PHOLEOS

Journal Of The Wittenberg University Speleological Society

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PHOLEOS

Pholeos *(*Greek - *cave)* is a biannual journal of the Wittenberg University Speleological Society (WUSS), an internal organization of the National Speleological Society (NSS).

Purpose
The Wittenberg University Speleological Society is a chartered internal organization of the National Speleological Society, Inc. The Grotto received its charter in May 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.

WUSS Web page
http://www.wusscavers.com

Subscription rates are $10 a year for two issues of *Pholeos*. Back issues are available at $5.00 an issue.

Exchanges with other grottoes and caving groups are encouraged. Send all correspondence, subscriptions and exchanges to the grotto address.

Membership
The Wittenberg University Speleological Society is open to all persons with an interest in caving. Membership is $10 a semester or $20 a year and comes with a subscription to *Pholeos*. Life membership is $150.

Meetings
Meetings are held every Wednesday at 7:00 p.m. when Wittenberg University classes are in session. Regular meetings are in Room 319 in the Barbara Deer Kuss Science Hall (corner of Plum St. and Bill Edwards Dr. - parking available in the adjacent lot).

Submissions
Members are encouraged to submit articles, trip reports, artwork, photographs, and other material to the Editor. Submissions may be given to the Editor in person or sent to the Editor at the Grotto address. Guidelines for submitting research papers can be found on the inside back cover of this issue.

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Front Cover: This harvestman is one of numerous critters seen this summer with red mites hitching a ride. Photo by K. M. Kissell.

EDITOR'S NOTE

I bet you were not expecting to see a new issue of Pholeos so soon! After all, it has been nearly a decade since the club was able to publish two separate issues in one academic school year. However, we will hopefully be able to fulfill our "biannual" journal pledge in the future and there is no time like the present to start.

In this issue we are eager to share with you our preliminary overview of the Ohio Cave Bioinventory, a study that has encompassed three years, nearly 300 Ohio caves, and countless man-hours of hard work. We are also overly excited to announce the date for the celebration of the 30th Anniversary of the club - April 9th – 11th, 2010 (see page 3 for the official announcement). This is shaping up to be an exciting year and I can't wait to see what it brings. As always, if you are interested in submitting something for Pholeos please send me an email, after all we have another issue to put out within the next six months.

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MESSAGE FROM THE PRESIDENT

Howdy fellow cavers!

It feels like just yesterday I was still being called the freshman at WUSS meetings… oh wait, that was almost yesterday. Holly Kellar and I are now the Co-Presidents and finally seniors! WUSS has continued its active involvement with Erin Hazelton and the Ohio Department of Natural Resources in providing a detailed bioinventory of the caves and karst features throughout Ohio. In between trips, Jared Embree came up with the beautiful idea to make giant PVC puppets for the Doo-Da parade for this year's OTR. With a giant Bat Boy boasting a 9 m wing span and a 5 m tall Caver Girl in tow, we pranced around and took first place for the second year in a row! We'd like to extend a huge thank-you to the members of the CO house for dealing with sewing machine shenanigans and a disarray of fabrics throughout the basement and living room while we hustled to complete the projects.

It is the start of a new year and we've begun the preparation for the 30th anniversary, scheduled for the weekend of April 10th, 2010. We've had a great turn out of new freshmen this year and they continue to be eager to get underground! Though caving is limited because of White Nose Syndrome, we still have a full schedule with canoe trips, vertical clinics, hiking, and even some caving. I hope that this year brings eager new members and tons of time getting dirty! Remember to cave softly and be gentle with our environment.

Danielle Carey, Co-President
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Come See How Our Family Tree Has Grown!

You are invited to the 30th Anniversary Celebration
of the Wittenberg University Speleological Society
April 9th – 11th, 2010

A Pictorial Preliminary Assessment of the Cave Fauna of Ohio

Horton H. Hobbs III (WUSS #0001, NSS #12386 HM, CM, FE, SC)
Erin A. Hazelton (WUSS #0397)

Introduction

A stoop entranceway began the descent to a lower level where a pitfall trap had been placed three days prior. Having been to the cave back in July 1986 and having noted very little fauna when the trap was set, we were not anticipating much, if anything, to be in it on this warm July day in 2007. In spite of our jaundiced outlook we wanted to get a good idea of what did live here. After a low crawlway through the thin-bedded Ordovician limestone the passage quickly enlarged into a tiny room; we continued through a short winding channel that terminated at the top of a small pit. We climbed partway down the sturdy iron ladder that had been placed there by the land owner and then stemmed over to an intermediate level where we looked closely at the walls, ceiling, and floor for any life. We did see numerous heleomyzid flies ("red-eyed" flies - Figure 39), camel crickets (*Ceuthophilus* sp. - Figure 34), and several small spiders. We then descended to the lowest level of the cave and observed oligochaetes (earthworms) and additional spiders. We entered a short hands-and-knees crawlway and near the end of this passage, the white lid #12 came into view along with pink flagging tape, signaling that the pitfall trap we had placed earlier was dead ahead. A quick look into the trap and smiles were shared along with enthusiastic hollering! Somehow the odiferous Limburger cheese used as bait had attracted a blind beetle (or its prey and hence the beetle). This small, lightly colored reddish-brown beetle belonged to the genus *Pseudanophthalmus*, a rare find in Ohio and, at that time, only the third known locality for this group of carabids in the state (Figure 36). Carefully lid #12 was screwed onto the trap jar and, along with the flagging tape and screen, was put into a pack. So went a memorable trip to the small (34m THC) Bumbaugh's Cave in Brown County, Ohio (see Hobbs et al. 1986) which added fodder to the adage that you can't judge a book by its cover! Amazingly, one of the small spiders collected was subsequently identified to be *Phanetta subterranea*, a species unknown to Ohio!

Although numerous exciting discoveries have been made in the nearly 300 Ohio caves sampled during the past three years, not all that were entered resulted in anecdotal tales as noteworthy as the one above. Regardless, since the makeup and distribution of Ohio's cave fauna were poorly known (only a handful of studies focused on these cavernicoles – e.g., Hubbell 1936, Krekeler 1973, Beckett et al. 1977, and Hobbs and Flynn 1981), we initiated this biological inventory investigation which was supported by the Ohio Department of Natural Resources, Division of Natural Areas and Preserves with funds granted by the U. S. Fish and Wildlife Service, The Cleveland Grotto (third oldest National Speleological Society grotto), and the Ohio Biological Survey. Of significance, only 32 of the known caves in Ohio are located on ecologically managed properties (e.g., state and county preserves, land trust properties) (Hazelton 2008). Data from this study have been added to the Ohio Biological Survey and also stored in Ohio's Natural Heritage Database and will be used to aid in the management and protection of Ohio's karst resources.

Caves are divided commonly into a series of **ecological zones**, each of which demonstrates distinct biological, chemical, and physical properties. The ***threshold zone*** (subdivided into *entrance* and *twilight* zones) is an ecotone, serving as a transition province between surface (epigean) and subsurface (hypogean) environments and provides refuges from surface temperature and humidity extremes (Barr 1967, Hazelton and Hobbs 2003).

The ***transition zone*** of caves is a dynamic region of constant darkness (aphotic) where the microclimate is affected by ephemeral surface actions and subsurface conditions. Humidity and temperature

fluctuations occur, species diversity decreases, and lower biomass reflect the impact of both epigean and hypogean environments on this zone. As distances increase from the threshold zone, the transition zone shifts gradually into a more stable ***deep zone***. This part of the cave is characterized by permanent darkness, greater environmental reliability, practically no food production in most caves, and a community typically characterized by few, relatively small, sparse, troglomorphic, aquatic and terrestrial invertebrates.

Historically, organisms residing in subterranean environments have been assigned to an assortment of classification systems reviewed recently by Boutin (2004). ***Cavernicole*** is applied to an inhabitant of caves that has no restrictions placed upon it concerning its association with the cave environment. Although not accepted by all students of biospeleology, the terms *troglofauna* and *stygofauna* are utilized for subterranean terrestrial and aquatic fauna, respectively. ***Trogloxenes*** ("cave visitors") are terrestrial species that spend varying amounts of time in caves but also are part of epigean communities, usually living and feeding in surface habitats (e.g., crickets, bats, birds). ***Troglophiles*** ("cave lovers") are facultative cavernicoles, capable of living and reproducing in caves but also can occur in epigean habitats (e.g., the Long-tailed Salamander, *Eurycea longicauda*). ***Troglobionts*** are permanently and obligately troglomorphic, hypogean species (e.g., blind beetles). The prefix "stygo-" is applied to aquatic cavernicoles; ***stygoxene***, ***stygophile***, and ***stygobiont*** share definitions similar to those for the troglofauna categories except these are limited to aquatic cave-dwelling fauna. In the following checklist the following abbreviations are utilized: AC = accidental, TX = trogloxene, TP = troglophile, TB = troglobiont, SX = stygoxene, SP = stygophile, and SB = stygobiont.

Methods and Materials

Much of the field work was carried out during the summers of 2007-2009, mostly by a core of Wittenberg University Speleological Society members, past and present. During 2007 the majority of efforts were focused on caves in Adams, Brown, Clark, Pike, and Ross counties (Figure 1) although a week was spent on S. Bass Island in Lake Erie (Ottawa County). Thirty days were spent in the field sampling 89 caves, eight of which were new, and surveying 1100m (3608.9ft) of passages. In 2008 we directed our

Figure 1. Map of Ohio showing location of all counties sampled during study.

efforts to caves and springs in Champaign, Delaware, Erie, Franklin, Greene, Highland, Logan, Miami, Montgomery, Preble, Seneca, Shelby, and Wyandot counties and we returned to S. Bass Island for a week. The team spent 37 days in the field, sampled more than 100 caves, and discovered more than 20 new caves. Twenty-four caves were surveyed resulting in 499.56m (1638.9ft) of passages. All of the karst features sampled (caves, springs, sinkholes, blue holes) were located in the western half of the state within the seven major karst regions (Figure 2; see Hobbs 2009) and were developed in Ordovician, Silurian, and Devonian dolomites and limestones (see Hovarth 1967, Hamilton and Forsyth 1972, Swinford 1985, and Hull 1999 for information on the stratigraphy of the carbonate rocks of Ohio). Additionally, in February 2008, we initiated the bioinventory study of rock shelter/overhangs in the Black Hand sandstone formation in eastern Ohio by looking for bats in Fairfield and Hocking counties and this continued into 2009. We located and sampled 38 caves and springs in Medina and Summit counties, all of which were associated with the Sharon

Figure 2. Seven major karst regions of Ohio; S & O = Scioto and Olentangy (Hobbs 2009).

Conglomerate (see Ver Steeg 1932, Stout 1944, Tague 1953, and Corbett and Manner 1988 for details of the conglomerate). During the summer of 2009, survey efforts were focused on caves in northeastern Ohio (Cuyahoga, Geauga, Holmes, Lake, Loraine, Portage, and Summit counties). However, several caves and shelters in Holmes, Muskingum, Ottawa, Tuscarawas, and Wood counties were documented as well. We spent 26 days in the field, sampled 65 caves and shelters in northeastern Ohio; one cave and one shelter in Holmes County (sandstone); one cave and one shelter in Muskingum County (sandstone); three caves in Ottawa County (carbonate); four caves, one shelter, and one arch in Tuscarawas County; and two caves and one shelter in Wood County (carbonate) for a grand total during 2009 of 80 caves, arches, and shelters visited, with 41 of these being new to the survey. We also surveyed 11 caves for a total of 633.9m (2,079.19ft) of horizontal passages.

On field days, one or two groups of at least two individuals (but usually three to four) departed from the area's base camp to conduct faunal surveys. Each team had a certain group of caves to locate and sample and/or a specific area to appraise. In each cave, various techniques were used to assess the fauna: hand/eye collection/recognition, terrestrial pit-fall traps baited with Limburger cheese, and aquatic baited (shrimp/fish) traps. Many caves were visited twice when baiting was deemed appropriate, with terrestrial and aquatic traps set during the first visit and retrieved on the second. However many caves did not have extensive passage development and thus were heavily influenced by surface fauna. Baiting these caves usually resulted in disturbed traps and very little fauna. Traps were retrieved after three days during the second trip and hand collections were made during both visits. The number of traps deployed varied from one to four per cave and was dependent on the length of the cave and field conditions. If the cave had not been surveyed previously and sufficient time was available, a survey using a Suunto compass and clinometer, and a Leica Disto A6 laser rangefinder was made.

Credit for photographers is given for each of the following figures using the letters: EH – Erin Hazelton, HH – Horton Hobbs, KK - Kevin Kissell, WS – Bill Stitzel.

During the initial visit, cavers made a visual inspection of available microhabitats and collected specimens by hand, focusing on allochthonous debris (e.g., leaf or wood detritus, scat), areas beneath cobble-sized rocks, mud banks, crevices along the floor, walls, or ceiling, stream riparian areas, and within drip pools or streams (on and beneath rocks). A small paint brush (Figure 3) or an aspirator (Figure 4) were used to

Figure 3. Holly Kellar hand collecting terrestrial fauna with the aid of a small paint brush in Kindt's Cave II, Ottawa County, Ohio [KK].

Figure 4. Matt Hazelton using an aspirator to collect microarthropods in Ellison's Cave, Highland County, Ohio [HH].

collect terrestrial organisms and aquatic animals were obtained via vacuuming with a turkey baster (Figure 5, 6) or were brushed from rock removed from the stream or pool. All specimens collected were placed in plastic vials (21mm x 70mm) and preserved in a 70% ethanol solution except for spiders, which were placed into a 95% ethanol solution (preserved for future molecular analyses). A limited representative sample of individuals observed was collected and preserved except for tubellarians (flatworms) and oligochaetes (earthworms). Both of these faunal groups require special preservation techniques in the field and currently there are no taxonomic specialists to provide identification to the level of species.

Pitfall traps used for attracting terrestrial fauna consisted of a plastic container (pre-numbered) 6.4cm in diameter and 11cm in height. At the chosen site, a hole was dug with the aid of a trowel and the container was lowered into the hole. Bait consisted of a piece of Limburger cheese about 1cm^2 that was wrapped

Figure 5. Use of a turkey baster and tea strainer to collect aquatic fauna [HH].

Figure 6. Turkey baster removing copepods from an epikarstic drip pool in Kindt's Cave II, Ottawa County, Ohio [HH].

Figure 7. Kerry Siddens and other team members putting Limburger cheese in cheese cloth for pitfall trap baits [EH].

Figure 8. Pitfall trap with Limburger cheese bait in Hogwaller Cave, Pike County, Ohio [HH].

Figure 9. Flagging tape and trap top (#118) used to help relocate trap on return trip to cave [KK].

Figure 10. Erin Hazelton and Richard Hand examining contents of pitfall trap after removal in Skull Cave, Ross County, Ohio [HH].

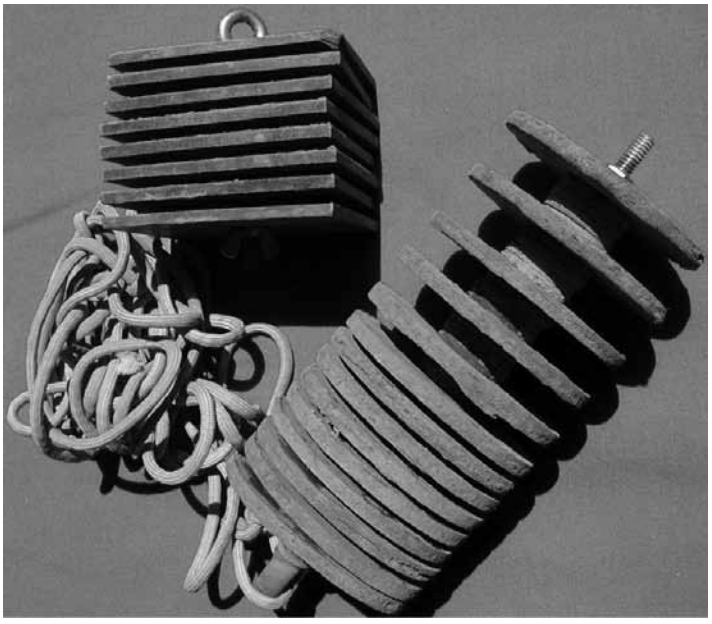

Figure 11. Multi-plate Dendy samplers [HH].

Figure 12. Washing machine lint traps and nylon mesh used for holding shrimp or fish bait for aquatic traps [HH].

in a 8cm^2 piece of cheese cloth (Figure 7) and then suspended with a paper clip about 2cm beneath a metal wire 5mm x 5mm mesh screen which was placed on top of the trap (Figure 8). Soil was filled in around the trap to a level that was flush with the trap top, covering the screen edges.

The top to the trap was placed nearby along with flagging tape (Figure 9) and the location and number of the trap were recorded in a field notebook. Three days later the cave was revisited and the trap

relocated. First, the area around the trap was examined for any organisms. The mesh screen was removed carefully and inspected for fauna crawling on the bait or hanging from the screen which were brushed into the trap. The trap was then pulled from the substrate and, depending on conditions, capped to be processed later or examined and specimens removed to a screw-capped plastic vial with appropriate preservative (Figure 10). All stygobionts and troglobionts as well as other less cave-adapted cavernicoles were collected and preserved.

Aquatic traps were placed in isolated pools or various places within streams. Traps used were either multi-plate Dendy samplers (Figure 11), baited washing machine lint trap bags, or nylon mesh (Figure 12), the latter two baited with a small piece of shrimp or fish. As with terrestrial traps, these were checked three days after being placed and organisms caught in any of the traps were identified or preserved immediately in 70% ethanol.

Upon completion of field studies, all specimens were transported to the laboratory at Wittenberg University where all traps and vials (holding hand-collected specimens) were sorted individually and each specimen was examined under a dissecting microscope and identified to lowest taxonomic level possible. Specimens were placed in glass vials containing appropriate preservative and with identifying labels. Groups of specimens belonging to common taxonomic levels were then packaged and sent to corresponding taxonomic experts who had previously agreed to identify specimens to specific level (see list of specialists in Table 1).

All of these procedures are similar to those employed by Fong et al. (2007) in their investigation of the invertebrate fauna of West Virginia caves.

Although used only rarely, a plankton net was employed to collect small microarthropods in water sufficiently deep to deploy the sampler (Figure 13).

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Table 1. List of cave faunal groups and the corresponding taxonomists who have (and will) provided specimen identifications.

Amphipoda	John R. Holsinger (Old Dominion University)
Isopoda (aquatic)	Julian Lewis (Lewis & Associates LLC)
Isopoda (terrestrial)	Ralph Gibson (Cleveland State University)
Acari	Miloslav Zacharda (Czech Republic Academy of Sciences)
Aranaea	Pierre Paquin (SWCA Environmental Consultants)
Pseudoscorpiones	James Cokendolpher (Texas Tech University Museum)
Collembola	Felipe Soto-Adames (Illinois Natural History Survey)
Diplopoda	William Shear (Hampden-Sydney College)
Coleoptera	Stewart Peck (Carlton University); Carmen Trisler (Wittenberg University)
Decapoda	Horton H. Hobbs III (Wittenberg University)

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Figure 13. Juday Plankton net (49µm mesh) [HH].

Figure 15. Christy Taylor taking a water sample in Paradise Cave (formerly a show cave on S. Bass Island), Ottawa County, Ohio [HH].

Physicochemical data were taken using a YSI Model 55 oxygen meter and a YSI Model 30 salinity, conductivity, and temperature instrument (Figure 14). Water samples were collected in a 1litre Boston Bottle (Figure 15) for subsequent analysis using a Hach DREL/2400 Water Quality Laboratory.

Figure 14. YSI instruments in use at Wet Cave (Cave of the Springs), Highland County, Ohio [HH].

Additionally, members of The Cleveland Grotto began locating and surveying the caves on Green Island in Lake Erie and some of the small caves in Lake and Medina counties; these two projects were headed by Curt Harler, Chad Waffen, and Frank Vlchek.

Results

Numerous specimens have not been identified to the species level and thus at this time we cannot offer a definitive description of the cave fauna of Ohio. In spite of this restriction, we can provide a pictorial account of many taxa occupying the caves and springs of the state [by no means a complete list of fauna and, in fact, entire groups (e.g., Acarina – mites) are missing from this treatment]. In spite of numerous shortcomings this should be a useful contribution to those individuals who share an interest in the subterranean fauna of caves and specifically of Ohio. Additionally, it provides preliminary documentation for these cavernicoles, some of which are site-specific endemics. A detailed presentation of Ohio's cave fauna will appear in a future publication.

PHOTOGRAPHIC CHECKLIST OF REPRESENTATIVE OHIO CAVERNICOLES

Phylum Platyhelminthes Class Turbellaria

Planarians occur in a variety of aquatic cave habitats, including on and under stream cobble and gravel, in drip (epikarst) pools, and pools within streams (Figure 16). For additional information on cave planarians, see Kenk (1970, 1977) and Carpenter (1982).

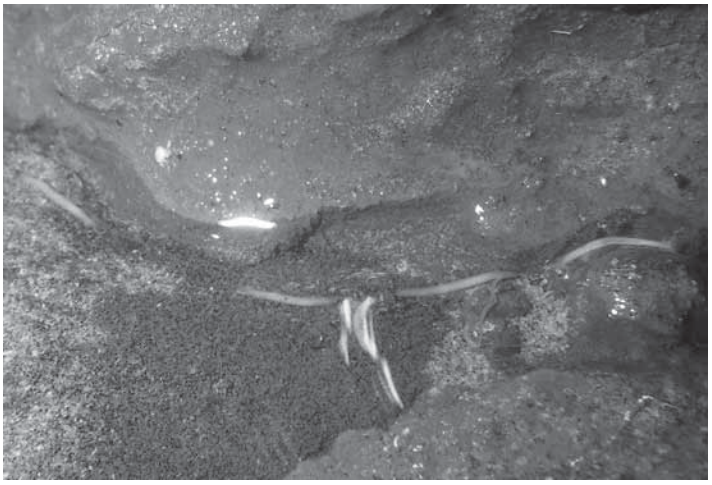


Figure 16. Unidentified planaria (SB) gliding on a silt and sand-bottomed, small pool in Kessler's Cave, Highland County, Ohio [HH].

Phylum Nematomorpha (Hairworms)

Hairworms or horsehair worms (AC/TX/TP) are observed fairly often in caves as adults. These interesting worms have a complex life history, beginning as an egg that hatches into a preparasitic larva, a parasitic larva that develops within an invertebrate (mostly within camel crickets for our discussion), and a free-living aquatic adult (see Poinar 2001 and Schmidt-Rhaesa et al. 2003) (Figure 17).

Figure 17. This unidentified worm, demonstrating the proverbial "Gordian knot", was observed in large numbers in Fern Cave, Adams County, Ohio, 18 July 2007 [HH].

Phylum Annelida
Class Clitellata
Order Oligochaeta
Family Lumbriculidae

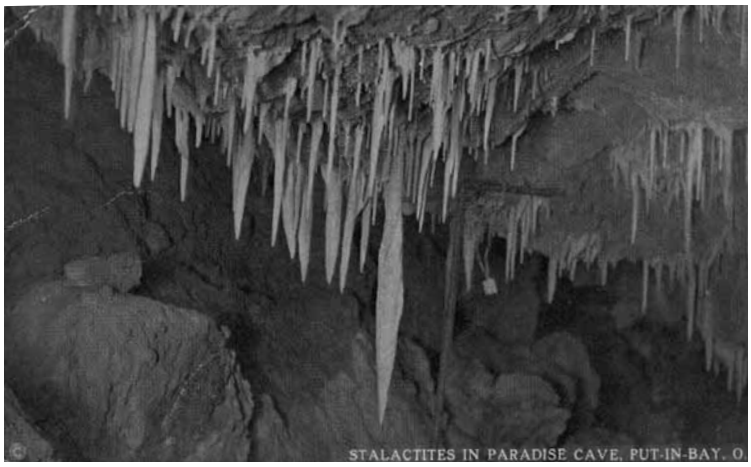
An unidentified oligochaete inhabits the sand and small gravel substrate of a small trickle in McKimie Cave, Highland County, Ohio (Figure 18). Oligochaetes (aquatic and terrestrial) are common inhabitants (TP/TB/SB) of the gravel substrata of streams and soils associated with caves.

Figure 18. *Stylodrilus* (?) sp. – an aquatic oligochaete in McKimie Cave, Highland County, Ohio [KK].

Phylum Arthropoda
Class Malacostraca
Order Amphipoda

Amphipods belonging to four genera, *Bactrurus*, *Crangonyx, Gammarus*, and *Synurella*, have been observed in Ohio caves and springs (Figure 19). These small crustaceans (SP/SB) are prominent components of aquatic ecosystems and are often associated with several species of isopods. See Holsinger (1972), Koenemann and Holsinger (2001), and Zhang and Holsinger (2003) for additional information on amphipods inhabiting ground waters.

Figure 19. Unidentified amphipod (SP?) from Ellison's Cave, Highland County, Ohio [HH].



Order Isopoda

Aquatic isopod crustaceans are represented by species assigned to the genera *Lirceus* (SP) (Figure 20) (although this is a complex of stygoxenic/stygophilic species requiring taxonomic attention, the reader is referred to Hubricht and Mackin 1949) and *Caecidotea* (Figure 21), the members of which are stygobionts. The terrestrial species found in Ohio caves are fairly diverse and although many are characterized as accidentals, several species are trogloxenes or troglophiles (Figure 22).

Family Asellidae

Figure 20. *Lirceus fontinalis* Rafinesque (SX) from Ellison's Cave, Highland County, Ohio [HH].

Figure 21. *Caecidotea rotunda* Bowman and Lewis (SB) from Frost Cave, Pike County, Ohio [HH].

Family Armadillidiidae

Figure 22. *Armadillidium nasatum* Budde-Lund (TX) from Ellison's Cave Highland County, Ohio [HH].

Order Decapoda

Decapod crustaceans are represented in Ohio's caves and springs by several species of crayfishes belonging to the genera *Cambarus* (SP) (Figure 23) and *Orconectes* (SX/SP).

Figure 23. Form I (breeding) male of *Cambarus* (*Cambarus*) *bartonii cavatus* Hay from Freeland's Cave, Adams County, Ohio [HH].

Class Arachnida
Order Acarina (Mites and Ticks)

The Blacklegged (or Deer) Tick is occasionally observed in caves (Figure 24). It is an ectoparasite of large mammals and is probably brought into caves when attached to raccoons or other mammals.

Figure 24. Male tick, *Ixodes cookei* Packard (AC) on the cave floor in the threshold zone of Buckskin Cave I, Ross County, Ohio [HH].

Order Aranaea
Family Tetragnathidae (Longjawed Orbweavers)

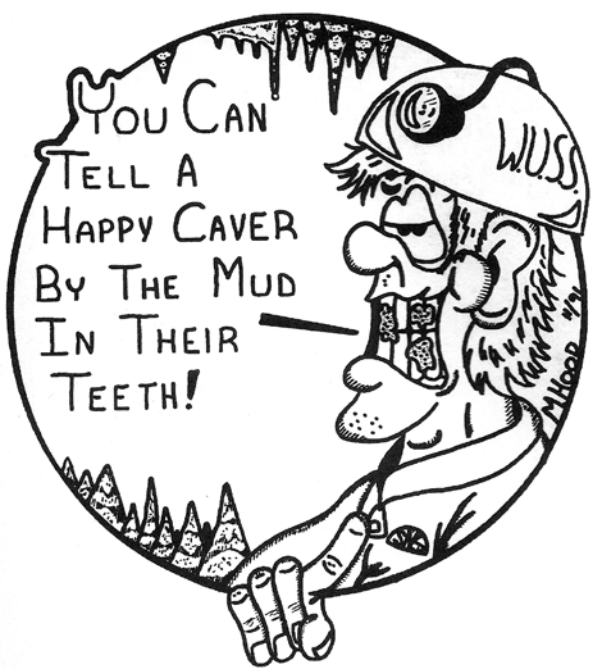
***Meta ovalis* (Gertsch)** (TP) – Like crickets, this spider is one of the most common inhabitants of the threshold zone of caves. This is a large species with a conspicuous orbed web and is quite abundant in many caves (Figure 25).

Figure 25. This female *Meta ovalis* and her egg case were seen in Cedar Forest Cave 4, Ottawa County, Ohio on 20 June 2008 [HH].

Family Pisauridae (Fishing Spiders)

These large spiders are typically observed along the margins of streams or springs among rocks or vegetation. They are frequently encountered within caves (Figure 26), both in the threshold and deep, dark zones.

Figure 26. *Dolomedes scriptus* Hentz (TX) was observed with an egg case in Paradise Cave, Ottawa County, Ohio, 06 August 2007 [HH].



Order Pseudoscorpionida
Family Chthoniidae

***Apochthonius hobbsi* Muchmore** (TB) – The Buckskin Cave Pseudoscorpion is a large, blind pseudoscorpion that is a site-specific endemic species, restricted to Buckskin Cave I, Ross County, Ohio (Muchmore 1994)(Figure 27).

Figure 27. Photograph of *A. hobbsi* from the type locality [HH].

***Chthonius virginicus* Chamberlin** (TX) – This species was identified originally by William Muchmore and reported by Hobbs and Flynn (1981) as *Chthonius tetrachelatus* (Preyssler). Subsequent evaluation by Muchmore (1994) led to the conclusion that the specimens from several Ohio caves, including Trimmer's Cave (Figure 28), were indeed *C. virginicus* and not *C. tetrachelatus*. Known previously from forest litter epigean environments in the mid-Atlantic states, its recognition from Ohio was the first record from the interior of the United States as well as from a cave, where Muchmore considered it to be an accidental occurrence. Since it was collected in July of 1980 and again from Trimmer's Cave in June 2007, it seems that the species should be labeled a trogloxene, at least in the several Ohio caves from which it is known.

Figure 28. *Chthonius virginicus* from Trimmer's Cave, Ross County, Ohio; adult on left, juvenile on right, 07 June 2007 [HH].

Family Chernetidae

***Hesperochernes mirabilis* (Banks)** (TB) – This species is observed usually on the floor of caves in bat guano or in the middens of pack rats (see below) and is common in caves in the southeastern United States. In the five Ohio caves from which it is known (Figure 29), there is limited bat and rat occurrence and the populations in Ohio and Indiana are considerably disjunct from those to the south and east (Muchmore 1994).

Figure 29. *H. mirabilis* (?) from Alpha Cave, Highland County, Ohio [HH].

Order Phalangoda

Harvestmen (TP) – these "Daddy Long Legs" are quite common in Ohio caves (Figure 30) and are found in the threshold zone as well as in deep cave.

Figure 30. Unidentified harvestman with ectoparasitic mites in Zane Caverns, Logan County, Ohio [KK].

Class Diplopoda

Millipedes are an ancient, very diverse group of terrestrial arthropods and occur primarily in moist, deciduous habitats. They feed almost exclusively on decaying plant matter and associated microbes and can occur in very high densities, even in caves (Figure 31).

Figure 31. An unidentified millipede from Parker Spring Cave, Geauga County, Ohio [KK].

Class Chilopoda

Centipedes are very common within leaf litter and duff on the surface and do appear in caves (Figure 32) most commonly in the threshold zone (TX).

Figure 32. This large, unidentified centipede was observed in Wet Cave (Cave of the Springs), Highland County, Ohio [HH].

Class Entognatha
Order Collembola
Families Entomobryidae, Tomoceridae, Onychiuridae, Sminthuridae

Collembola (springtails) (TP, TB) are abundant in most Ohio caves (Figure 33) and are associated with damp, decaying organic material of a variety of sources (e.g., guano, scat, vegetative debris).

Figure 33. An unidentified member of the genus *Tomocerus* from Cave Hill Cave, Adams County, Ohio [KK].

Class Insecta
Order Orthoptera
Family Gryllacrididae

Camel Crickets (TX) are one of the most ubiquitous organisms to inhabit the threshold zone of caves. Numerous species of the genus *Ceuthophilus* have been recognized from carbonate and non-carbonate caves throughout the state (Figure 34) and *Hadenoecus puteanus* (Scudder) is known from at least one cave in Vinton County. For a comprehensive treatment of these crickets, see Hubbell (1936) and Hubbell and Norton (1978).

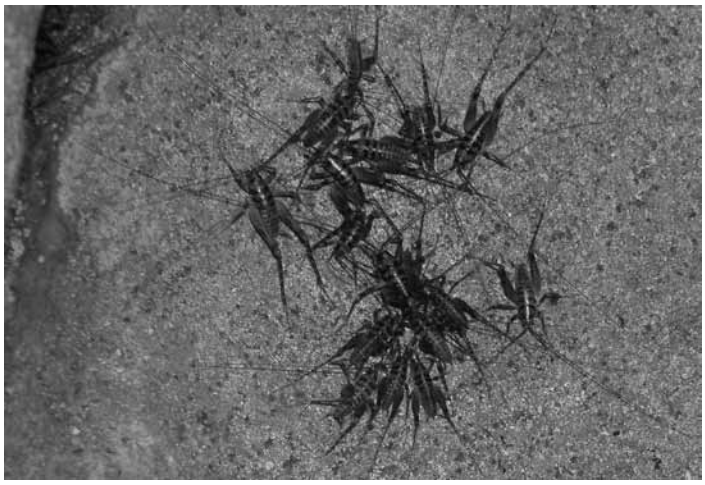


Figure 34. *Ceuthophilus* sp. cluster on ceiling in Stout Run Cave, Adams County, Ohio [EH].

Order Coleoptera (Beetles) Family Carabidae

Numerous beetles belong to this family and range from accidentals to highly specialized troglobionts.

***Pseudanophthalmus krameri* Krekeler** (TB) – The endemic Kramer's cave beetle was described by Krekeler (1973) from Cave Hill Cave, Adams County, Ohio. In spite of seasonal searches from August 1994 to April 1996 (Hobbs 1996, 1997) and three additional visits through February 2008, no individuals of this species have been observed since its description. It is likely that this troglobiont has been extirpated, possibly from the spraying of pesticides above the cave. Even though we do not have a photograph of this site-specific endemic species, we have included it within this paper to underline the potential plight of all cave communities in response to anthropogenic disturbances.

***Pseudanophthalmus ohioensis* Krekeler** (TB) – The Ohio cave beetle also is a site-specific endemic, state endangered species; its global status is listed as G1 (Critically Imperiled). It is found in the stream level of Freeland's Cave (Figure 35) where this omnivore/ occasional predator is observed on gravel margins of the stream and on riparian mud banks. This obligate cavernicole is likely a Pleistocene relict species.

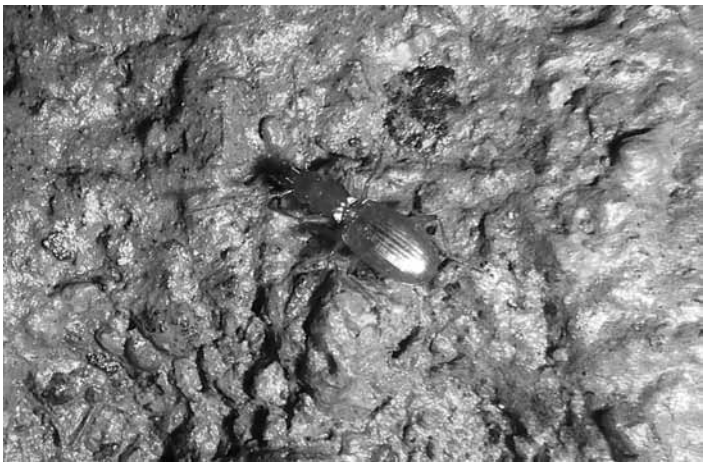


Figure 35. The Ohio cave beetle in Freeland's Cave, Adams County, Ohio [HH].

***Pseudanophthalmus* sp.** (near *P. ohioensis*) (TB) – This blind beetle is the one referred to in the opening paragraph of this paper (Figure 36). It also is an obligate cave species and currently known only from Bumbaugh's Cave. An additional specimen of the genus was collected from Wet Cave (Cave of the Springs), Highland County, Ohio in May 2008.

Figure 36. The unidentified blind beetle (*Pseudanophthalmus* sp.) from Bumbaugh's Cave, Brown County, Ohio [HH].

Family Staphylinidae (Rove Beetles)

***Quedius* sp.** (TP) –This and other species of rove beetles were observed in raccoon scat and other organic debris in numerous caves throughout the state (Figure 37). See Klimaszewski and Peck (1986), Peck and Thayer (2003), and Moseley et al. (2006) for additional information on this family of beetles.

Figure 37. *Quedius erythrogaster* Mannerheim (?) from Cave Hill Cave, Adams County, Ohio [WS].

Order Diptera (Flies)
Family Tipulidae

Tipulids (crane flies) (TX) along with culicids (mosquitoes) (TX) are important constituents of the threshold zone of caves (Figure 38) and can attain very high densites.

Figure 38. One of many crane flies in Ellison's Cave, Highland County, Ohio [HH].

Family Heleomyzidae

Heleomyzid flies (TX/TP) are fairly common in midwestern caves (Figure 39), particularly during the winter months. They are rarely seen near the floor of cave passages and can be quite numerous on ceilings and walls.

Figure 39. The walls within the threshold zone of Dry Bone Cave, Pike County, Ohio were densely covered with this unidentified red-eyed fly on 15 June 2007 [HH].

Family Mycetophilidae (Fungus Gnats)

These small adult flies are abundant in caves and are particularly associated with fungus. The larvae spin complex webs (Figure 40) and feed on fungal spores and may even be predacious.

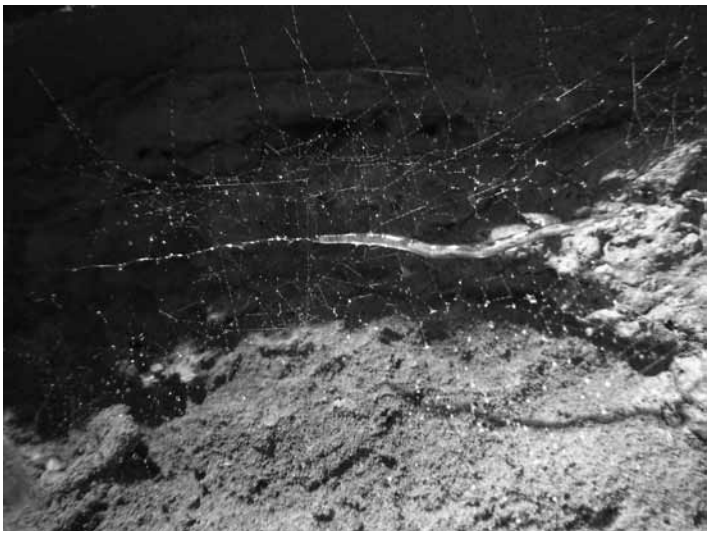


Figure 40. Larval fungus gnat (TP) (*Macrocera* sp.?) in Cave Hill Cave, Adams County, Ohio [HH].

Phylum Craniata (Chordata) Subphylum Vertebrata Class Amphibia Order Urodela Family Plethodontidae (Lungless Salamanders)

***Desmognathus fuscus* (Rafinesque)** (TX or TP?) – The dusky salamander is one of the most widely distributed in North America and is typically observed under flat rocks and debris in streams, springs, and seeps. Occasionally it is an inhabitant of cave streams (Figure 41) and is known from at least 56 counties in Ohio (Pfingsten and Downs 1989).

Figure 41. The dusky salamander from Dart's Cave, Geauga County, Ohio [KK].

***Eurycea bislineata* (Green)** (TX or TP?) – Although normally an epigean species, this two-lined salamander is fairly common in the threshold zone of caves (Figure 42) and usually is associated with moist leaf litter or beneath rocks and allochthonous debris along the margins of cave streams. *E. bislineata* is likely a species complex; see Guttman and Karlin (1986), Jacobs (1987), Pfingsten and Downs (1989), and Petranka (1998).

Figure 42. *Eurycea bislineata cirrigera* from Reif's Cave, Ross County, Ohio [KK].

***Eurycea longicauda* (Green)** (TP) – The long-tailed salamander is most frequently observed beneath logs and rocks along the margins of shaded streams, springs, and seeps. It can be abundant in caves (Figure 43), particularly during the hot, dry months in the southern parts of its range (see the following references for additional information on cave populations: Mohr 1944; Hutchison 1956, 1958).

Figure 43. A long-tailed salamander in Freeland's Cave, Adams County, Ohio [KK].

***Gyrinophilus porphyriticus* (Green)** (TP) – The spring salamander is most often observed in springs, seepages, caves, and first order streams lacking predatory fishes. Larvae inhabit cave streams in Kentucky, Ohio (Figure 44), Virginia, and West Virginia (see Bruce 1972, Pfingsten and Downs 1989).

Figure 44. A mature larva of *Gyrinophilus porphyriticus duryi* from Freeland's Cave, Adams County, Ohio [KK].

***Plethodon cinereus* (Green)** (TX or TP?) – The Northern redback salamander is found almost exclusively north of the glacial boundaries and is characteristic of relatively cool and moist conditions of hardwood forests during the growing season. It occupies caves (Figure 45) occasionally but is primarily an epigean species.

Figure 45. The Northern redback salamander from The Squeeze Cave, Portage County, Ohio [KK].

***Plethodon glutinosus* (Green)** (TP) – The Northern slimy salamander is the most often observed moderately-sized salamander in Ohio and is characterized by a black dorsal surface with scattered white flecks. In the epigean environment it is encountered on talus slopes, and beneath rocks and logs and is often found with the Eastern Newt (see right) as was noted in Super Sink, Adams County, Ohio (Figure 46). This species frequently occupies caves (Noble and Marshall 1929, Peck 1974) and it can use caves as refugia from hot, dry surface conditions (Hazelton and Hobbs 2003).

Figure 46. The slimy salamander in Super Sink, Adams County, Ohio [HH].

Family Salamandridae (Newts)

***Notophthalmus v. viridescens* (Rafinesque)** (AC/TX) – The Eastern newt has a complex life history involving the egg, an aquatic larval stage, a terrestrial eft phase, and an aquatic adult stage. It is in this eft stage that it is found under logs and occasionally in moist sinkholes and cave entrances (Figure 47) (see Pfingsten and Downs 1989).

Figure 47. The terrestrial eft stage of *N. v. viridescens* in Super Sink, Adams County, Ohio [KK].

Order Anura
Family Ranidae (Frogs)

***Lithobates palustris* (Le Conte)** (TP) – Pickerel frogs are occasional inhabitants of caves (Figure 48), particularly during winter months (see Brode 1958 and Resetarits 1986). Similar in appearance to the Leopard Frog, *Rana pipiens* Schreber which also sometimes over-winters in caves (Rand 1950), they can be readily distinguished by the yellow to orange concealed (mesial) surfaces of their thighs.

Figure 48. This pickerel frog was at the entrance to Preston Cave III, Adams County, Ohio [HH] (note Turkey Vulture down feather – young birds occupied this cave 14 July 2007).

Class Reptilia
Order Squamata (Lizards and Snakes)
Suborder Serpentes (Snakes)
Family Natricidae

***Nerodia sipedon insularum* (Conant and Clay)** (TX) – The Lake Erie water snake is a unique subspecies of the Northern Water Snake; this aggressive, nonpoisonous reptile is restricted in distribution to the islands of Lake Erie (Figure 49). It is viviparous in that it has live birth instead of laying shelled eggs. See King and Lawson (1997) for additional information on this distinct water snake.

Figure 49. This is a recently born young, one of many observed in Larcomb's Cave, Ottawa County, Ohio on 19 June 2008 [HH].

***Storeria dekayi* (Holbrook)** (AC) – These small snakes are observed usually under rocks, logs, old boards, etc. where they feed on snails, slugs, earthworms, and some insects. The brown snake is not typically a cavernicole (Figure 50) and probably rarely ventures into caves.

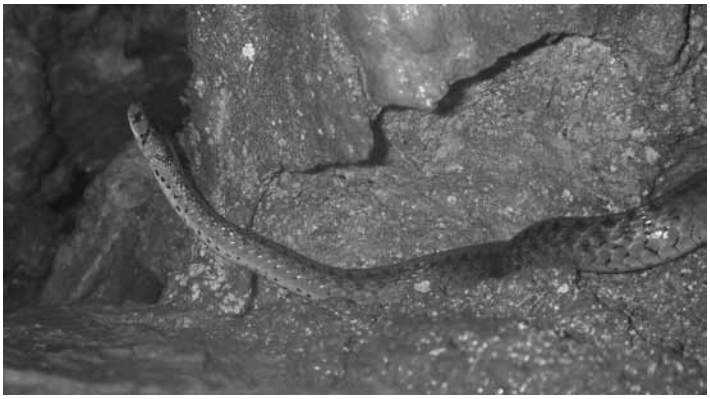


Figure 50. *Storeria dekayi dekayi* x *wrightorum* in Dancing Cave, Highland County, Ohio [KK].

Class Aves (Birds)
Order Passeriformes (Perching Birds)
Family Tyrannidae (Tyrant Flycatchers)

***Sayornis phoebe* (Latham)** (TX) –Eastern phoebes are common inhabitants of the threshold zone of caves (Figure 51), building their nests in the entrance or twilight zones where eggs are laid.

Figure 51. On 15 July 2007 these young Eastern phoebes were in the nest in the entrance to Kessler's Cave, Highland County, Ohio [WS].

Class Mammalia
Order Chiroptera (Bats)
Family Vespertilionidae

***Perimyotis subflavus* (Menu)** (TX) – This small, solitary bat is the most commonly occurring bat in Ohio caves (Figure 52). Its fur is tri-colored (roots dark, middle pale, tips dark), its face, ears, and forearms are pinkish, and its tragus is broad. It is found typically in the deep, dark zone of caves hanging from the ceiling or walls and is almost never immediately adjacent to or touching another bat. For additional information on this and other bat species refer to Mills (1971), Mills et al. (1975), and Kunz and Fenton (2003); for an informative discussion on the conservation of bats the reader is directed to Fenton (1997).

Figure 52. A solitary bat in Frost Cave, Pike County, Ohio [HH].

***Eptesicus fuscus* (Beauvois)** (TX) – The big brown bat is a relatively large, usually dark brown bat that is commonly observed in caves, particularly during the winter months (Figure 53). Individuals often occupy crevices where they pack themselves tightly into small cracks particularly near entrances where temperatures approach 0°C.

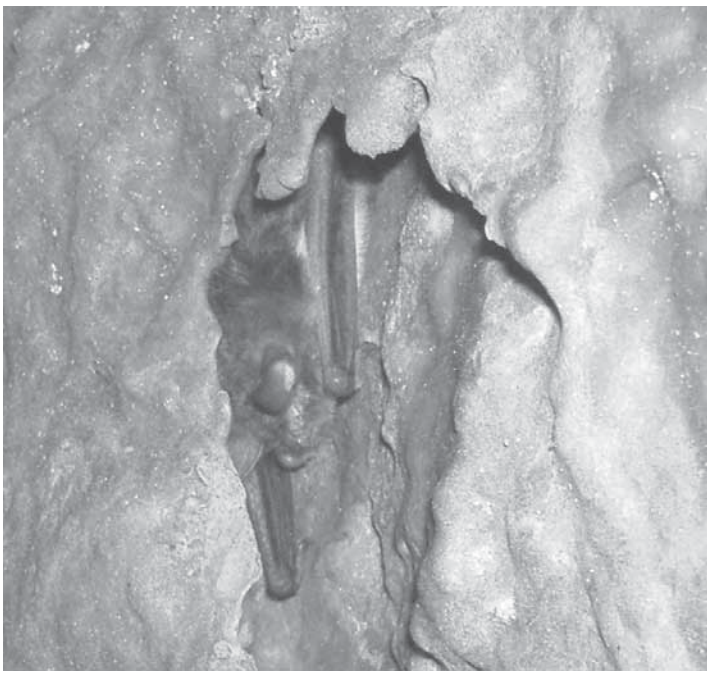


Figure 53. A big brown bat partially behind a flowstone coating on a wall in Black Run Cave, Adams County, Ohio [EH].

***Myotis lucifugus* (LeConte)** (TX) – The little brown bat is a common inhabitant of Ohio caves and is one of the few species that will hibernate in these grottoes (Figure 54).

Figure 54. This cluster of *Myotis lucifugus* was in the ceiling passage between two entrances in Skull Cave, Ross County, Ohio, 07 June 2007 [HH].

Order Rodentia (Rodents)
Family Muridae

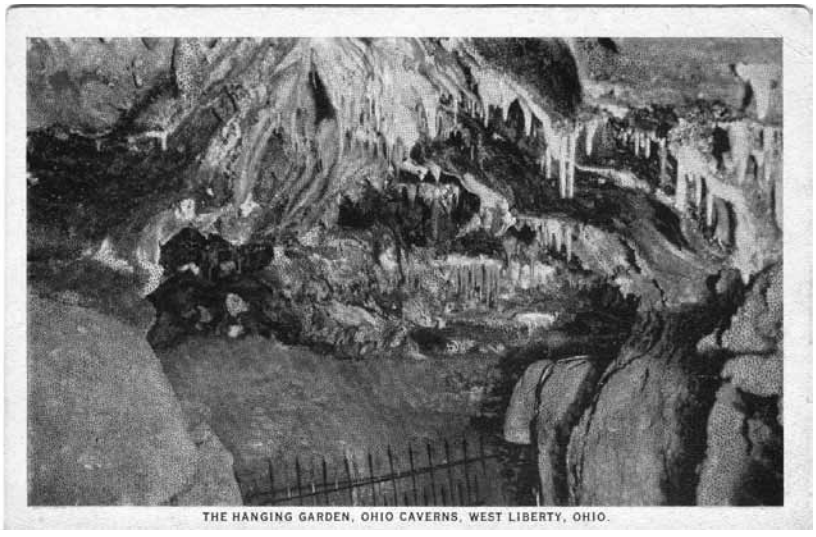
***Neotoma floridana* (Ord)** (TX) – The Eastern woodrat (Pack Rat) is primarily a herbivore and lives in rugged, rocky terrain and often occupies caves in the southern part of the state (Figure 55). Globally this is considered a secure species (G5) but in Ohio, it is rare and is classified as an Endangered Species. See Wiley (1980) for additional information about this species.

Figure 55. This Eastern woodrat midden is characteristic of the species and was found on 8 August 2007 in Widow Maker Cave, Adams County, Ohio [EH].

Order Carnivora (Carnivores)
Family Procyonidae (Raccoons)

***Procyon lotor* (Linnaeus)** (TX) – Raccoons are nocturnal, opportunistic, omnivores that are readily recognized by their "mask" and the ringed, bushy tail (see Lotze and Anderson 1979). Although rarely encountered in caves, they certainly visit them often and scat (Figure 56) and footprints were observed in a large percentage of caves sampled.

Figure 56. Piles of scat, such as observed in Hogwaller Cave, Pike County, Ohio, are common sites in caves in the midwestern and southeastern United States [HH].



A Brief Conservation Message

Not everyone has the concern or awareness of the fragile nature of cave ecosystems or karst systems in general. Most people are uninformed of how mismanagement of surface features and activities above a cave can impact negatively the underlying cave ecosystem. As stated in the introduction, the deep cave is characterized by permanent darkness, greater environmental constancy, and practically no food production in most caves. These are distinguishing features that certainly limit the diversity and numbers of organisms that can inhabit the subterranean environment. This results in a community characterized typically by few, relatively small, sparse, troglomorphic, aquatic and terrestrial invertebrates that are highly vulnerable to any number of disturbances (see Elliott 2000).

An important feature of numerous subterranean species is their geographical rarity which, in turn, increases their likelihood of extinction. Cave endemism is common when examining species distributions and site-specific endemics are far from rare (at least four species are site-specific endemics in Ohio's caves – Hobbs and Hazelton 2008). Additionally, due to low reproductive rates, elevated sensitivity to environmental stress, and, in the case of some bats clustering in large numbers in a few caves, increased rate of extinction is exacerbated (Culver and Pipan 2009). This last feature is particularly critical, given the impact of White Nose Syndrome (WNS) on various bat populations in the northeastern United States (Blehert et al. 2009, Gargas et al. 2009). As of this writing, no bat populations/communities in Ohio are known to exhibit characteristics of WNS.

Slightly more than 50% of all imperiled U. S. fauna that are tracked in the central databases of the Natural Heritage Program are troglobionts and stygobionts. These are concentrated in a small part of the landscape, with more than 50% of cave-inhabiting species occurring in less than 1% of the land. Consequently, it is theoretically easier to preserve a large percentage of at-risk species by focusing habitat conservation efforts in those areas housing dense numbers of obligate cave fauna (Hobbs 2005). Yet, the adage of "out of sight, out of mind" may override the ability to protect, manage, and conserve karst habitats and their biodiversity in Ohio as well as on a global scale.

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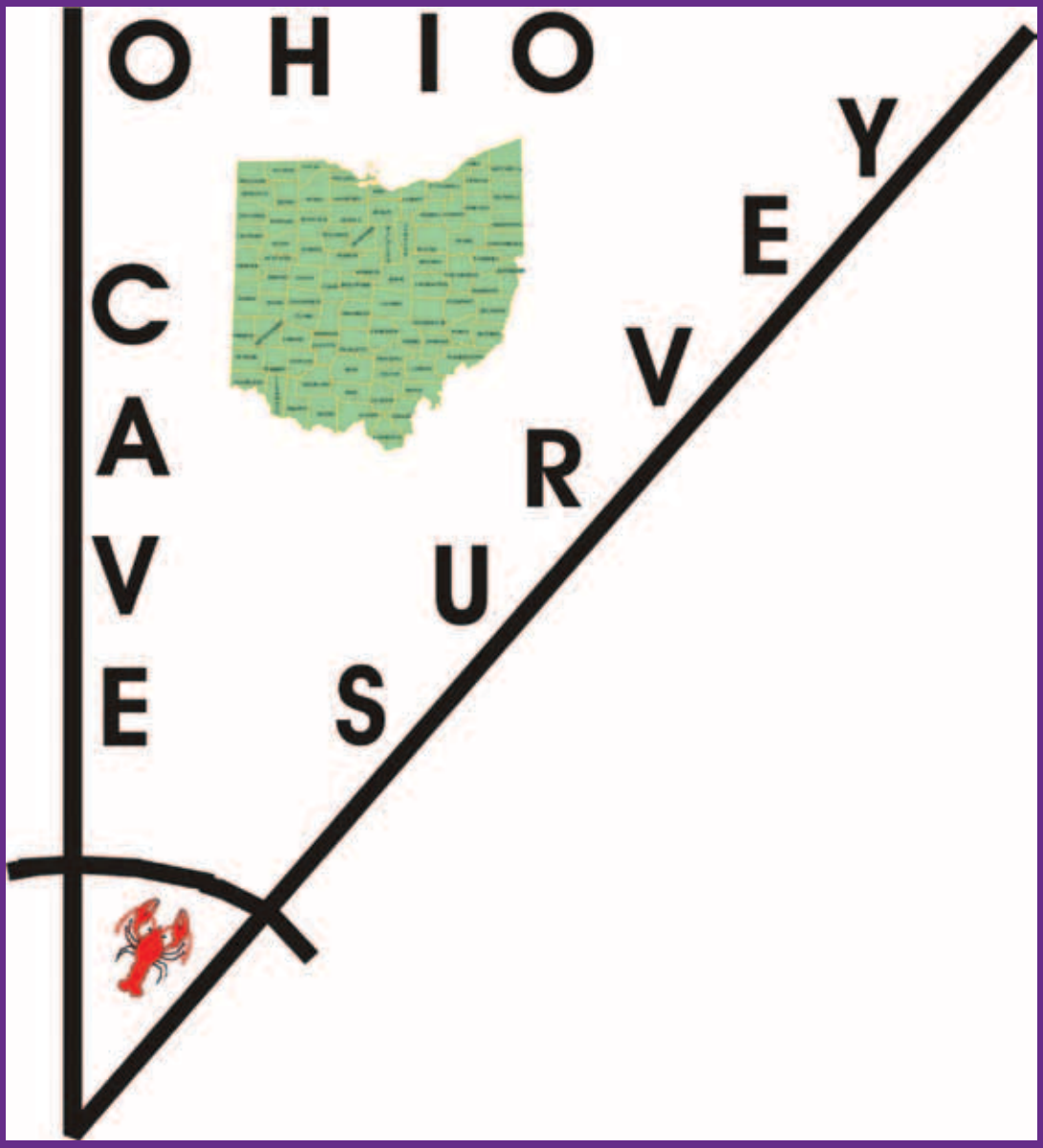

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