotremia carterensis was first found in Carter Caves in 1874 by A. S. Packard who believed it to be a subspecies of a closely related millipede, Pseudotremia cavernarum. Later biologists recognized that these two species are distinct from one another and that the latter does not occur in the Carter Caves area. In 1937 a seemingly different species of millipede was found in Bat Cave and named Pseudotremia sodalis. However, it is now thought that this may actually be simply a variation of Pseudotremia carterensis.

The Carter Caves Millipede is common to caves throughout the park and is an important part of the cave community in which it dwells. It is generally found among decaying plant material which has been washed underground by sinking streams. In Bat Cave, the millipede is also common in areas where bats have deposited piles of guano. It commonly occurs deep in the aphotic zone but may also be found closer to the entrance. Considered troglophilic, the Carter Caves Millipede has light coloration and reduced eyes. Its dependence on caves is probably the most important factor keeping the species from spreading to other areas. Since it cannot travel overland, it will no doubt remain confined to a small geographic area in the vicinity of Carter Caves.

INSECTS

Phylum Arthropoda; Class Insecta

Insects are by far the most successful animals in the world in terms of number of species and variety of habitats occupied. With the realization that over 70 percent of all living animal species are insects, people should think twice about the idea that mankind reigns supreme on earth. Along with their tremendous numbers, insects as a group exhibit an incredible diversity in form and can therefore spread out successfully into many habitats where other animals are less likely to occur. With this in mind, it is no surprise that insects are the most abundant cavernicoles in terms of number of species; the only cave animals which may rival the insects in number of individuals are the mites.

The most abundant cave insects are the springtails (order Collembola). These primitive creatures go unnoticed by most cavers because of their extremely small size, which in some cases may be so small that they can hardly be seen without the aid of a microscope. Even so, they occur in such great numbers in guano piles and plant debris that they are without doubt a critical link in the cave food chain. Springtails get their name from a small spring-like structure at the tip of their abdomen which allows them to jump considerable distances to escape predation. They generally live deep in the soil or in decaying vegetation and feed on small bits of organic material. Some springtails found in caves are also common epigean forms; however, there are many species which occur nowhere other than in caves.

The most easily observed springtails in the caves of Carter County are those belonging to the family Entomobryidae. These range in size from almost microscopic to nearly a quarter of an inch in length. Dark purple troglodiles,

Tomocerus bidentatus and Tomocerus flavescens, can be seen crawling across the cave floor in areas where beds of bat guano or plant debris have accumulated. The troglobites, Sinella cavernarum and Sinella basidus, are also common in such areas; their pale color makes them stand out easily against the dark floor. Less conspicuous but equally abundant are the tiny round springtails of the genus Arrhopalites (family Sminthuridae). These also occur most commonly in areas rich in organic material, but may be found in large numbers far away from major food deposits. Other springtails known to occur in some of the park's caves include Onychiurus (family Onychiuridae) and occasionally some members of the families Isotomidae and Poduridae. The latter three families are rare to the caves and generally live only in decaying plant debris.

In the eyes of most visitors to the park, the most visible cave insects are undoubtedly the crickets (order Orthoptera). Entering almost any cave in the park, one is likely to see several large brown crickets with black bands across the abdomen. These camel crickets are mostly Ceuthophilus latens, but another species, Ceuthophilus stygius, has also been reported from the area. The camel crickets are troglloxenes which rarely venture farther into a cave than the crepuscular zone. They use the cave primarily as a daytime shelter and move outside at night to feed. Deeper in the aphotic zone the camel crickets are replaced by their pale relatives, the cave crickets. Cave crickets are obviously more highly adapted to life in darkness as indicated by their small eyes, light coloration and elongated legs and antennae. (The long appendages help in feeling the way when light is not available .) The cave crickets are also troglloxenes, but may not leave the cave for months if plenty of food is available inside. Both cave and camel crickets are important to many cave ecosystems because of their habit of feeding outside and then depositing their guano inside the cave where other animals can feed on it. Two species of cave crickets are

known to occur in Carter Caves. Euhadenoecus puteanus is common in the park's caves but is not widespread in other areas of eastern Kentucky. Hadenoecus cumberlandicus is the most widespread cave cricket in eastern Kentucky and is common in Carter County. In most areas, this small cricket lives in populations with both males and females. However, in the early 1970's a group of biologists discovered that there were no males of this species in Carter Caves. The females there are able to produce viable eggs without fertilization, a process known as parthenogenesis. This phenomenon is rare indeed; the report of this species undergoing parthenogenesis in Carter Caves and other caves nearby was the first such report for any of the grasshopper/cricket group in all of North America. To this day, no males of Hadenoecus cumberlandicus have been encountered in the Carter Caves area.

Most insect species in the park's caves are beetles (order Coleoptera). Biologists have found numerous beetle species in the caves, many of which are accidentals underground and will not be mentioned here. Several species are common in the caves and contribute significantly to the hypogean food chain -- at least in Bat Cave where they have been studied most often. The most common beetles in Bat Cave are the rove beetles, Atheta and Aleochara. These two insects are troglaphiles. Both appear to be guanobic to some extent although Atheta is frequently associated with plant debris and has been observed feeding on the carcasses of bats which had died during hibernation. The Small Carrion Beetle, Prionochaeta opaca, is also a guanobic troglaphile. It is commonly associated with bat guano which is deposited during summer, the normal activity period for this beetle. Summer guano piles in Bat Cave also harbor a tiny blind beetle species, Aglenus brunneus, which evidently feeds on fungi and other organic material. This beetle is less than one-eighth of an inch long and is very pale in color.

beetle species, Aglenus brunneus, which - - -

Predaceous ground beetles also dwell in the park's caves. Most common among these is the troglophile, Bembidion wingatei, which often occurs in large numbers near the larger cave streams. The most fascinating beetle living in Carter Caves is the blind troglobite, Pseudanophthalmus packardi. This small predator was first discovered in X Cave during the late 1800's but was mistaken for another species. It was not until 1957 that Thomas C. Barr discovered that this was actually a unique species which had been found nowhere else in the world. To this day, Pseudanophthalmus packardi is known to live only in the Carter Caves area where it generally stays close to underground streams.

Several species of flies (order Diptera) live in the caves of Carter County, and some are abundant there. The small dung fly, Leptocera tenebrarum, is common near the larger guano deposits in Bat Cave, as is the humpbacked fly, Megaselia cavernicola. Both species are highly dependent upon the bats for a food supply; the latter may even deposit its eggs in bat carcasses where their larvae feed on decaying meat. These flies remain active all winter in the cave and may become food items for active Indiana Bats at that time. Some flies in the park's caves are more closely associated with plant debris near cave streams. These include one or more species each of fungus gnats (family Mycetophilidae), dark-winged fungus gnats (family Sciaridae) and moth flies (genus Psychoda). Dance flies, Chelipoda, are common during the fall and winter in the main bat hibernation room in Bat Cave. They have never been observed feeding there and may simply use the cave as a refuge from extreme environmental conditions outside.

Although most moths are active at night, few venture into the perpetual darkness of caves. One exception is Scoliopteryx libatrix, a common moth which often hibernates in caves. This moth is occasionally seen inside the caves of Carter County and may penetrate even into the aphotic zone.

Because insects are so abundant, many species have been found in the caves only a few times and obviously are not true cavernicoles. These are not mentioned in this text because of the large number of species involved.

FISHES

Phylum Chordata; Class Osteichthyes

So far, no blind cave fish has been found at Carter Caves, but that isn't to say that it will never happen. Although such fish do exist in other Kentucky caves, the waterways in Bat and Cascade Caves may not be large enough to harbor such creatures. However, there is a lot more water in Bat Cave than meets the eye, much of it far underneath the rocks where no human can penetrate. Who knows? With more searching, biospeleologists may come up with something yet. After all, there are some normally epigean fish which are rather successful inhabitants of Cave Branch in Bat Cave's aphotic zone. The most commonly encountered of these is the Creek Chub, Semotilus atromaculatus, whose large eyes are useless in the darkness of the cave, but whose keen sense of smell evidently enables it to find food. Large individuals of this species are surprisingly common in the large stream pools of Bat Cave. Tiny sculpins (genus Cottus) are common in Cave Branch and are frequent inhabitants of Bat Cave where they occur near the entrance as well as deep in the cave.

Several other fish species are seen occasionally in cave streams throughout the park. However, these occur in such small numbers underground that it is unlikely they live for long in caves; most are probably accidental victims of stream floods which wash them inside. There is much remaining to be learned about the fish living in the park's caves. Thus far they have been largely neglected by biospeleologists.

AMPHIBIANS

Phylum Chordata; Class Amphibia

Frogs, toads and salamanders are the common animals which biologists refer to as amphibians. The name comes from the fact that all of these animals depend upon some body of water for at least part of their life cycles, usually for breeding and laying eggs, but may spend much of their time on dry ground. Amphibians are unable to cope with very dry conditions and therefore even the most land-worthy forms must remain in moist areas at all times. For this reason, it is easy to see how many amphibians seem to survive adequately in caves, even if they aren't true cavernicoles. Of course, some blind salamanders are actually troglobites; but, no troglobitic salamanders have been found in Carter Caves. Those amphibians which are known to occur in the park's caves are mostly wash-in victims and actually spend little time in the aphotic zone. However, the crepuscular zone of many caves may harbor several species that are merely seeking a cool moist place to escape the daytime heat.

Two different salamanders which are found in the park's caves from time to time deserve special mention. The Kentucky Spring Salamander, Gyrinophilus porphyriticus duryi, was unknown to science prior to its discovery in 1930; it was first collected in Cascade Cave by the young biologist, W. H. Weller. One year after his trip to Cascade Cave, Weller was killed when he fell from a high point in the Smoky Mountains while searching for another new salamander. Several years later, biologists discovered another new salamander in Cascade Cave and named it Pseudotriton montanus diastictus, the Midland Mud Salamander. Since these two unique discoveries, biologists have found that both of these salamanders are common to a wide range of the eastern United States. Both generally occur in or near small streams and seem to adjust well to cave life, though they are common

outside as well. In some cases they may be common enough in caves to contribute to the hypogean ecosystem as predators at the top of the food pyramid. Most of the caves of Carter County harbor them occasionally, but they are more common to the caves with large streams.

Other salamanders which have been observed in the park's caves include the Northern Red Salamander, (Pseudotriton ruber ruber), and the Slimy Salamander, Plethodon glutinosus. These salamanders are common epigean forms and are only occasionally found in caves. The Cave Salamander, Eurycea lucifuga, is a common troglophile in many cave areas. Although this species has well-developed eyes and coloration, it frequently lives deep in the aphotic zone where it may become an important predator in the cave's ecosystem. Despite its prevalence in many Appalachian caves, the Cave Salamander is less common in Carter County caves; only a few specimens have been observed.

Frogs and toads are not as likely to live for long periods in caves as are their salamander relatives. When they do occur in caves, it is rare to find them beyond the crepuscular zone. Despite their overall tendency to remain outside, it is not uncommon to see toads just inside the entrance where they can escape the daytime heat that can dry their fragile skin. Two toad species are common in eastern Kentucky and both have been observed in several of the park's caves. The American Toad, Bufo americanus, and Fowler's Toad, Bufo woodhousei fowleri, frequent the caves' crepuscular zones and may occasionally be encountered deep in the aphotic zone of Bat and Cascade caves where they remain near the main streams.

Because toads are more highly adapted as land dwellers than are frogs, the former naturally inhabit caves more frequently. On the other hand, frogs may be found in some caves where a stream is large enough to allow them to continue their normal existence. Once again, Bat and Cascade caves are the only caves in the park that meet this condition. Several species of frogs are common in the park and any of these could accidentally be washed into a cave. The Bull Frog,

Rana catesbeiana, has been seen many times in Bat Cave, usually just following a flood in Cave Branch. In one instance, a single Green Frog, Rana clamitans melanota, was known to live for a long period beside a stream pool deep in Bat Cave's aphotic zone. The frog spent the entire winter near the pool; it disappeared in early spring and was never seen in the cave again. Although other Green Frogs have been seen in the caves, none has been known to remain for that long. It is unlikely that most frogs could survive for long in total darkness since most depend highly upon vision for food capture. It may be this factor that enables salamanders to outnumber frogs in caves since the former are less dependent upon vision.

REPTILES AND BIRDS

Phylum Chordata; Classes Reptilia and Aves

Birds are perhaps the most familiar of all animals to most people, with reptiles coming close behind. In view of this, it is ironic that these two groups are almost totally absent from caves.

It is interesting to talk with people who are unduly frightened at the thought of entering a cave and admit that part of their fear results from imagining seething dens of rattlesnakes just inside the darkness. Although some snakes do seek out cool rock crevices in which to hide by day, few have been known to purposefully enter the aphotic zone. In fact, most experienced spelunkers will quickly admit that they have seen few if any snakes even in the crepuscular zones of caves. One notable exception is the reported occurrence of a Black Rat Snake, Elaphe obsoleta, preying on bats in Penitentiary Cave, Kentucky. However, this incident would probably not have occurred if the bats had been roosting in the aphotic zone. There have been no such incidents reported for any of the caves of Carter County. If a snake is seen in a cave, it is likely that it was washed in by flood waters and will soon die if it cannot regain the outside. In general, snakes are not adapted to a cavernicolous existence.

The only reptile to be observed deep in any of the park's caves is the Eastern Box Turtle, Terrapene carolina, which is frequently washed into caves throughout the eastern United States, probably because its sluggish habits make it difficult to escape flood waters. However, like the snakes, the turtle is not a true cavernicole and will soon die if unable to find its way out of the cave.

No North American bird is known to be a cave dweller in a true sense, but some species do make a habit of nesting just inside the entrance of caves. Notable among these are the Barn Swallow (Hirundo rustica), the Cliff Swallow (Petrochelidon pyrrhonota), and the Eastern Phoebe (Sayornis phoebe) -- all of

which occur as summer residents throughout Kentucky. Of the three, only the Eastern Phoebe is commonly seen nesting in the caves of the park where it glues a nest of mud and twigs to the rock wall just inside the cave's entrance. The phoebe is a woodland species and may also build its nest under rock ledges and even under the eaves of buildings. The two species of swallows have similar nesting habits but are more common in fields than in the woods. As far as the birds are concerned, the deep cave itself is unimportant, the cave entrance serving just as another rock overhang to provide shelter. The birds are unable to venture into the aphotic zone.

MAMMALS

Phylum Chordata; Class Mammalia

If a person lives on the shore of Lake Erie in Michigan or Ohio and ever sees an Indiana Bat flying around his house, it is quite possible that the bat being watched may spend its winters at Carter Caves State Park. This is not really surprising when one realizes that this bat is a migratory animal and that the park's Bat Cave is one of the world's largest hibernacula (places ^{bf} where animals hibernate) for the species. Biologically speaking, the Indiana Bat, Myotis sodalis, is probably Carter Caves' greatest claim to fame. Much of what is known about the species was discovered through research conducted in Bat Cave.

Throughout the summer, Bat Cave seems rather devoid of bat life, and a casual visitor would probably wonder why such a name was ever given to the cave. Although a few hundred bats of different species live in the cave during summer, most are hidden away in small passages where they cannot be readily observed. It is not until September of each year that the cave's name becomes meaningful. At about that time, thousands of Indiana Bats begin arriving at the cave from their summering grounds to the north. When they first begin to arrive, the bats move into the upper end of Bat Cave where they sleep by day.

During the early fall the bats move outside each night to feed on insects in an effort to build up fat reserves for the long winter ahead. As the weather becomes colder, they gradually move toward the lower entrance so that by late November the large rooms just inside the mouth are occupied by anywhere from 40,000 to 60,000 individuals. The bats generally breed at this time and then enter the long hibernation period which lasts until the following spring. Unlike most other bat species, Indiana Bats characteristically hang from the ceiling in large tight clusters -- a habit that prompts some people to call

them Social Bats. While in hibernation, a bat's body temperature drops to near room temperature, the heart beats slowly and breathing occurs at an almost imperceptible rate. In most bat species this state remains relatively constant throughout the winter.

However, biologists studying the Indiana Bats in Bat Cave have found that each bat of this species awakens every eight to ten days and moves to an active cluster in a warmer part of the cave. Because of this habit, some active bats are present in the cave throughout the winter. After a short spell of activity, the bat returns to the main hibernation area and becomes inactive once again. During their active spells, the bats deposit guano on the cave floor near the spots of activity. This is a very important factor in the total ecology of Bat Cave since it provides food material to some insects and other cavernicoles throughout the winter. In return, the bats probably feed to some extent on flies that use the cave as a winter retreat. However, much of their winter feeding may be done outside on warmer nights.

In late March and early April the bats begin to arouse and slowly move back toward the upper end of the cave in much the same manner as they moved into the cave during the fall. By mid May, nearly all of the bats are gone and Bat Cave once again seems quiet and virtually empty. The Indiana Bats which hibernated in the cave migrate north to their summering grounds where the females raise their young in relative secrecy. Little is known about the summer habits of this species, but it is certain that the same bats return to hibernate in Bat Cave each winter along with their young. Likewise, individuals from other hibernacula return to their respective caves each year.

Unfortunately, a sad note must be included along with any comment on the Indiana Bat. Although the Bat Cave population seems to be large, the total number of bats hibernating in the cave was near 100,000 until recently. The

recent decline in the number of bats in the cave has been paralleled by similar reductions in populations throughout North America. At present, little more than 400,000 Indiana Bats are known to be in existence, with nearly 90 percent of that number hibernating in only seven caves in Missouri, Kentucky and Indiana. Although small populations hibernate in numerous small caves throughout the area, the species is for the most part dependent upon a few select caves where the temperature is just right. Their highly selective nature is one of the main reasons for their decline.

Most other species spread their populations out into hundreds of caves in a given area. Since the Indiana Bat hibernates in only a few caves, it is in much greater danger of disturbance. As it turns out, disturbance by humans is probably the greatest reason for the bat's decline; destruction of favorable hibernation caves ranks second (see chapter on Cave Conservation). Because of rapidly decreasing numbers, the Indiana Bat has been listed as an endangered species by the United States Department of the Interior and is legally protected by the federal Endangered Species Act of 1973. Hopefully, with efforts to protect the Indiana Bat and its habitat, a unique creature ^{can be saved} from extinction.

Of course, other bat species live in the park's caves. The Little Brown Bat, Myotis lucifugus, also uses Bat Cave as a hibernaculum in the winter. About 3,000 individuals of this species overwinter in the cave, most of them near the same areas occupied by the Indiana Bats. As a general rule, Little Brown Bats do not form dense clusters but often hang in rows along cracks in the ceiling. Over all, the Little Brown Bat is more common than its endangered cousin but chooses to hibernate in many caves rather than concentrate in just a few. When spring comes, few Little Browns remain in Bat Cave. They are migratory and generally move north for the summer where they are most common in attics and other parts of buildings.

The Eastern Pipistrelle, Pipistrellus subflavus, is the most abundant bat in eastern North America. During the summer, most individuals of this species

roost by day among the foliage of trees. When winter arrives they retreat to numerous caves where they hibernate singly. Most caves at the park contain a few of these bats in the winter; nearly 500 hibernate in Bat Cave each year. The Pipistrelle is also frequently encountered in the caves during the summer, but only in very small numbers.

The only other bat which regularly hibernates in the park's caves is the Big Brown Bat, Eptesicus fuscus. This species is also called the House Bat because of its habit of using houses for summer roosts. Big Browns can be found in several of the park's caves during winter, but no more than 30 or so can usually be found on any single day. As usual, Bat Cave is the most frequently used hibernaculum for this species in the park.

In late summer or early fall, a few Red Bats, Lasiurus borealis can sometimes be found in Bat Cave. Other reports of bats from Carter Caves include a single sighting of a Gray Bat, Myotis grisescens, in Bat Cave on September 6, 1931 and a single Rafinesque's Big-eared Bat, Plecotus rafinesquii, in a rock crevice in the winter of 1932.

Mammals other than bats may be found in the caves from time to time. The Allegheny Wood Rat, Neotoma magister, is common in some of the caves where it builds a nest close to the entrance and goes outside to feed at night. Unlike the cave-adapted bats, the rat cannot find its way in the darkness by sonar and must depend on a keen sense of smell. Another rodent, the White-footed Mouse, Peromyscus leucopus, is an occasional visitor to some of the park's caves where it may venture into the aphotic zone.

Though rarely seen in a cave, the Raccoon, Procyon lotor, is a very common visitor even in the deep aphotic zone. The presence of this mammal is easily detected by the distinct footprints which it leaves in the mud floor while searching for food near cave streams. Tracks are especially abundant in Bat Cave during the winter. Although it has never been verified, the coons may prey

on hibernating bats. This behavior has been verified for the Mink, Mustela vison. In the winter of 1950, two of these medium sized mammals were captured in Bat Cave and a third was captured just outside of the entrance. All three had the remains of several bats in their stomachs and had obviously made the bats a part of their regular winter diet. It was reported in 1939 that a single Bobcat, Lynx rufus, was caught in a trap some 300 feet inside Bat Cave. However, the biologists who reported the incident made no speculation as to why the cat may have been so deep inside the cave.

Other Animals

The preceding outline of animal groups includes the more common animals inhabiting the park's caves, but by no means should it be considered a complete list. Several other animals are known to live in the caves, albeit in small numbers. For instance, many earthworms and snails are washed into the caves and may survive there for some time. Tiny pseudoscorpions are fairly common in decaying plant material along the banks of cave streams. Parasites of bats and other cave animals may never actually come in contact with the cave environment, but even in the protective bodies of their hosts they are an integral part of the total cave ecosystem. The list could go on and on, but anyone who is interested in more information should consult the appropriate scientific literature.

With everything else put aside, perhaps the most important of all "other animals" in the caves of Carter County are those which remain to be discovered through the efforts of biospeleologists. Who knows? The most fascinating creatures in the park may be living yet unnoticed within an arm's length of tourists who daily make their way through the caves.

CAVE CONSERVATION

"Take nothing but pictures; leave nothing but footprints; kill nothing but time." This motto has been used extensively by the National Speleological Society, an organization devoted to the exploration, study and conservation of caves. It is a catchy motto and certainly should be practiced by anyone who ventures into a cave for any reason. Unfortunately however, far too many of America's caves have suffered from the activities of people who for one reason or another have not followed this simple rule. Whether the violation is made by an individual who insists on painting his name on the wall or by a commercial developer who is more interested in making a buck than in preserving a cave's natural beauty, the damage done may be long in healing or even irreversible.

The first part of the motto, "Take nothing but pictures;" is probably the most frequently violated part of the rule. For some reason, many cave explorers cannot resist the urge to break off a stalactite and take it home for a conversation piece. Other rocks and mineral formations in caves are frequently taken out of caves and sold at souvenir stores by people who are out for a quick profit. When these formations are taken from a cave, later visitors are deprived of a chance to view them in their natural state. At Carter Caves, the collection of any natural item is strictly prohibited and violators are in danger of prosecution.

Many people also enjoy taking cave animals home to show their friends. This is especially damaging to the cave ecosystem since many cave animals are very rare and may literally be wiped out by too much collecting. Anyone who wants a friend to see the animals can invite him to the cave so that the animals can be viewed in their wild state and left to continue as before discovered. The collecting of cave animals for school science projects further intensifies the problem. Only a well-trained biospeleologist may know whether or not the animal is in danger of extinction or depletion. Far too many times ~~has~~ a population of cave animals ^{has} been damaged by well-meaning but uninformed science students.


The second phrase in the motto, "leave nothing but footprints;" is another rule which is often broken. Many people who go into a cave feel that they must leave their names painted or scratched on the wall so that others will know that they were there. However, to a conservation-minded person who later comes into the cave, the name on the wall simply indicates that the person who wrote it must not have any respect for the natural beauty of the cave. In a similar way, many people take food into a cave and leave the empty wrappers to turn the cave into an underground garbage dump. This is not only unsightly, but may cause injury to other cavers if the materials left behind are glass or metal. Many cavers also dump the spent ash from their carbide lamps on the cave floor. This material is messy and may be poisonous to some animals in the cave. Anything taken into a cave should be brought out.

Commercial cave operators generally try to keep their caves clean. Sometimes, in their zeal to keep a cave attractive to tourists, they may do considerable damage. An example of this occurred in a commercial cave in western Kentucky when the cave owners had problems with moss growing around the lights. To get rid of the moss they treated the area with 2,4-D, a very toxic herbicide. The treatment killed the moss as planned but also leaked into the water and killed the cave flatworms and other animals. It is also thought that failure in later attempts to re-establish a colony of cave crayfish in the cave may have resulted from traces of poison remaining in the water. At Carter Caves State Park, any decision to make tourist oriented improvements in the caves must be made only after careful consideration of the impact it will have on the cave environment.

It is sad to realize that the third phrase of the motto, "kill nothing but time," has been violated occasionally at Carter Caves by some cruel and thoughtless individuals. Most such incidents have involved the Indiana Bat which, as

noted earlier, is listed by the federal government as an endangered species. Most biologists who study the bats agree that human disturbance is the main cause for the bat's decline in many areas, including the Bat Cave population. When this was brought to the attention of park officials at Carter Caves, they took a lead in protecting the bat by discontinuing tours through Bat Cave during the winter hibernation season and by constructing gates to discourage people from entering the cave. However, intrusion by curious tourists is not the worst thing that could happen to the bats. Threat of vandalism is the reason behind Bat Cave being the only non-developed cave in the park that is kept locked at all times. In an article appearing in the August 1973 issue of National Parks and Conservation Magazine, Arthur M. Greenhall gives the following gruesome account:

"A series of such disasters actually occurred at Carter Caves State Park, Kentucky. In the winter of 1957, hundreds of Indiana bats were killed when they were stoned from the low cave ceiling. In December, 1958, vandals discharged firecrackers and homemade bombs in the midst of the clusters. On December 26, 1960, three boys tore great masses of bats from the ceiling, then trampled and stoned the helpless animals. Thousands of these bats fell into a stream that flows through these caves and were drowned before they could arouse themselves from their torpid state. An estimated 10,000 bats were killed."

Although it is hard to even imagine anyone being so cruel and inhumane, park officials must guard against the possibility of such catastrophes in the future by locking Bat Cave and enforcing stiff penalties on anyone entering the cave without a permit. Concerned citizens should not only abide by the rules, but also report any violators that they see. The responsibility for preserving a  beneficial species belongs to all of us.

If the bat population disappears from Bat Cave, several other animals will doubtlessly disappear as well. As discussed in the chapter on cave ecology, biologists have found that many insects and other animals in Bat Cave are highly

dependent upon bat guano for food. If the bats die out, lack of food would cause the death of many unique living creatures which are now common in Bat Cave. This relationship, coupled with the fact that bats destroy millions of harmful insects each night, should provide an adequate reason for going to great lengths to protect the great population of Indiana Bats in Bat Cave.

GLOSSARY OF CAVE TERMS

aphotic zone - the area in a cave where no light enters from the outside.

biospeleology - the study of cave life.

cavernicole - any animal that lives in a cave.

cavernicolous - the habit of living in a cave.

crepuscular zone - the area in a cave where some light enters from the outside -- the "twilight zone".

epigean - the habitat outside of caves -- above ground.

guano - digestive wastes deposited in piles by certain animals. In caves guano is deposited by bats and crickets.

guanobic - the association of cave life dependent upon guano as a food source.

hypogean - the habitat inside caves -- underground.

speleology - the scientific study of caves.

troglobite - an animal that must live its entire life inside a cave. They are usually blind and have light coloration.

troglophile - an animal that can live in caves but may also live in cool, damp, dark places outside.

trogloxene - an animal which spends part of its life in caves but must occasionally move to the outside for some reason -- usually to find food.

xylophagous - the association of cave life dependent upon in-washed plant debris as a food source.

Inside back cover

David Bruce Conn was born and reared in the Southern Appalachian Mountains. He earned a B.S. degree in biology from Lee College in Cleveland, Tennessee and an M.S degree in biology from Morehead State University, Morehead, Kentucky. While at Morehead, Mr. Conn conducted extensive research in the ecology of cave animals in Carter Caves while writing his thesis. His research generated an interest that resulted in further exploration of the caves even after he had satisfied the requirements for the M.A. Degree. This book, Cave Life of Carter Caves State Park, is the product of a sincere dedication to excellence in the field of biological research.

