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Field Research to Determine the Distribution of a Cave-Adapted Sculpin (Osteichthyes: Cottidae)

Jean Krejca

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FIELD RESEARCH TO DETERMINE THE
DISTRIBUTION OF A CAVE-ADAPTED SCULPIN

(OSTEICHTHYES: COTTIDAE)

By

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in partial fulfillment of

Zoology 493

Honors Research

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ABSTRACT

Careful examination of 35 Missouri caves, 95 Illinois caves, 17 Tennessee caves, 2 Indiana caves, and 11 Arkansas caves has shown cave-adapted banded sculpins (*Cottus carolinae*) to be limited to only two karst areas of Perry County, Missouri. Within these two karst areas, the sculpins are known from only 7 caves, though they may be in a few other caves that are hydrologically connected to these known sites. They were found in large cave streams, in pools and riffles, and on a variety of substrates, from sediment to breakdown. Banded sculpins without features of cave adaptation were found in caves of other areas of Missouri, and in Illinois, Indiana, and Tennessee and are reported from Kentucky, Virginia and West Virginia caves as well.

Caves of Perry County provide a unique habitat for sculpins, and also pose a serious threat, as they are located downgradient of the city of Perryville and other smaller communities that are intensively farmed. Specific documented threats include high levels of potassium, ammonia, nitrite + nitrate, and chloride, probably from agricultural fertilizers, organic waste, septic systems, and livestock (Vandike 1985). Underneath Perry County lies the highest concentration of caves in Missouri (about 630 known in the county), and the four largest caves in the state (Unklesbay and Vineyard 1992). The size of these caves and their respective streams is probably a major factor in the limited distribution of these sculpins.

ACKNOWLEDGEMENTS

The collection of data in subterranean environments has required countless hours of assistance from a variety of speleologists. Among those who have repeatedly accompanied me through the mud, water, and rock are Steven J. Taylor, Myron L. Mugele, Philip L. Moss, Brooks M. Burr, Regina J. Paul and Jeff J. Swayne. Jeff Swayne, Steven J. Taylor, Brooks M. Burr, John A. Lloyd and Brian T. Schaffner allowed their photographs to be reproduced here.

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INTRODUCTION

Perry County lies in the extreme east region of the Ozark uplift of southeastern Missouri. The eastern part of the county is underlain by limestones and dolomites of Ordovician age, while the western part of the county typically contains sandstone, and generally lacks caves. The study area is referred to as a sinkhole plain: the drainage is primarily internal, and there are few surface streams. Intense karstification is evident by the abundant springs, sinkholes and caves - the highest concentration of caves in Missouri!

The unique environment of a cave often provides a harsh yet simple study area because of a lack of the many factors that interact with a surface stream. In a cave, the temperature and relative humidity is rather constant, and the energy input is limited to several definable factors. In Perry County, there is an abundance of energy that enters caves via sinkholes in the form of organic debris and farm animal waste. Caves in this area are typically "high-transit," in that they carry their water through discrete conduits rapidly and with little filtration (Vandike 1985).

In 1991 sculpins from Mystery Cave, Perry County, Missouri, were brought to the attention of Dr. Brooks M. Burr, Southern Illinois University at Carbondale, by local speleologists Jeff Swayne and Sharon Cline. Though these fish had been known to speleologists for many years, they had never been closely

examined. These unusual sculpins were found to have reductions in eye size, pigmentation, and meristic features when compared to hypogean sculpins from surface streams in Missouri. Based on comparative morphological features, these cave sculpins are most closely aligned with the banded sculpin, *Cottus carolinae*.

In examining the boundaries of cavernicolous sculpin distribution, it was found to be fairly common in the midwest for sculpin populations to occur deep in caves, though the only populations that showed cave adaptations occurred in Perry County. Also of interest is that surface specimens from Perry County appear to be different than those from other areas of southeast Missouri. Many questions about the cave-adapted sculpin remain: life history, genetic communication with surface fish, nature of cave adaptation (inherited and/or environmental), and further distribution and population level information.

MATERIALS AND METHODS

Cave techniques: Standard caving equipment was used, as outlined in Rea (1987). Specialized gear (wetsuits, ropes and vertical gear) was used as conditions dictated, and vertical techniques followed standard methods outlined in Padgett and Smith (1987). A predetermined check-in/check-out point known to local cavers that contains a call-down list was used as a safety precaution. Cave locations were obtained through the Missouri Speleological Survey (MSS Inc. c/o Missouri Geological Survey PO Box 250 Rolla, MO 65401) and are property of the MSS, confidential, and only available on a need to know basis.

Fish collecting techniques: Sculpins were searched for in caves by walking slowly upstream in shallow water, catching them in dip nets, and storing them in jars (Figure 1). Often a portable aerator, thermometer, ruler, and camera were used as well. On occasion cave streams were seined. Sculpins were collected on the surface by seining. Fish were collected with authorization from the Missouri Department of Conservation, permit number 3042, and placed in the Southern Illinois University at Carbondale fish collection.

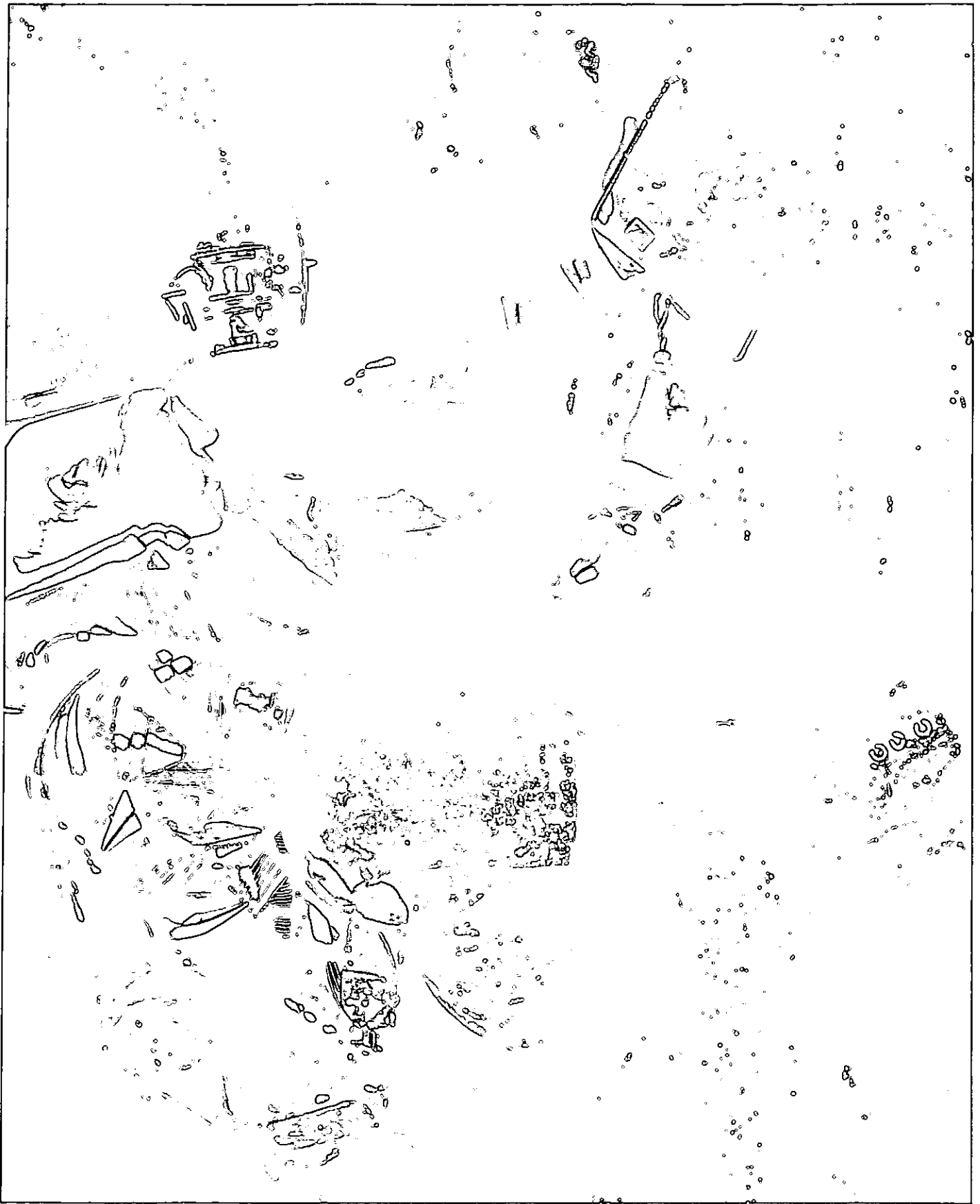


Figure 1. Sculpin collecting techniques.

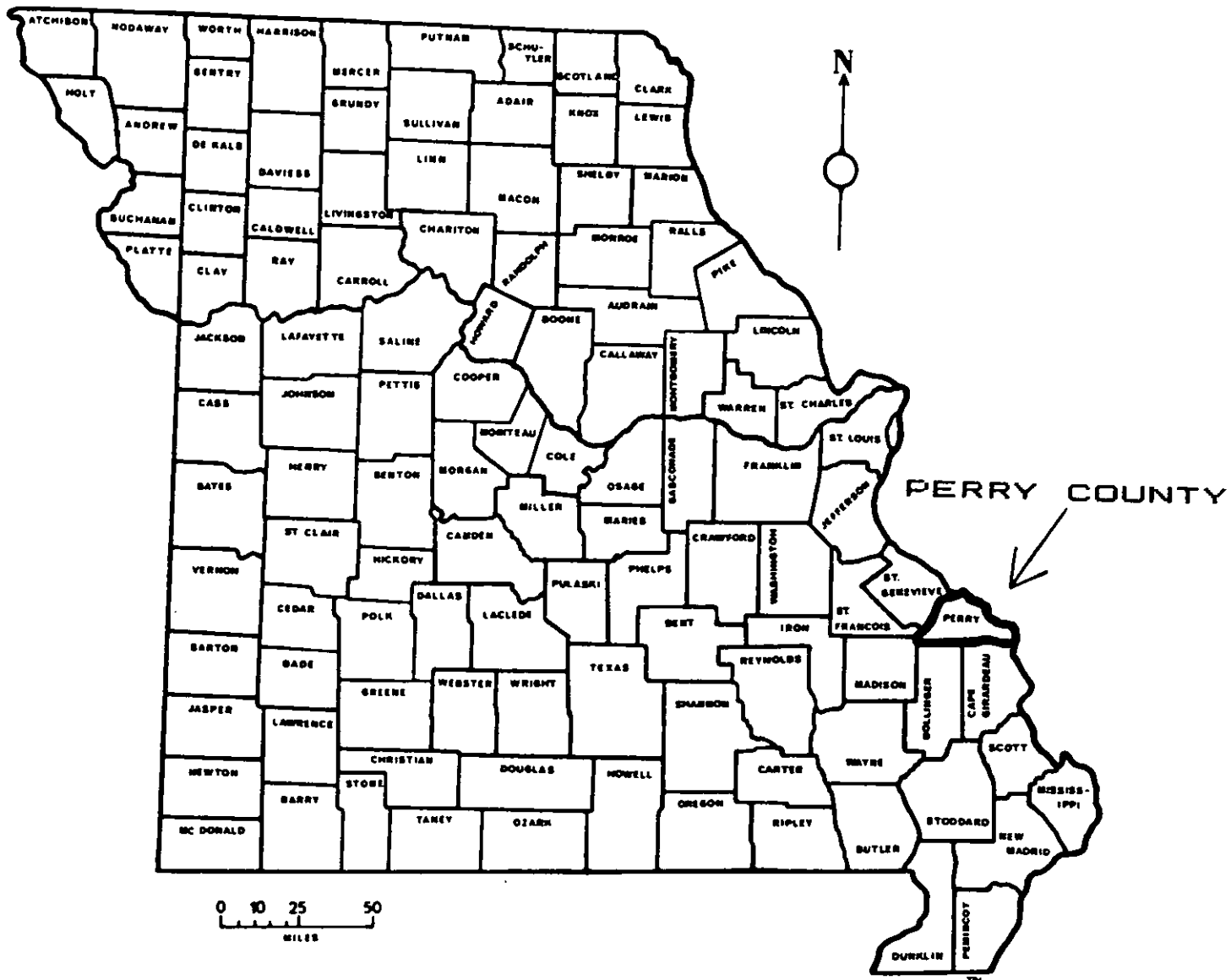
STUDY AREA

History

Perry County is located in the Salem Plateau of the Ozark Uplands (Figure 2), an area that experienced volcanic activity 1.3 - 1.5 billion years ago (Unklesbay and Vineyard 1992). After this period, shallow oceans covered southeastern Missouri. As a result of the advancing and receding shallow Ordovician ocean 500 million years ago, sand and calcareous material became deposited and solidified into the sandstones and dolomites of the area (Unklesbay and Vineyard 1992, Walsh 1988, 1989). Caves of this county are generally found in limestones and dolomites of the Ordovician Age.

The Tertiary Epoch spanned 1 - 64 million years ago, and during the early part of this time the Ozark Uplift began to occur (Vineyard and Feder, 1974), causing the rock layers in Perry County to dip to the northeast 4 - 6 degrees. Due to the forces associated with the Ozark Uplift and simultaneous subsidence of the Illinois basin, jointing and movements along major faults such as the Ste. Genevieve fault occurred. Water, slightly acidic from trickling through soil, passed through these joints and fractures, dissolving rock along the way. This occurred during the late Pliocene Epoch (5-10 million years before present) and the developing caves of Perry County were then in a phreatic stage (Walsh 1988, 1989).

During the Pleistocene, (2 million to 10,000 years before present) the Mississippi River level was affected by glaciers,



MISSOURI

Figure 2. Map of Missouri, showing Perry County.

and it fluctuated in response to varying temperatures and the building up and cutting through of deposits in the floodplain. This caused the water table to rise and fall, and therefore the caves to drain and refill. Overall, a lowering of the water table was achieved through the combination of the increasing dip of the rocks and the erosion of the land, leaving the caves in their current vadose (above the water table, or air-filled) stage (Knox 1976a, Wallin 1975, Walsh 1988, 1989). Thus, the cave passages of today were already in existence in the early to mid Pleistocene. That cave passages existed at this time is corroborated by archeological findings. In gravel layers (present in several stream passages of Perry county, usually about 90 cm above the present cave floor and 30-90 cm thick), fossil bones and teeth of mammoth, mastodon, peccary, bison, and camel have been identified (Wallin, 1975, Walsh 1988, 1989). Camel are thought to have disappeared from most of North America by the beginning of the Pleistocene (Walsh 1988, 1989).

Between 1 million and 20,000 years before present, glaciers affected Perry County caves in three advances: the Nebraskan, Kansan, and Illinoisan. While never covering this area, they provided vast amounts of loess, some of which ended up in the caves (Walsh 1988, 1989; Yokum 1972). In addition, their meltwaters affected the level of the Mississippi and the water level in caves of Perry County (Knox 1976a).

Karst Regions:

Perry County was divided into nine karst regions by House

(1976). The following descriptions are adapted from House (1976), though some assumptions as to boundaries were made in order to clarify the divisions of the regions (Figure 3):

1. Apple Creek Karst: Located south of Longtown and the Mystery-Rimstone Karst, west of Indian Creek and north of Apple Creek in Joachim Dolomite. There are not many large caves in the area, caves examined for sculpins include four recently discovered "cow caves": Angry Cow Cave, Bovine Beauty Cave, Raging Bull Pit, and Twisting Heifer Hole. Several of these have short sections of small stream passage in which no sculpins were found. Other caves in the area are Shrine Cave and Union Cave. The drainage is southward toward Apple Creek.

2. Frohna Karst: Located north of Apple Creek, east of Indian Creek, southeast of the Eureka Karst, south of Brazeau Creek and west of the Mississippi River. Caves in this area are mainly in the Plattin Formation, though Gerler Spring Cave is said to be in the Devonian Bailey Formation. Two caves in this area include Underground Cave and Mueller Pit. The caves drain toward Apple and Brazeau Creeks. No caves in this area have been examined for sculpins.

3. Swan School Karst: Located north of Brazeau Creek, west of the Mississippi River, southeast of Omete Creek and east of the Eureka Karst. Spectacular karst features, including karst canyons, natural bridges, and deep collapse sinks, can be found in the area. Fantastic Pit, Miesner Crevice Cave System, the Kassel Caves and Lorenz Cave drain toward Omete Creek and its

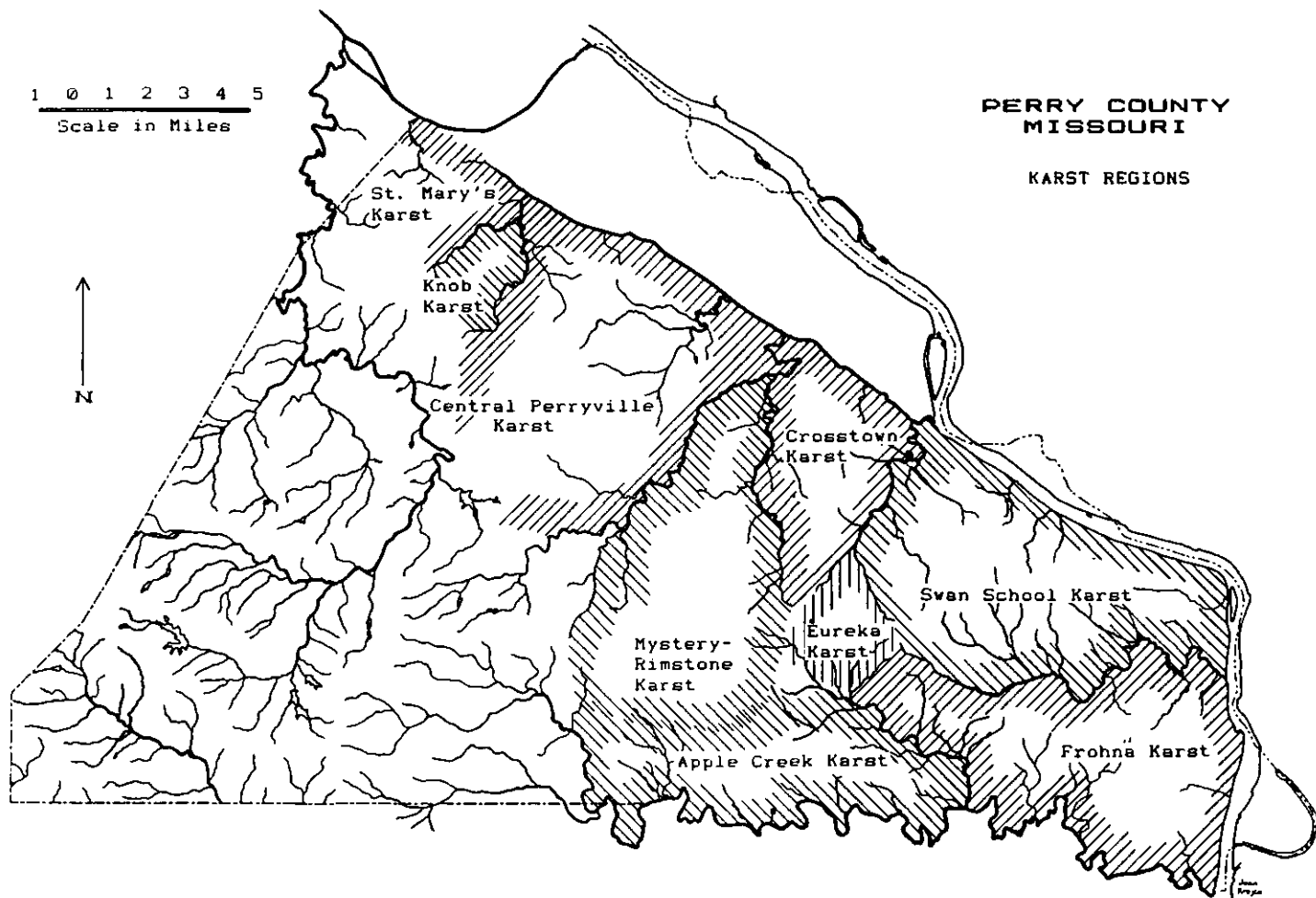


Figure 3. Karst Regions of Perry County, Missouri, adapted from House (1976).

tributaries (Figure 4). Sculpins have been found in the entrance of Lorenz Cave, but have not been found in Miesner Crevice or the Kassel Caves. The Seventysix area caves (including Seventy Six Cave, Seventy Six Spring Cave, and Osteology Pit) are also in this karst area and they drain into surface streams that are direct tributaries of the Mississippi River (Figure 4). No sculpins have been found in these caves.

4. Eureka Karst: Located southwest of the Swan School Karst, northwest of Frohna Karst, north of Apple Creek Karst, east of Mystery-Rimstone Karst and south of Crosstown Karst. Soehl Cave, Carl's Bad Caverns, and Mueller Cave are typical of the area. They are developed in the Plattin formation and drain north toward Omete Creek. No caves in this area have been examined for sculpins.

5. Crosstown Karst: Located northwest of Swan School Karst and Omete Creek, north of Eureka Karst, east of Dry Fork and south of the Mississippi floodplain. Huge sinks abound in the area, subsurface drainage is complex and little understood. Possum Pit, a 27 m deep vertical shaft, is in this area. Fritche Caverns and New Years Cave have been examined for sculpins, and none were found.

6. Central Perryville Karst: Located north of Cinque Hommes Creek, south of the Mississippi River floodplain, and southeast of Blue Spring Branch, it is developed in Joachim Dolomite and Plattin Limestone. Drainage is southward toward Cinque Hommes Creek and northward toward Blue Spring Branch. The Moore and

A.



B.



Figure 4. Two sites in the Swan School Karst area: A. Lorenz Cave, B. Seventy Six Spring.

Crevice Cave Systems dominate the area, and numerous smaller caves, such as Mertz, Zoellner, Hoff, and Sutterer supply water to the larger systems. The Sereno Karst, in Plattin Limestone west of Sereno, is probably part of the Crevice Cave System drainage pattern. Sculpins have been found in the waters of the two main systems of this area.

7. Knob Karst: Located north of Blue Spring Branch and south of Falls Branch, it is named for its most prominent feature, an erosional mound that towers 30m above the surrounding plain. The caves are in Joachim Dolomite, and drain south to Blue Spring Branch and north to Falls Branch. Jesse Moore, Tom Parrers, Graff, and Knob School Spring Caves are typical of the area. Sculpins have not been found in Knob Pit or Briar Caverns, two other caves of the area.

8. St. Mary's Karst: Located north of the Knob Karst and Falls Branch, it continues northward into Ste. Genevieve County. Many sinks are in the area, and it is crossed by the complex Ste. Genevieve Fault Zone. No caves in this area have been examined for sculpins.

9. The Mystery-Rimstone (or Longtown) Karst: Located south of Cinque Hommes Creek, north of the Apple Creek Karst and west of Dry Fork. The caves are in Joachim Dolomite and drainage is northward toward Cinque Hommes Creek where several spectacular spring resurgences are found. Sculpins have been found in both the Mystery and Rimstone River Cave Systems that dominate this karst region. Sculpins have also been found in Hot Caverns and

Running Bull, which are believed to be tributaries to Rimstone River Cave (Figure 5).

Sculpins have been found in the Mystery-Rimstone, Central Perryville, and Swan School karst regions. Of note is that the sculpins found in Swan School Karst, though they were in an entrance to a cave, are considered here as being surface specimens (see trip reports of results section for more). Searching in adjacent karst regions, including Apple Creek, Crosstown, Knob and Swan School Karsts (Figure 3) has not yielded any more cave sculpins (refer to trip reports in data section). Below are descriptions of the major cave systems in Perry county where sculpins have been found. See Figure 5 for their hydrological relationships. The order, from top to bottom, of the rock formations discussed in the following descriptions is as follows: Plattin, Rock Levee, Joachim. These descriptions below predate the recent change by the Missouri Department of Natural Resources' Division of Geology and Land Survey that the Rock Levee Formation is now formally included in the Joachim Dolomite (Vandike 1985).

Major Cave Systems with Sculpins

Rimstone River Cave

This cave is formed almost entirely in the Joachim Dolomite, with the only contact to the overlying Rock Levee formation at the highest level (historic Rimstone Passage at Schauptert entrance) of the cave (Walsh 1988, 1989). Draining northward toward Cedar Spring on Cinque Hommes Creek, it is thought to be

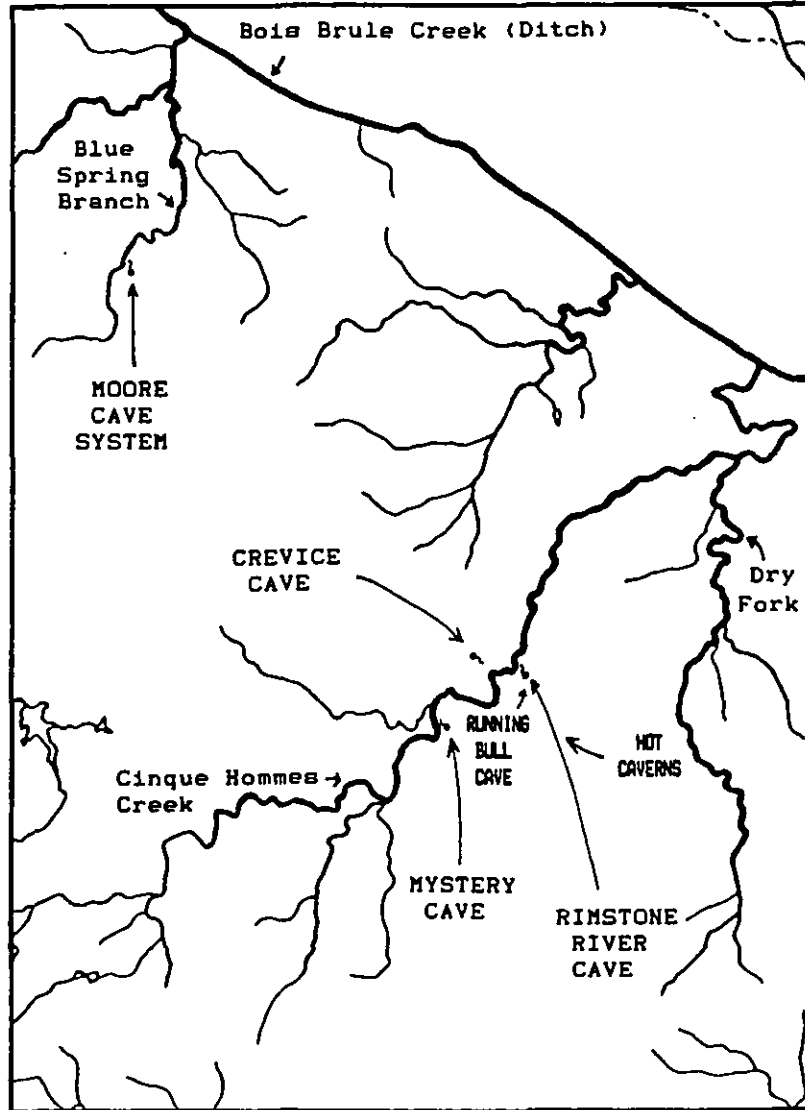
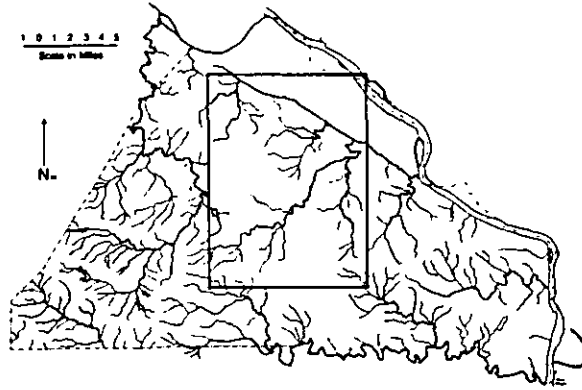


Figure 5. Hydrological relationships of caves where sculpins have been found in Perry County, Missouri.

a major southern tributary of an ancestral "Cinque Hommes Cave System" whose main stream was the present day surface stream, Cinque Hommes Creek (Knox 1976a, Walsh 1989). Rimstone River Cave has 22.59 km of surveyed passage, making it the fourth largest cave in Missouri (Unklesbay and Vineyard 1992). The main trunk contains 8 km of underground river called the Nile. The upstream section is accessible through the Flaming River entrance. This entrance passage intersects the Nile which can be followed upstream for 183 m to a siphon, where the passage becomes water-filled. The siphon is only 91 m from an unenterable surface sinking stream, presumably the source of the Nile. Downstream of the Flaming River entrance passage, the ceiling lowers, becoming close to the water, sometimes dipping below the water level in which case the passage is entirely submerged. The cave is located in the Mystery-Rimstone Karst region.

Sculpins have been collected from between the gravel bar downstream of the low air (67 m from Flaming River entrance) and the Southwest Discovery Passage (671 m into cave from Flaming River entrance).

Hot Caverns

The Friedenbug Pit entrance to Hot Caverns is in the Plattin formation which overlies the Joachim or Rock Levee, when present (Walsh 1988, 1989). This cave contains a section of the Nile river (see Rimstone River Cave description), as well as the Labyrinth stream, a tributary to the Nile. This cave is located

in the Mystery-Rimstone Karst region.

A sculpin was seen in this section of the Nile, and other sculpins were seen and collected in the Labyrinth.

Running Bull Cave

This cave has 374 m of mapped passage, and is thought to be part of a "Middle System" drainage between Mystery Cave and Rimstone River Cave, perhaps ultimately draining into the Nile river downstream of the northernmost terminal siphon in Rimstone River Cave (Walsh 1989), or into Thunder Hole Resurgence (Brod 1976). Running Bull or the Thunder Hole Complex (including Dog Gone Pit, Maple Leaf Cave, Thunder Hole and Thunder Hole Resurgence) may be the downstream most enterable section of the Middle System, with caves like Breezeway Cave, Snow Caverns, and Calcite Pit (in that order, upstream to downstream) forming the upstream part. According to Brod (1976), the entrance of this cave appears to be in the Rock Levee formation, while the cave passage is in the Joachim formation. From the entrance chamber of Running Bull Cave the stream can be followed upstream for 47 m to a complete siphon, and downstream for 335 m. Peck and Lewis (1978) inventoried the invertebrate fauna here, which could aid in gathering information about potential food for cave sculpins. This cave is located in the Mystery-Rimstone Karst area.

Sculpins were found in Running Bull Cave from between the first crawlway downstream of the entrance (about 23 m from entrance) to the deep pothole near the end of easily traversable cave (about 275 m from entrance).

Moore Cave System

The Moore Cave System contains 31.18 km of mapped passage, making it the second longest cave in Missouri (Unklesbay and Vineyard 1992) (Figure 6). The cave is often divided into two sections, the Tom Moore and the Berome Moore sections (these names refer to the names of two of the entrances, and the passage around these entrances). The Moore System lies above and below the contact between the Joachim and overlying Rock Levee formations. Chert nodules indicative of this contact zone can be seen in the cave (Yokum 1972). The streams enter this bedding plane controlled system from the west and south, flowing toward the north and east, where about five resurgences have been located in the Blue Spring Branch Creek valley (Vandike 1985, Yokum 1972, 1976). This system is located in the Central Perryville Karst area.

The Central Perryville karst area where the Moore Cave System is located has been studied by Vandike (1985) who used dye traces to outline more definitively the drainage basins of major springs known to take water from this area. Vandike (1985) notes that Blue Spring is the major resurgence of the Moore Cave System, and others, such as Blue Spring Resurgence (upstream of Blue Spring) and Keyhole Resurgence (downstream of Blue Spring) are overflow routes for the cave.

Yokum (1972, 1976) reports that sculpins are confined to the main cave stream - from its source in Tom Moore to the Siphon area in downstream Berome Moore. He describes them as about 7.6

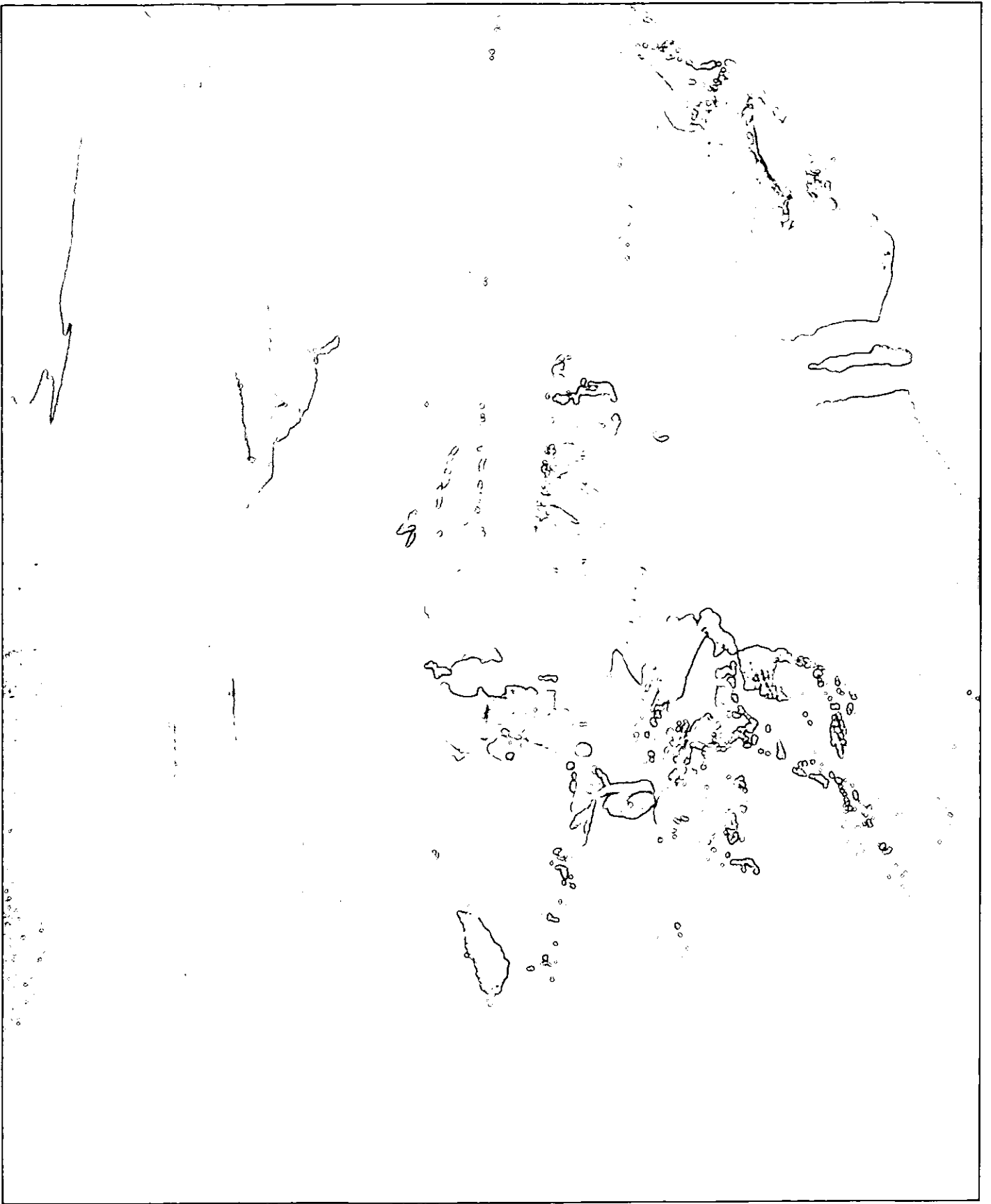


Figure 6. Stream passage in the Moore Cave System, Perry County, Missouri.

cm long, light in color, and appearing to be bottom feeders. He also notes that they are not a true cave species. In addition, he mentions that during floods other types of fish will be washed in and stranded in the cave. An invertebrate faunal inventory by Peck and Lewis (1978) in both the Tom and Berome sections of this cave could yield valuable data on the potential food sources for cave sculpins.

Sculpins have been collected for this study in several different sections of the main stream of the Moore Cave System.

Mystery Cave

This cave has 27.35 km of surveyed passage, making it the third longest cave in Missouri (Unklesbay and Vineyard 1992). The source of water for Main Stream in this cave is a perennial spring in a pasture 244 m west of the upstream entrance to the cave. Issuing from a fissure in the Joachim Dolomite, this spring fills a circular basin about 3.1 m across and at least 5.5 m deep (as shown by soundings) (Walsh 1988). Several cubic feet per second of water overflows from the rise pool, forming the headwaters to the surface creek during periods of normal flow. During heavy rain a boil of water more than 90 cm high is formed at the rise pool (Walsh 1988). Between this spring and the upstream cave entrance, collapsed cave passage can be seen as the water follows a shallow channel with small pieces of flowstone and stalactites. The cave is formed at or above the contact of the Joachim and overlying Rock Levee formations (Walsh 1988). Similar to Rimstone River Cave, Knox (1976a) and Walsh (1988)

speculate that Mystery Cave was a southern tributary of an ancestral "Cinque Hommes Cave System." Mystery Cave is located in the Mystery-Rimstone Karst area. Peck and Lewis (1978) conducted an invertebrate faunal inventory here, which could aid in determination of potential food for sculpins.

Sculpins have been collected in many parts of Main Stream in Mystery Cave.

Crevice Cave

This is the longest cave in Missouri, at 45.37 km (Unklesbay and Vineyard 1992), the 9th longest cave in the United States, and the 30th longest cave in the world (Fee and Fee 1993). It is comprised of four major cave streams that run first northeast, then turn southeast where they join together, then flow through Mertz Cave, then (as determined by dye tracing) resurge at Sutterer Spring (a.k.a. Mertz Resurgence) on Cinque Hommes Creek (Vandike 1985). Knox (1976b) accounts for the initial northeast trend as following the regional dip to the northeast, then the southeast turn as a result of the southeasterly gradient of the water tables toward Cinque Hommes Creek. Knox (1976a) also suggests that Crevice Cave may be a northern tributary of the ancestral "Cinque Hommes Cave System." The cave is formed nearly entirely in the Joachim Dolomite, with only a few high passages located in the overlying Lower Plattin limestone (Knox 1976b).

The Central Perryville karst area where Crevice Cave is located has been studied by Vandike (1985) who used dye traces to

outline more definitively the drainage basins of major springs such as Sutterer Spring, Doc White Spring, and Blue Spring.

Sculpins have been seen in the major southeast trending Eternity Passage of Crevice Cave. They are probably also in Mertz Cave, as this is downstream of the Eternity Passage. Sculpins were not found in Sutterer Spring where Crevice Cave resurges.

RESULTS

Summary of Sites Examined

Cave-adapted sculpins were found to be restricted to two karst areas of Perry County, Missouri (Table 1), and sculpins were found in several streams of the county as well (Table 2). Figure 7 shows the above surface sites on a Perry County map, overlain with the boundaries of karst regions where sculpins were found in caves. Note that the Lorenz Cave site was treated as a surface site because the fish were found in such close proximity to the surface stream (see individual trip report for additional information).

Cottus carolinae were found in caves of Illinois, Indiana, Tennessee, and other areas of Missouri as a part of this study, though none exhibited cave adaptations similar to the fish from Perry County caves. Reports of non cave-adapted sculpins were also obtained from caves in Kentucky, Virginia, and West Virginia from other cave specialists. Table 3 summarizes these caves.

In addition to these sites where non cave-adapted sculpins were found, there were many cave and karst spring sites outside of Perry County, Missouri where careful searching yielded no sculpins. Table 4 summarizes these data.

Table 1. Cave Sites in Perry County, Missouri.

("+ " = sculpins found, "-" = sculpins not found),
date of trip (MM/DD/YY) follows cave name

Apple Creek Karst:

- Angry Cow Cave 6/14/92
- Bovine Beauty Cave 08/30/92
- Raging Bull Pit 6/14/92
- Twisting Heifer Hole 08/30/92

Central Perryville Karst:

- + Berome Moore Cave (Gated Entrance) 07/10/93
- Crevice Cave (Echo Pit Entrance) 09/05/92
- + Crevice Cave (Pipistrelle Entrance, Merlin and Eternity
streams) 12/08/92
- Disappointment Doline Dump Cave 02/06/93
- Sutterer Spring Cave 12/05/92
- + Tom Moore Cave 10/25/92
- Zahner Cave 09/22/93

Crosstown Karst:

- Fritche Caverns (Six Shooter Entrance) 01/09/93
- New Years Cave 06/21/92

Mystery-Rimstone Karst:

- + Hot Caverns (Friedenburg Pit Entrance, Nile and Labyrinth
streams) 10/04/92
- + Mystery Cave (Gated entrance) 04/21/91, 10/01/91, 03/07/92
- + Rimstone River Cave (Flaming River Entrance) 07/03/92
- + Running Bull Cave 09/05/92, 10/25/92, 12/05/92, 09/22/93,
10/11/93

Knob Karst:

- Briar Caverns 05/16/93
- Knob Pit 09/07/92, 10/24/92

Swan School Karst:

- Kassel Canyon Cave 02/06/94
- Kassel Cave 02/06/94
- Kassel Spring Cave 02/06/94
- + Lorenz Cave 02/06/94
- Meisner Crevice 06/20/93 and 11/23/93
- Osteology Pit 04/11/93
- Seventy Six Cave 04/11/93
- Seventy Six Spring Cave 04/11/93

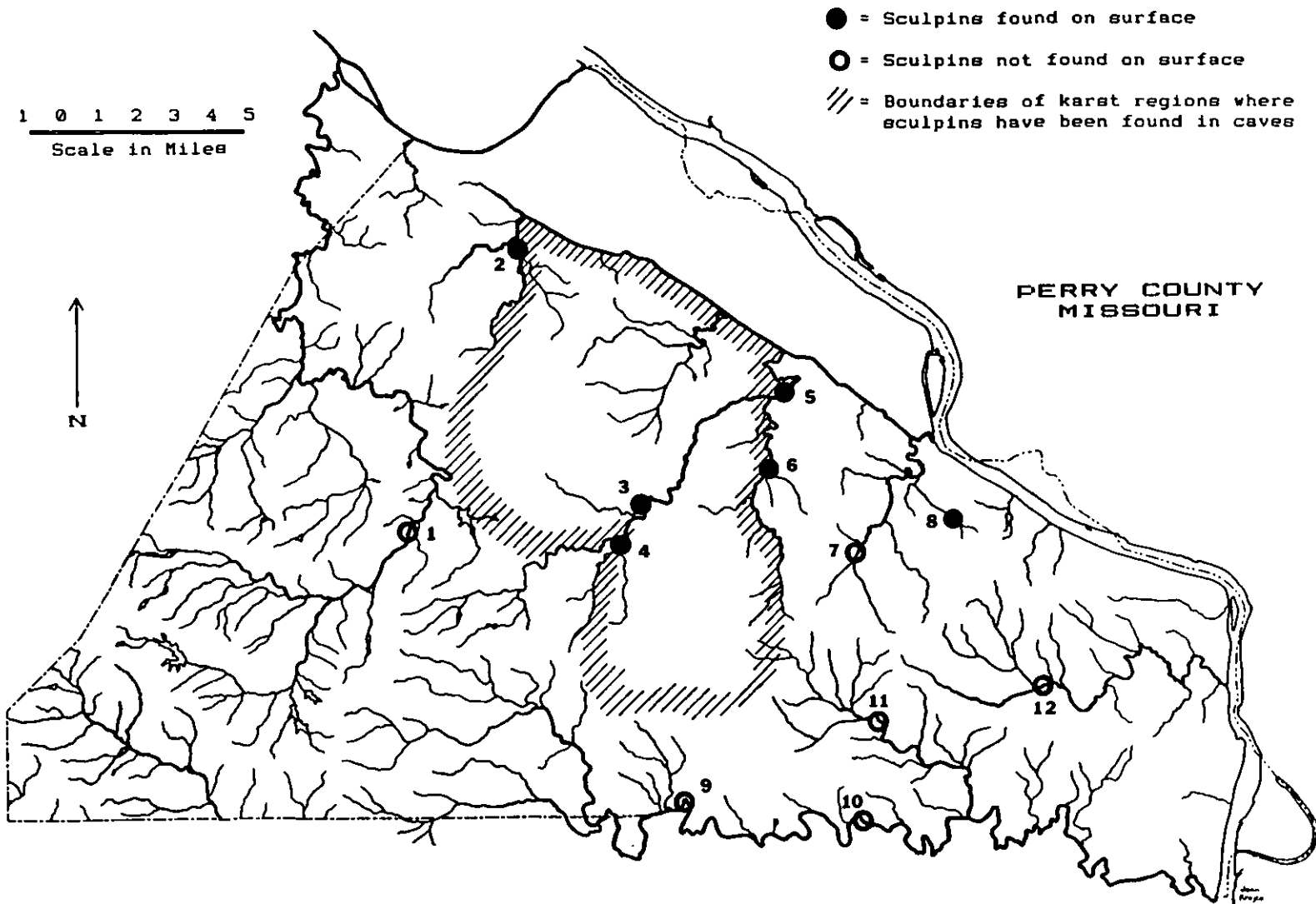
Table 2. Surface sites in Perry County, Missouri.

("+ " = sculpins found, "-" = sculpins not found)
date of trip (MM/DD/YY) follows name

- Apple Creek, Appleton 04/24/92
- Apple Creek, West of 55
- + Blue Spring Branch, Lithium 04/24/92
- Brazeau Creek, C bridge 04/24/92
- + Cinque Hommes Creek, 61 bridge 11/05/91, 04/24/92
- + Cinque Hommes Creek, 322 bridge 07/10/92
- + Cinque Hommes Creek, near Mystery Cave resurgence 03/05/92
- + Dry Fork, P bridge 07/10/92
- + Just downstream of confluence of Dry Fork & Cinque Hommes
- Indian Creek, Wichern's land 04/24/92
- Omete Creek, C bridge 04/24/92
- Saline Creek, near T and N junction 04/24/92

14 total sites

Figure 7. Surface sampling locations overlain with boundaries of karst areas where sculpins have been found.



1 = Saline Creek; 2 = Blue Spring Branch; 3 = Cinque Hommes Creek, Mystery Cave resurgence; 4 = Cinque Hommes Creek, 61 bridge; 5 = Cinque Hommes

Creek, 322 bridge; 6 = Dry Fork; 7 = Omete Creek; 8 = tributary of Omete Creek; 9 = Apple Creek; 10 = Apple Creek, Appleton; 11 = Indian Creek; 12 = Brazeau Creek.

Table 3. List of caves where non cave-adapted *Cottus carolinae* have been found. "*" = denotes a trip report in this paper. (MM/DD/YY) date follows cave name.

ILLINOIS:

Monroe County - Fogelpole Cave *
Source: 1 specimen collected by Jean Krejca and Steve Taylor (07/01/92), deposited in SIU collection

Hardin County - Crystal Cave *
Source: Jean Krejca 08/07/91

INDIANA:

Crawford County - Seiberts Well
Source: Horton H. Hobbs III, and Jerry Lewis

Green County - Batey's Cave
Source: Horton H. Hobbs III

Harrison County - Binkley's Cave
Source: Horton H. Hobbs III

Lawrence County - Connerley's Cave
Source: Horton H. Hobbs III

Lawrence County - Donnehue's Cave
Source: Horton H. Hobbs III

Lawrence County - Popcorn Spring Cave
Source: Horton H. Hobbs III

Lawrence County - Sullivan's Cave *
Source: Horton H. Hobbs III, and Jean Krejca 10/29/92

Owen County - Boone cave
Source: Horton H. Hobbs III

Washington County - three small spring caves
Source: Horton H. Hobbs III

Washington County - Fredericksburg Cave
Source: Jerry Lewis

Table 3. Continued.

KENTUCKY:

Barren County - Cool Spring Cave
Source: Horton H. Hobbs III

Edmonson County - Mammoth Cave (Echo and Mystic Rivers)
Source (Echo River): Jerry Lewis, (Mystic River): Michael Sutton

MISSOURI:

Crawford County - Saranac Spring Cave *
Source: Jean Krejca and Steve Taylor 09/25/92, 09/26/92

Laclead County - Blowing Spring Cave (Pittman Cave) *
Source: Doug Feakes, confirmed by Jean Krejca and Steve Taylor 10/15/93

Oregon County - Cropper Cave
Source: Michael Sutton, and Gardner (1986)

Shannon County - Powder Mill Creek Cave
Source: Michael Sutton, Steve Ervine

Washington County - Spring near Hamilton Cave
Source: Jean Krejca and Steve Taylor 09/26/92

TENNESSEE:

Robertson County - Rapids Resurgence *
Source: Jean Krejca and Steve Taylor 04/23/94

Robertson County - Yates Cave *
Source: Jean Krejca and Steve Taylor 04/24/94

VIRGINIA:

Bath County - Butler Cave System
Source: Horton H. Hobbs III

Giles County - Tawneys Cave
Source: Horton H. Hobbs III

WEST VIRGINIA:

Greenbriar County - Buckeye Creek Cave
Source: Horton H. Hobbs III, and Williams and Howell (1979)

Table 4. Cave and karst spring sites where *Cottus carolinae* have not been found (with date of author's visit).

ARKANSAS:

Izard County

Clay Cave 10/14/92, 10/15/92
Solitary Sun Cave 10/13/92
Mack Cypert Cave 10/16/92
Oz Cave 02/12/94
Turkeyfeather Cave 10/12/92

Stone County

Ain't that Sumpin' 12/26/91
Alexander's Cave 12/25/91
Dustbowl Cave 12/28/91
Hell Creek Cave 10/17/92
Janus Cave 12/27/91
Tex Yokum Memorial Cave 12/26/91

ILLINOIS:

Adams County:

Bobtail Salamander Cave 05/27/93
Unnamed Cave Spring on Fall Creek 06/03/93
Weed Cave 05/27/93

Calhoun County:

Madison Creek Spring Cave 06/02/93 and 06/03/93
McNabb Hollow Cave Spring 05/16/92

Carroll County:

Babe's Cave 05/27/92
Bat Cave 05/29/92
Nadig Spring 05/27/92
Raccoon Den Cave 05/27/92
Sand Boil Spring 05/28/92
Skeeter Spring 05/28/92
Sorrel Horse Camp Spring 05/27/92

Greene County:

Crinoid Cave 08/21/92

Jackson County:

Ava Cave 10/20/92
Ava Spring 10/20/92
Toothless Cave 03/04/92
Stearn's Cave 05/24/92

Table 4. Continued.

Jo Daviess County:

Jean's Cave 05/28/92
Kevern's Cavern 05/26/92
Kopper's Crevice 05/28/92
Tree Root Pit 05/28/92

Johnson County:

Cedar Bluff Cave 04/29/92 and 08/18/93
Jug Spring Cave 04/30/92
Mason Cave #1 05/21/93
Mason Cave #2 05/21/93
Mason Cave #3 05/21/93
Mason Spring 05/21/93
Pipistrellus Pit Cave 05/21/93
Procyon Cave 03/06/92
Sink-Joint Cave 06/15/93
Teal's Cave 05/20/93

Kane County:

Devil's Den Cave 04/20/92

La Salle County:

Mathiesen Park Cave 08/20/92
Skeleton Cave 08/20/92

Monroe County:

Auctioneer Cave 09/04/92
Cave Spring #1 09/03/92
Cave-Name Unknown near Collier Spring 09/04/92
Collier Spring 06/30/92 and 07/02/92
Couch Cave 09/03/92
County Line Cave 09/04/93 and 09/06/93
Dulcet Waterfall Cave 06/24/93
Erwin Vogt Spring 09/28/92
Fogelpole Cave 02/24/92, 09/29/92, and 08/28/93
Fults Saltpeter Cave 03/26/92
Illinois Caverns 02/24/92 and 08/30/93
Indian Hole 07/02/92
Kelly Spring Cave 08/21/93 and 09/05/93
Kreuger Dry-Run Cave 04/03/92 and 08/29/93
Paw Paw Pit 09/03/93
Quirky Quarry Spring 09/06/93
Running Spring Cave 06/26/93 and 06/30/93
Shelter Dome Cave 11/19/93
Shivery Slither Cave 09/05/93 and 09/06/93
Slippery Dell Cave 06/23/93
Terry Spring Cave 05/06/92
Unnamed Spring 08/21/93
Wanda's Waterfall Cave 04/03/92 and 08/21/93

Table 4. Continued.

Weeping Buddha Cave 06/23/93
Weird Wall Cave 06/26/93

Pike County:

Cedar Cave 08/22/92
Cloven Hoof Cave 08/22/92
Boat Ramp Cave 05/15/92
Lost Creek Cave 05/15/92
Lower Lost Creek Cave 05/26/93 and 06/03/93
Lucky Calf Spring 06/03/93
Slick Crawl Cave 05/27/93 and 06/03/93 and 08/20/93

Pope County:

Big Grand Pierre Creek Cave 04/14/92
Brasher Cave 10/23/93
Lackey Cave 10/23/93
Simmon's Creek Cave #2 04/15/92
Spring at Simmon's Creek 04/15/92
Tube Cave 04/18/93

Pulaski County:

Boiling Spring 10/24/93

Randolph County:

Indian Cave 04/09/93 and 09/06/93

Saline County:

Equality Cave 10/22/93

St. Clair County:

A Little Pit More Cave 06/22/93
Charles' Cave 06/25/93
Cossile Fast Pit 08/18/92
Dieciseis Tigrinum Pit 06/22/93
Drainage Cave 06/25/93 and 06/30/93
Misplias Cave 06/26/93
Puppies, Eggs & Apples Spring 06/24/93
Sparrow Spring Cave 09/29/92
Spring Valley Cave 06/22/93 and 06/30/93
Stemler Cave 06/25/93 and 06/30/93 and 10/10/93

Union County:

Apis Annex 05/08/92
Barefoot Cave Spring 10/24/93
Graig Cave #4 08/25/93
Guthrie Cave 04/30/92
Honeycomb Hole 05/08/92
Migrant Camp Cave 08/25/93
Rich's Cave 05/07/92
Saratoga Cave 03/02/92
Shilly-Shally Cave 10/05/93

Table 4. Continued.

INDIANA:

Floyd County
Heffalump Caverns 10/30/93

MISSOURI:

Franklin County
Sheep Cave 09/25/92

Pulaski County
Berry Cave 10/17/93

Ste. Genevieve County
Andrew Brumfield Pit 04/10/93
Arnold's Cave 01/25/92
Kohms Cave 06/20/92
Pits of Little Egypt Pit 04/10/93

Texas County
Jack's Fork (seined surface stream) 05/02/93

Washington County
Hamilton Cave 09/26/92
Green Cave 09/26/92

TENNESSEE:

Robertson County

Head Cave 04/23/94
Swirling Springs Cave 04/23/94
Cross Plains Caverns 04/23/94
Dry Cave 04/24/94
Kilgore Cave 04/23/94
Cashmere Rift 04/09/94
Highway 161 Spring Cave 04/09/94
Cooperstown Caverns 04/24/94
Middle Cave near RB105 04/24/94
Spring Cave near RB105 04/24/94
Large Spring near RB073 04/09/94
Santee Creek Cave 04/09/94
Sinking Spring Cave 04/09/94
Small Spring near RB073 04/09/94
Stark Cave 04/09/94

Trip Reports

The following are individual accounts of each site visited during this study. Not included are sites from Illinois, Tennessee or Arkansas where no sculpins were found.

Illinois

CRYSTAL CAVE

Hardin County, IL

On 7 August 1991, Shawn Robinson and I visited Crystal Cave, located in the Shawnee Hills. The cave is on a wooded hillside surrounded by abandoned and operating mines. The entrance was a mine that intersected cave passage. The mined entrance is 6.1 m tall by 10.7 m wide. From the entrance, the natural cave can be followed to the left as walking height passage up a breakdown pile that leads to a breakdown choke in <15 m. The cave can also be followed directly forward as a bellycrawl 46 cm tall by 1.8 m wide that intersects a cave stream. This small stream cannot be followed in either direction, as the passage becomes humanly unenterable. In this stream (in the dark zone) I saw one sculpin. I remember it as appearing normal, though I made no particular note of its pigmentation or eye size.

This small cave receives little human visitation, and the major threat to this site is that it will be blasted closed by the nearby miners.

CREEK NEAR RENAULT

Monroe County, IL

In the late evening of 3 September 1992 (and early morning of the following day), Steve Taylor and I noticed abundant sculpins in a small creek near Renault that drains southwest towards Fults Creek Ditch. The creek is gravel/rubble/bedrock bottomed, 1.8 m wide and 30 cm or so deep. Located in a wooded valley, it is fed by several cave springs, and a return visit to seine the creek and examine the caves for sculpins thoroughly is in order.

FOGELPOLE CAVE

Monroe County, IL

On 1 July 1992, Steve Taylor and I visited Fogelpole Cave (Lemonade Cave) located in the sinkhole plain of Illinois. This cave passes under a large area of upland karst which contains much farm land (crops and livestock), rural dwellings, and several small communities. Throughout the area are small woodlots containing sinkholes that receive runoff from fields, residential land, roads, etc.

We went in through the Main or Fogelpole entrance, though seven entrances are known to exist: Fogelpole or Main Entrance (2 openings), Lemonade Entrance (2 openings), Northwest Entrance, Twin Pits Entrance, and Southeast Entrance. After 335-610 m, the entrance passage joins the main stream of Fogelpole Cave (Figure 8) where one sculpin was seen and collected. The passage in the main stream is about 12.2 m wide and 9.1 m tall, with a cave stream 3.1-6.1 m wide and 0.3-1.2 m deep. Here, there are three



Figure 8. Mainstem passage of Fogelpole Cave, Monroe County, Illinois.

directions to continue. Upstream there are two passages, the stream passage continues up as a deep pool, and a smaller passage leads up a clay slope. Downstream the main trunk continues as a single passage. Both upstream and downstream of this area there are several side passages, and the cave is in excess of 21 km in length. The main stream is characterized by deep pools, shallow riffles, raceways, etc. Large gravel bars and breakdown blocks are found along the shorelines of the main stream. A wide variety of other habitats are found in the cave.

According to Frasz (1983), the general dip of the limestone to the east accounts for Fogelpole's general eastward flow. Fogelpole is known to resurge at Collier Spring, and Indian Hole may be another resurgence. Bretz and Harris (1961) discuss geological features of the cave and surrounding area, and also include a partial map, though a more complete map is known to exist. Peck and Lewis (1978) performed an invertebrate faunal inventory of this cave.

This large and unique cave is threatened by human development and agricultural practices. Most of the entrances to this cave are protected by unfriendly landowners or unpleasant passage, and the main entrance is gated. Thus, human visitation is not a major threat to the cave and its life.

On our many other visits to this cave (02/24/92, 09/29/92, and 08/28/93) sculpins have not been seen, thus this specimen probably represents an accidental, and was probably washed into the cave rather than successfully living there (as the Perry

County, MO cavernicolous sculpins seem to be).

Indiana

HEFFALUMP CAVERNS

Floyd County, IN

On 30 October, 1993, Myron Mugele, Barry Smith, Steve Taylor and myself visited Heffalump Caverns. This 972 m long cave carries a gravel, silt and breakdown bottom stream that averages 90 cm wide and 30 cm deep. The habitat seemed fair for sculpins, though the stream may be a bit too small.

SULLIVAN'S CAVE

Lawrence County, IN

On 29 October 1992, as part of a field trip at the 19th Annual Natural Areas Conference, I learned of the presence of a very large population of banded sculpins throughout Sullivan's Cave. All of the individuals I saw were fully pigmented with normal eye size. They tended to be larger (13-15 cm not uncommon) than the ones I have observed in Perry County, Missouri caves. According to Horton H. Hobbs III, one of the leaders of the trip, a very large population has been noted in lower level streams in various parts of the cave in trips in 1970, 1971, 1972, 1973, 1990, and 1992.

Missouri

SARANAC SPRING CAVE

Crawford County, MO (CFD-126)

On the evening of 25 September 1992, I saw two banded sculpins in the entrance of this cave spring. One was approximately 10.2 cm, the other 2.5 cm in length. They both appeared to have normal pigmentation and eye size. This cave has less than 12.2 m of air-filled passage, and is a large spring that feeds into the Maramec River.

Upon returning to the cave the following day (26 September 1992), we donned snorkel and mask, and neither Steve Taylor or I saw sculpins, though several other small (less than 7.5 cm) surface fish were seen.

BLOWING SPRING CAVE

Laclede County, MO (PRY-451)

(also known as Pittman Cave)

On 15 October, 1993 Steve Taylor and I visited this cave in search of sculpins. A small crawl only a meter above the Gasconade River opens up to walking passage about 15 m in, where we saw the first two small sculpins. This site was in the dark zone, and was a silt, gravel, and breakdown floored stream pool. The sculpins were found next to each other on sediment bottom. Other sculpins were seen farther into the cave, the largest ones were in the back and were seen as far back as the sump. Our estimate of the distance to the sump is over 460 m, and the 1993 Fall MVOR Guidebook states that it is over 800 m, though the cave has not been mapped.

The stream averaged 1.5 m wide and 10.2 cm deep, with a some pools up to 90 cm deep. The stream bottom was usually silt and gravel, with a few spots being clean bedrock. At places the stream floor is deep silt, where one can a meter or so into the mud. This cave sees frequent visitation judging by the tracks, but there is no vandalism. Judging from the lack of debris on the walls and ceiling, the cave probably does not flood often. Also there is little organic debris, and in general life is scarce. We explored all of the stream passage to the sump, where a dive line plunged into the deep blue water. Upon later discussion with Doug Feakes we learned that divers had penetrated 46 m, going down at a steep angle, and that the passage continued.

Aquatic life observed: (water temp = 13 C)

2 madtom, 8.9 cm, dark, not checkered, did not look like stonecat, found under flat rock

4 large female crayfish - 1 dead, 1 in molt, 1 collected (2 or 3 legs on one side injured before time of capture, prob Cambarus)

several small crayfish (less than 5.1 cm long)

troglobitic isopods - not very abundant

about 12 Rock Bass (Ambloplites rupestris)

3 small sculpin and 3 large sculpin collected- normal pigment and normal eye size

4 more large sculpin seen, not coll.

Terrestrial life observed:

bats heard

1 *Pipistrellus subflavus* seen

SHEEP CAVE

Franklin County, MO (FRA-022)

On 25 September 1992, Steve Taylor and I explored the entire length of this cave, finding no stream, and therefore no sculpins. The cave is about 150 m long, and extends in a straight "subway" like large passage. The end of the cave has a large dome room that is heavily decorated with speleothems.

ANGRY COW CAVE

Perry County, MO (PRY-)

(in the Apple Creek Karst)

On 14 June 1992, John Lloyd, Myron Mugele, Steve Taylor and I explored and mapped the entirety of this cave. Of the 150 m of passage, there was a total of 9.1 m of deep pooled water, and 4.6 m of stream riffle. The south passage had three 3.1 m sections of water pooled in excess of 90 cm deep, the bottom was not visible. The middle passage had 4.6 m of enterable stream riffle 30 cm wide, 2.5 cm deep, over gravel and clay - too small for sculpins. No sculpins were seen in any of the water, though it is possible that they were present in the deep water. One troglobitic Planarian was collected by Steve in a deep pool in the south canyon passage.

APPLE CREEK

Perry County, Missouri

This site is located 30 m downstream of the spillway in Appleton where 61 crosses Apple Creek. On 24 April 1992, Steve Taylor, Diane Krejca, and myself seined this creek in search of sculpins. No sculpins were found here.

Description: 7.5 - 9 m wide gravel and rubble bottom stream riffle, to 61 cm deep. This site had appropriate substrate for sculpins, but seemed rather swift, perhaps too swift for sculpins.

Parameters

Measured*:
pH = 8.3 @ 16 C
Cond. = 385 uS @ 16.1 C
TDS = 193 mg/L @ 16 C
Therm. = 15.5 C

Notes on fish

Collected: One large (3.85 L) Nalgene jar of fishes preserved in formalin. One rainbow darter was caught, but not included in jar.

* pH, Cond. (= Specific Conductivity), and TDS (= Total Dissolved Solids) measured using Dr. Burr's Corning Checkmate Meter (SIU # 341227). We did not calibrate meter. Last calibrated? Therm. = measurement obtained from regular thermometer, property of Jean Krejca and Steve Taylor.

Weather was partly sunny, breezy, high 60's.

BEROME MOORE CAVE

(Gated entrance) Perry County, MO (PRY-045)

(In the Central Perryville Karst Area)

On 10 July, 1993 Steve Taylor, Brooks Burr, Christopher B. Geyerman, and myself visited Berome Moore Cave to do some sculpin population estimates.

The visibility in the middle main stream we traversed (from the dropoff downstream to the waterfall) was fair to poor, with frequent deep pools. According to cavers, they often see sculpins in this stretch, implying that in times of better visibility this would be a worthwhile place to return. This time, however, we could not make reasonable population estimates. Stream here was 0.9-2.4 m wide, mostly 1.5 m, with silt, sand, gravel, rubble, and bedrock bottomed pools and riffles, 5.1-90 cm deep.

The tributary we followed in to middle main stream had better visibility, similar bottom, and tended to be narrower and shallower (90 cm wide, 2.5-15 cm deep). About half the sculpins were seen here.

Sculpins:

1 collected live

1 dead one found, preserved in formalin

? live ones found, preserved in formalin

3 seen, not collected, all medium eyes, one was 60mm
long

Other life:

3 larval *Eurycea*
troglotic isopods (mainly seen in drip pools)
several frogs
abundant flatworms (troglotic and others)
abundant tiny (<5mm) snails (probably *Fontigens*)

Underground temperatures (taken in middle main stream)

air: 15 C

water: 15 C

BLUE SPRING BRANCH

Perry County, Missouri

This site is located 90-150 m upstream of the confluence with Falls Branch. It is in Lithium, right across the road from the spring with the structure over it. On 24 April 1992, Steve Taylor, Diane Krejca, and myself seined this creek in search of sculpins. A normal amount of effort yielded one sculpin, then an above average amount of effort was exerted in attempt to find more. No more were found, and we were soon forced to leave because it became dark.

Description: 4.5-6.0 m wide gravel and rubble bottom stream riffles and stream pools, up to 60 cm deep, mostly \leq 30 cm in depth. The sculpin was caught at the very bottom of a stream pool, right before a riffle.

Parameters

Measured*: pH = 8.24 @ 17 C

Cond. = 530 uS @ 17.1 C

TDS = 284 mg/L @ 16.9 C

Therm. = 16 C

Notes on fish

Collected: One large (3.85 L) Nalgene jar of fishes preserved in formalin. Also one 3.85 L Nalgene jar containing one live sculpin.

* pH, Cond. (= Specific Conductivity), and TDS (= Total Dissolved Solids) measured using Dr. Burr's Corning Checkmate Meter (SIU # 341227). We did not calibrate meter. Last calibrated? Therm. = measurement obtained from regular thermometer, property of Jean Krejca and Steve Taylor.

Weather was partly sunny, breezy, high 60's.

BOVINE BEAUTY CAVE

Perry County, MO (PRY-)

(in the Apple Creek Karst)

On 30 August 1992, Philip Moss, Myron Mugele and I explored and mapped the entirety of this cave. An entrance rappel leads to about 6 m of stream passage, none of which had sculpins. The upstream end was a sump pool, downstream of which was a section of 90 cm wide stream riffle/pool over cobble, not more than 15.2 cm deep. This water heads southeast, probably to Twisting Heifer Hole, then toward Apple Creek.

BRAZEAU CREEK

Perry County, Missouri

This site is located 91 m downstream of the C bridge which crosses Brazeau Creek between Brazeau and Frohna. On 24 April 1992, Steve Taylor, Diane Krejca, and myself seined this creek in search of sculpins. No sculpins were found here.

Description: 4.5-6.0 m wide gravel, rubble, and bedrock bottom stream riffles and stream pools, to 45 cm deep. This site seemed appropriate for sculpins.

Parameters

Measured*:
pH = 8.67 @ 18.4 C
Cond. = 386 uS @ 18.2 C
TDS = 193 mg/L @ 18.2 C
Therm. = 18 C

Notes on fish

Collected: One large (3.85 L) Nalgene jar of fishes preserved in formalin. Variety of fish, including log perch and stone cat.

* pH, Cond. (= Specific Conductivity), and TDS (= Total Dissolved Solids) measured using Dr. Burr's Corning Checkmate Meter (SIU # 341227). We did not calibrate meter. Last calibrated? Therm. = measurement obtained from regular thermometer, property of Jean Krejca and Steve Taylor.

Weather was partly sunny, breezy, high 60's.

BRIAR CAVERNS

Perry County, MO (PRY-473)

Knob Karst

On 16 May 1993, Kent Buckles, Steve Taylor and I visited this cave in search of sculpins. All of the entrance crawl and the majority of the trunk passage was searched, and no sculpins were found. The water was extremely clear, ranging 0.3-1.8 m wide (averaging 1.2 m in width), 0.05-1.50 m deep (averaging 0.23 m deep). There were stream riffles, pools, and raceways, with bedrock, silt, sand, and gravel bottoms. Of note, there was a relative rarity of breakdown blocks in the stream, which may be preferable sculpin habitat, though sculpins have been found in other cave streams with a similar bottom to Briar Caverns. Also of note, though there is a stream in this cave year around, it is a bit smaller than the other cave streams where sculpins have been found.

Stream life noted:

abundant troglobitic isopods

troglobitic amphipods

troglobitic flatworms

2 larval salamanders (1 unidentified, the other did not look like a *Eurycea*, perhaps it was an *Ambystoma*?)

Terrestrial life noted:

1 *Pipistrellus subflavus*, Eastern Pipistrelle bat

CINQUE HOMMES CREEK

Perry County, Missouri

This site is located 30.5 m upstream of the 61 bridge which crosses Cinque Hommes Creek between Perryville and Longtown. This site has been previously seined, we seined here again in order to check our technique. Because we had not caught sculpins anywhere yet this day, we began to doubt if our sampling efforts were sufficient. After obtaining one sculpin in the same amount of effort (or less, actually) than we exerted to the other day's sights, we successfully reaffirmed ourselves. Date: 24 April 1992, seined by: Steve Taylor, Diane Krejca, and myself.

Description: 6.1 m wide gravel, rubble, and bedrock bottom stream riffle and stream pool, approximately 30 cm deep.

Parameters

Measured*:
pH = 8.96 @ 18.7 C
Cond. = 390 uS @ 18.6 C
TDS = 194 mg/L @ 18.5 C
Therm. = 18 C

Notes on fish

Collected: One large (3.85 L) Nalgene jar containing one live banded sculpin. We did not preserve other fishes from this site, as it has been previously seined.

* pH, Cond. (= Specific Conductivity), and TDS (= Total Dissolved Solids) measured using Dr. Burr's Corning Checkmate Meter (SIU # 341227). We did not calibrate meter. Last calibrated? Therm. = measurement obtained from regular thermometer, property of Jean Krejca and Steve Taylor.

Weather was partly sunny, breezy, high 60's.

CREVICE CAVE (Echo Pit Entrance)

Perry County, MO (PRY-394)

(in the Central Perryville drainage)

On the 5 Sept 1992 Steve Taylor and I visited the Echo Pit entrance of Crevice Cave in Perry County, Missouri in search of sculpins. The 40 m entrance rappel leads into a small side passage that quickly intersects the Nile River. Figure 9 shows a side passage of Crevice Cave that carries a small stream. We began by travelling downstream, as the water there soon became shallow enough to easily observe any aquatic life. Passage we checked had stream that varied from 0.6-3.1 m wide, and up to 1.2 m deep (the majority being up to a foot in depth), with excellent (75 cm) visibility. The section of stream that we looked for sculpins in had a variety of habitats. The stream bottom had virtually all sizes of rock at some point, varying from mud to large breakdown boulders and bedrock. There were even a few areas with patches of organic debris on the bottom. We looked in both stream riffles and pools to no avail.

Most of the stream we observed was gravel and rubble bottomed stream riffle or pool, up to 30 cm deep--very similar to the habitat where sculpins were abundant in Rimstone River Cave. After checking a variety of habitats upstream and downstream of

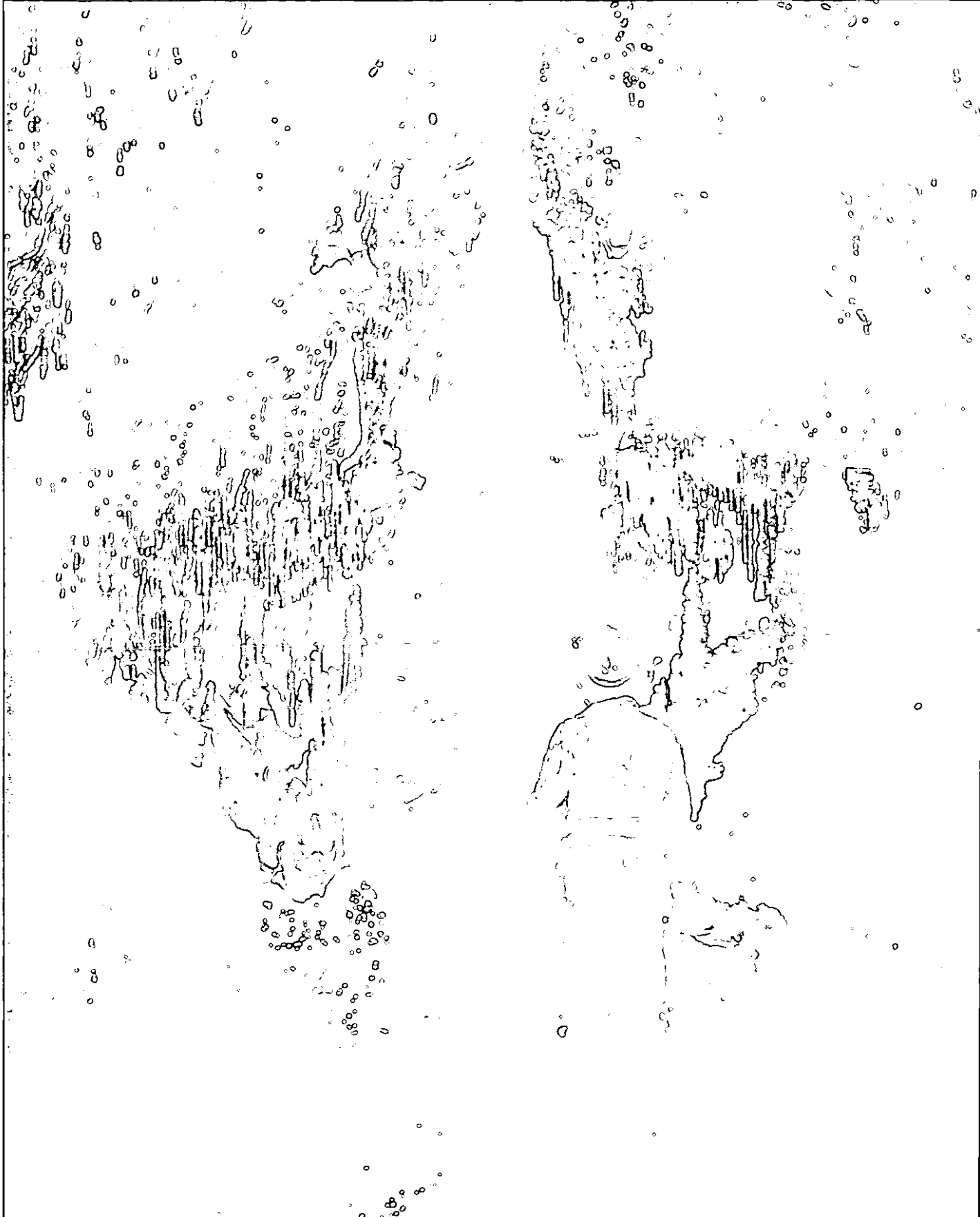


Figure 9. A side passage in Crevice Cave that carries a small stream.

the Echo Pit entrance, I believe that there are virtually no sculpins present (if there are any at all) in the area of Crevice Cave which we examined.

Due to the excellent visibility, we did observe quite a bit of other aquatic life, including:

amphipods (abundant)

isopods (two genera)

leeches

clams

snails

cave cricket (may have been knocked in by us from the entrance)

waterbug (accidental) *Belostoma* sp. (coll. by S. Taylor)

larval salamanders

one bullfrog (nearly positive on the id--the frog quickly made himself scarce)

two dead catfish (approx 25 cm long, they were both caught up in a shallow riffle, and in some stage of degradation)

Surface conditions: air temp 28 degrees C., partly cloudy and warm

Mainstem (Nile River) cave conditions: air temp 13 degrees C., water temp 13.5 degrees C., air was flowing upstream

CREVICE CAVE

Pipistrelle Entrance

Perry County, MO (PRY-010)

(in the Central Perryville drainage)

On 20 Sept 1992 Gina Paul, Philip Moss, and myself travelled to Perry County MO to meet Calli Jenkerson and Kevin Bonney from SEMO grotto in order to use this entrance. A little over 1.5 km from this entrance travelling downstream Merlin then across Independence there is a stream called Sculpin Lane that we intended to visit in search of sculpins. Unfortunately we experienced heavy rains on the way, and as this entrance is particularly sensitive to flooding (and the water would be cloudy in any other cave) we cancelled this trip. Efforts will be made in the future to again link up with the keyholders from SEMO grotto in order to visit this stream.

CREVICE CAVE

Pipistrelle Entrance

Perry County, MO (PRY-010)

(in the Central Perryville drainage)

On 8 December 1992, Steve Taylor, J.T. Henderson, and I went on a trip into the Pipistrelle entrance of Crevice Cave to look for sculpins. This entrance took us to Merlin stream where we travelled downstream to the Independence side passage which leads to sculpin lane. In this first section of Merlin, we saw no sculpins, but did see eight yellow catfish (*Ameiurus natalis*?) that appeared to be quite healthy (moved quickly, no sores or scratches, did not have the beat up look that many surface fish

have when encountered well into a cave). Sculpin Lane was small, lacked organic debris and aquatic invertebrates, and no sculpins were found in the section we checked.

Not finding any sculpins in this first part of Merlin or in Sculpin Lane, we went farther downstream Merlin towards Eternity Passage (the main stream). Downstream of a 1.8 m waterfall in Merlin, we began to see sculpins, and counted eight before reaching Eternity. They all had the larger eyes (of the cave specimens-not as large as other surface specimens) and varying degrees of slight pigment.

Eternity passage, of which Merlin is a tributary, proved to have relatively abundant sculpins. In the first 30.5 m (beginning at the intersection of Merlin and Eternity and going downstream), we saw nine sculpins, also with larger eyes. One total length was not recorded, the others were: 5cm, 7.5cm, 5cm, 5cm, 6cm, 7cm, 5cm, and 4.8cm. The last two were collected. Here the water was 13.5 degrees Celsius, and primarily stream pool with a gravel bottom less than 10.2 cm deep. Also note that along this 30.5 m of stream, there was about 9 m that was approximately 1 m wide that was undercut and inaccessible, and some of this water was deep and cloudy, making observation of sculpins impossible. Due to the unexpected extra time involved in getting to where the sculpins were, we did not count sculpins and measure the respective pool lengths, widths, and depths, but we did make a cross section in order to get an idea of the habitat where these nine sculpins were observed. The passage was

9.8 m wide, and stream information was recorded along 30 cm intervals (see Table 5).

Upstream of the intersection of Eternity and Merlin we saw 10 more sculpins before deciding to head back. The majority of them also had larger eyes, though two of them (the first two measurements given) appeared to have eyes that were a bit more sunken in. Their measurements were 6.5cm, 5cm, 7cm, 7cm, 6.5cm, 8cm, 5cm, 5.5cm, 6cm, and 5cm.

Other life noted:

- 6 unidentified sunfish
- 1 dead frog
- about 12 *Eurycea* sp. larvae
- 8 yellow catfish (mentioned above)
- 1 leech
- troglobitic clams
- troglobitic isopods
- other isopods (incl. *Caecidotea brevicauda*)
- amphipods
- snail egg cases
- cave crickets
- terrestrial isopod
- Carabid beetle
- 3 Pipistrelles (*Pipistrellus subflavus*)

 Table 5. Transect of cave stream in Eternity Passage of Crevice Cave, Perry County, Missouri. Cross section along 30 cm intervals.

| | | | | | | | | | | | |
|--------|------|------|-----|-----|------|------|------|------|------|------|------|
| Depth | 1.3 | 2.5 | 3.8 | 1.3 | DRY | DRY | DRY | DRY | 1.3 | 3.8 | 5.1 |
| Stream | R | R | R | R | | | | | P | P | P |
| Bottom | G | G | G | G | SG | SG | SG | SG | S | S | SG |
| Depth | 5.7 | 5.7 | 6.4 | 5.1 | 10.2 | 14.0 | 19.7 | 25.4 | 29.8 | 31.8 | 31.8 |
| Stream | P | P | P | P | P | P | P | P | P | P | P |
| Bottom | GR | G | G | G | G | G | G | G | G | G | G |
| Depth | 33.0 | 31.8 | DRY | DRY | DRY | 10.2 | 5.1 | 6.4 | 10.2 | DRY | |
| Stream | P | P | | | | P | P | P | P | | |
| Bottom | G | BKD | BKD | BKD | BKD | B | B | B | B | F | |

Depth: in centimeters or DRY = above water level, Stream: R = riffle P = pool, Bottom: G = gravel, SG = sand and gravel, S = sand, GR = gravel and rubble, BKD = breakdown, B = bedrock, F = flowstone

DISAPPOINTMENT DOLINE DUMP CAVE

Perry County, MO (PRY-)

(in the Central Perryville Karst)

On 6 February 1993, Steve Taylor and I explored and mapped the entirety (9.8 m) of this small cave. It is located very close to Sutterer Spring, the resurgence of Crevice Cave, so it had promise of connecting to the water of Crevice Cave that does have sculpins. However, as the name implies, our way was blocked by sediment and trash, and no stream passage that could contain sculpins was ever reached.

FRITCHE CAVERNS (Six-Shooter Entrance)

Perry County, MO (Fritche Caverns = PRY-540)

Crosstown Karst

On 9 January 1993, Steve Taylor and I visited this entrance to the Fritche System in search of sculpins. Unfortunately recent rains had clouded the water, making visibility extremely limited. No sculpins were found, though a return trip is warranted as the habitat seems suitable for sculpins, and this karst area (where sculpins have not been found) is adjacent to the Mystery-Rimstone area (where sculpins have been found).

Other life noted:

- mosquitos (thousands)
- cave spiders (*Meta americana*)
- cave crickets (*Cuethophilus*)
- a carabid beetle

isopods (*Ligidium*)

amphipods

two longtail salamanders (*Eurycea longicauda*)

several bats (*Pipistrellus subflavus*)

HOT CAVERNS

Perry County, MO (PRY-173)

(in the Mystery-Rimstone Drainage)

On 4 Oct 1992 Myron Mugele, Philip Moss and myself rappelled into this cave in search of sculpins. We examined the smaller streams above base level with no success. These upper level streams are generally (with a few exceptions that are large pools) <30-60 cm wide, 2.5-15.2 cm deep with a bedrock or silt bottom. In these streams we saw:

many isopods, (both intermediate and troglobitic)

a larval salamander (*Eurycea* sp.)

a white flatworm

terrestrial (all associated with raccoon feces and fungus):

carabid beetles

millipedes

flies (some heleomyzid?)

After descending the bypass waterfall and several more climbdowns we came to the Nile River which is base level water. This unfortunately is downstream of where we rappelled in (though we travelled upstream then later downstream to get there) which meant that the water was somewhat stirred up by our presence.

This portion of the Nile generally ranges from 0.9- 3.1 m wide and from 15 cm to over-your-head swimming deep with a silt and gravel or breakdown bottom. Even though the water was stirred up, we saw one sculpin but failed in our attempt to catch it. This sculpin was on the shallow (15 cm deep) edge of the gravel bottomed stream pool, but darted into the deeper murky water when it was approached.

Next we went to the Labyrinth Stream (a tributary to the Nile) and travelled upstream so that this water was clear. The Labyrinth varies in width and depth as the Nile does, but the stream life we noted was generally in gravel and silt bottomed stream pools 7.6-20.3 cm deep and 0.6-1.2 m wide. In this stream we saw:

- amphipods
- a larval salamander
- a large (bullfrog?) tadpole
- abundant isopods
- abundant crayfish
- 10 sculpins

and terrestrial:

- a spotted salamander (*Ambystoma maculatum*)
- a cave salamander (*Eurycea lucifuga*)
- two frogs- one a bullfrog (*Rana catesbeiana*)
- flies
- a small cave cricket

I captured six of the ten sculpins we saw, keeping two of them

alive in a baby bottle and placed the others in a small nalgene bottle of formalin. Getting to this stream involves some moderately strenuous traversing and is not conducive to carrying large bottles or aerators, but the small bottles I had worked relatively well. My attempts to catch the other four failed, mostly due to the interaction I witnessed between the crayfish and sculpins. As I approached a sculpin, at least one crayfish (and they were ever so abundant) would respond to my presence before the sculpin would, and the crayfish would proceed to scare away the sculpin before I could get within catching distance. This occurred several times. Sculpins are not as abundant in this stream as they were in Flaming River, but they are not rare.

INDIAN CREEK

Perry County, Missouri

This site is located on the Wichern's land, off of county road 410, 2.4 km N-NE of Uniontown. On 24 April 1992, Steve Taylor, Diane Krejca, and myself seined this creek in search of sculpins. No sculpins were found here.

Description: 4.6 m wide gravel and rubble bottom stream, 5-25 cm deep. Sampled below, in, and above riffle.

This site looked like ideal sculpin habitat. Took photograph of site.

Parameters

Measured*:
pH = 8.34 @ 17.0 C
Cond. = 492 uS @ 17.1 C

TDS = 243 mg/L @ 17.1 C

Therm. = 16.5 C

Notes on fish

Collected: One large (3.85 L) Nalgene jar of fishes preserved in formalin, including 2 stonecats, orangethroat darters, *Percina* sp. etc.

* pH, Cond. (= Specific Conductivity), and TDS (= Total Dissolved Solids) measured using Dr. Burr's Corning Checkmate Meter (SIU # 341227). We did not calibrate meter. Last calibrated? Therm. = measurement obtained from regular thermometer, property of Jean Krejca and Steve Taylor.

Weather was partly sunny, breezy, high 60's.

KASSEL CANYON CAVE

Perry County, MO (PRY-431)

(in the Swan School Karst Drainage)

On 6 February 1994, Kent Buckles, Mark Stamborski, Steve Taylor and I visited the entirety of this cave in search of sculpins. The only water present was in a small sump pool at the end of this short (<30 m) cave, and no sculpins were seen in the pool. The pool was 30 cm wide, 90 cm long and 60 cm deep. Visibility was very good, and the substrate was gravel and cobble. This cave likely feeds Kassel Cave, which in turn drains to Kassel Spring Cave.

KASSEL CAVE

Perry County, MO (PRY-046)

(in the Swan School Karst Drainage)

On 6 February 1994, Kent Buckles, Mark Stamborski, Steve Taylor and I visited the entirety of this cave in search of sculpins, and none were found. This cave has an interesting section of collapsed cave passage prior to the entrance "proper," that has left 4 natural bridges spanning historic cave stream (on this visit it was dry except for a few pools, the cave probably overflows here during wet weather). The water in the cave is nearly all over 1.2 m deep, making visibility of any fish difficult. Near the edges of the deep areas the substrate was gravel and silt. About 9.1 m from the sump at the downstream end of the cave is a small waterfall. We followed the stream beyond the waterfall to the downstream sump, and no sculpins were seen. Of note is that the water at the sump had some trash (appeared to be washed in pieces of styrofoam), foam, and a scummy film on the surface. Probably this cave is fed by Kassel Canyon Cave (and others, no doubt), and drains into the nearby Kassel Spring Cave.

KASSEL SPRING CAVE

Perry County, MO (PRY-024)

(in the Swan School Karst Drainage)

On 6 February 1994, Kent Buckles, Mark Stamborski, Steve Taylor and I visited this cave in search of sculpins, and none were found. There is little cave passage here, this site is primarily a spring. The water of the spring was deep (1+ m)

and/or very swift, making visibility difficult, even though it was clear. The stream coming out of the cave was 0.6-1.8 m wide, and up to 30 cm deep, with a gravel, cobble, and breakdown bottom. This would be a worthwhile site to return to seine.

KNOB PIT

Perry County, MO (PRY-476)

(in the Knob Karst Region)

On the 24th of October, 1992, Niel Nichols, Philip Moss and I went upstream in Knob Pit while Aaron Addison and Sean Bittle travelled downstream. Our search for sculpins was unsuccessful. Though the cave and stream was full of life, it appeared to me to be too small to support sculpins. It averaged 46 cm wide and 7.5 cm deep, typically bedrock or rubble bottomed. This cave is likely hydrologically connected to Briar Caverns, another cave in this area that I intend to visit for this project.

Stream life I noticed:

intermediate isopods

troglobitic isopods

amphipods

white flatworms

small snails

2 *Rana palustris*, pickerel frogs

Terrestrial life:

Meta menardi, cave spiders

other spiders

Ceuthophilus sp., cave crickets

millipedes

centipedes

2 Eurycea lucifuga, cave salamanders

several Pipistrellus subflavus, Eastern pipistrelle
bats

One coiled up unidentified black snake near entrance
(perhaps overwintering in the cave?)

LORENZ CAVE

Perry County, MO (PRY-023)

(in the Swan School Karst Drainage)

On 6 February 1994, Kent Buckles, Mark Stamborski, Steve Taylor and I visited the entrance and twilight areas of this cave in search of sculpins. At least one (probably two) individuals were seen in the entrance, as well as some other fish, including the creek chub, *Semotilus atromaculatus*. Attempts at collecting failed, though one dead sculpin was found and collected. The stream was primarily 0.9 m wide and less than 10 cm deep, though it was pooled at the entrance to 3.1 m wide and 30 cm deep (Figure 4). The substrate was primarily gravel and silt bottomed, with a few larger breakdown blocks.

No sculpins were seen beyond the entrance pool (which extended into the twilight zone), and upstream of this pool seemed to be too small for fish. Approximately 30 m of the cave was examined. Judging from the size of the cave stream and its

proximity to the surface stream (the cave is located <15 m from a small creek that is a tributary to Omete Creek), these fish probably just swam up to the entrance of the cave, versus actually dwelling in the cave as they appear to be in other large cave systems of the county.

Terrestrial life noted:

3 large fishing spiders in twilight zone (prob.

Pisauridae: *Dolomedes*)

Aquatic life noted:

amphipods (extremely abundant under large stones)-

collected (entrance)

Aquarius remigis on water surface (entrance)

MIESNER CREVICE

Perry County, MO (PRY-451)

(in the Swan School Karst Drainage)

On 20 June 1993 Sean Bittle, John Lloyd, Myron Mugele and myself visited this cave in search of sculpins. No positive identifications of sculpins were seen. Shortly downstream of the entrance (which is a 15 m free-climbable pit) I spotted what looked like a sculpin, but it escaped into the silt we stirred up. The only thing that makes me doubt that this was a sculpin is that 150-300 m downstream of this another "sculpin" was seen, and I triumphantly scooped it up only to discover that it had tiny legs. Alas, it was a very light colored (nearly white) tadpole. Also the fact that eight eyes carefully examined

approximately one half mile (walking or stoop-walk sections of trunk passage in addition to major side passage) of fairly clear water stream passage makes me doubt that there is a population of sculpins in this cave. Some things to take into consideration, though, are that for the most part (except for a side passage toward the downstream end) our group was walking downstream, which did cut down on the visibility a little bit, and that the habitat appeared ideal. The stream was 0.9-6.1 m wide (avg = 1.8 m), bedrock, gravel, rubble, breakdown and silt bottomed, 5-90 cm deep (avg = 10 cm), and had riffles, pools, and raceways. In addition to the substrate appearing ideal, there were also abundant food items (see below) and some organic debris. This cave warrants a return trip to seine the stream.

Terrestrial life observed:

cave crickets (*Ceuthophilus*)

spiders (with egg cases)

evidence of raccoons

Aquatic life observed: (water temp in side passage = 14 C)

*abundant intermediate isopods

amphipods

large sunfish

sculpin??/tadpole?? (see text above)

tadpole

small white snail

troglobitic flatworms

several crayfish, one collected (this one collected had a

branchiobdellid on it, was found in side passage in a 45 cm deep bedrock and silt bottomed stream pool, water temp here = 14 degrees C)

*also of note: an interesting phenomenon was observed here -- isopods were seen that were the "normal" white to tan color, an intermediate brown color, entirely black (just like the rocks in the stream), and half black/half white or white with a band of black across them. My theory is that there is an extremely rapid rate of manganese oxide deposition in this stream, and that the isopods accumulate this on their cuticle and periodically molt it off (the ones that were partially black and partially white were in the process of molting). In any case, it is something I have never observed before, and I plan on looking into it further.

MIESNER CREVICE

Perry County, MO (PRY-451)

(in the Swan School Karst Drainage)

On 23 November 1993 Loren Easter, Austin Jones, John Dahlin, Brian Schaffner, Jennie Diaz, Barry Smith, Steve Taylor and myself visited this Miesner Crevice. We traversed downstream in the main passage approximately 610 m beyond the major side passage that comes in from the left (heading downstream). Visibility was fairly good, but no sculpins were seen.

Aquatic life observed:

amphipods

troglobitic isopods

troglophilic isopods

1 juvenile salamander (probably *Eurycea* sp.)

1 live snapping turtle

MYSTERY CAVE

Perry County, MO (PRY-054)

Table 6 gives the results from population estimates conducted on 22 October, 1991. Figure 10 shows typical mainstem passage in Mystery Cave.

NEW YEARS CAVE

Perry County, MO (PRY-413)

(in the Crosstown Karst)

On 21 June 1992, Steve Taylor and I explored and mapped this cave. There had been earlier reports that a vertical lead remained unchecked at the back of this cave, but we found it to be only 8.5 m long, and lacking this lead. Probably the cave had filled in with debris since the last report. There was no stream, and hence no sculpins.

Terrestrial life noted:

1 cave salamander (*Eurycea lucifuga*)

cave crickets (*Cuethophilus*)

moth flies (Psychodidae, some are indicators of sewage

- we noticed no sewage odor, though)

Heleomyzid flies

Crane flies (Tipulidae)

 Table 6. Numbers of cavernicolous sculpins from Mystery Cave,
 Perry County, Missouri. Survey date: 22 October 1991.

| <u>Site</u> | <u>Length</u> | <u>Width</u> | <u>Depth</u> | <u>Number of Cottus</u> | |
|----------------------------|---------------|--------------|--------------|-------------------------|----------------|
| | <u>(m)</u> | <u>(m)</u> | <u>(cm)</u> | <u>Norm eye</u> | <u>Reduced</u> |
| 1. Rubble Room | 8.9 | 1.85 | 9.4 | 3 | 0 |
| 2. Stage Curtain | 10.4 | 2.00 | 13.7 | 0 | 3 |
| 3. 8 m down from site 2 | 14.8 | 1.34 | 8.3 | 1 | 0 |
| 4. | 13.5 | 1.90 | 33.9 | 2 | 4 |
| 5. | 13.3 | 1.88 | 12.9 | 1 | 1 |
| 6. Lily Pad Room | 8.5 | 1.40 | 7.4 | 0 | 0 |
| 7. Down from Lily Pad | 22.8 | 2.10 | 6.5 | 1 | 2 |
| 8. Waterfall Upper | 3.5 | 1.75 | 16.0 | 4 | 3 |
| 9. Five Forks Upper | 15.0 | 3.34 | 26.0 | 4 | 4 |
| 10. Right Fork | 22.7 | 2.23 | 13.2 | 2 | 0 |
| 11. Upstream From 10 | 2.3 | 2.00 | 26.3 | 2 | 2 |
| 12. | 7.4 | 1.04 | 14.9 | 3 | 0 |
| 13. | 18.0 | 2.34 | 8.5 | 3 | 1 |
| 14. Five Forks | 9.0 | 1.28 | 6.5 | 5 | 2 |
| 15. | 9.4 | 2.14 | 25.1 | 5 | 2 |
| ----- | | | | | |
| Mean | 12.0 | 1.91 | 15.2 | 4 | |
| ----- | | | | | |
| Totals | 179.5 | | | <u>36</u> | <u>24</u> |
| | | | | 60 | |

 Flow was negligible, substrata consisted of silt, bedrock, and
 breakdown. Current speed was slow (ca. 0.05m/sec). Stream
 temperature averaged 13 C. We observed another 20 sculpins in
 areas where measurements were not made. Of the nearly 180 m of
 stream intensively surveyed there was approximately 1 sculpin/3
 meters. We estimate that we surveyed about 3/4 mile of the cave
 stream. Assuming that we overlooked some, it is estimated that
 about 100 sculpins occur for every mile of stream in the cave.
 Assuming that at least 5 miles of stream in the cave provides
 suitable habitat for sculpins, there should be approximately 500
 sculpins in Mystery Cave.

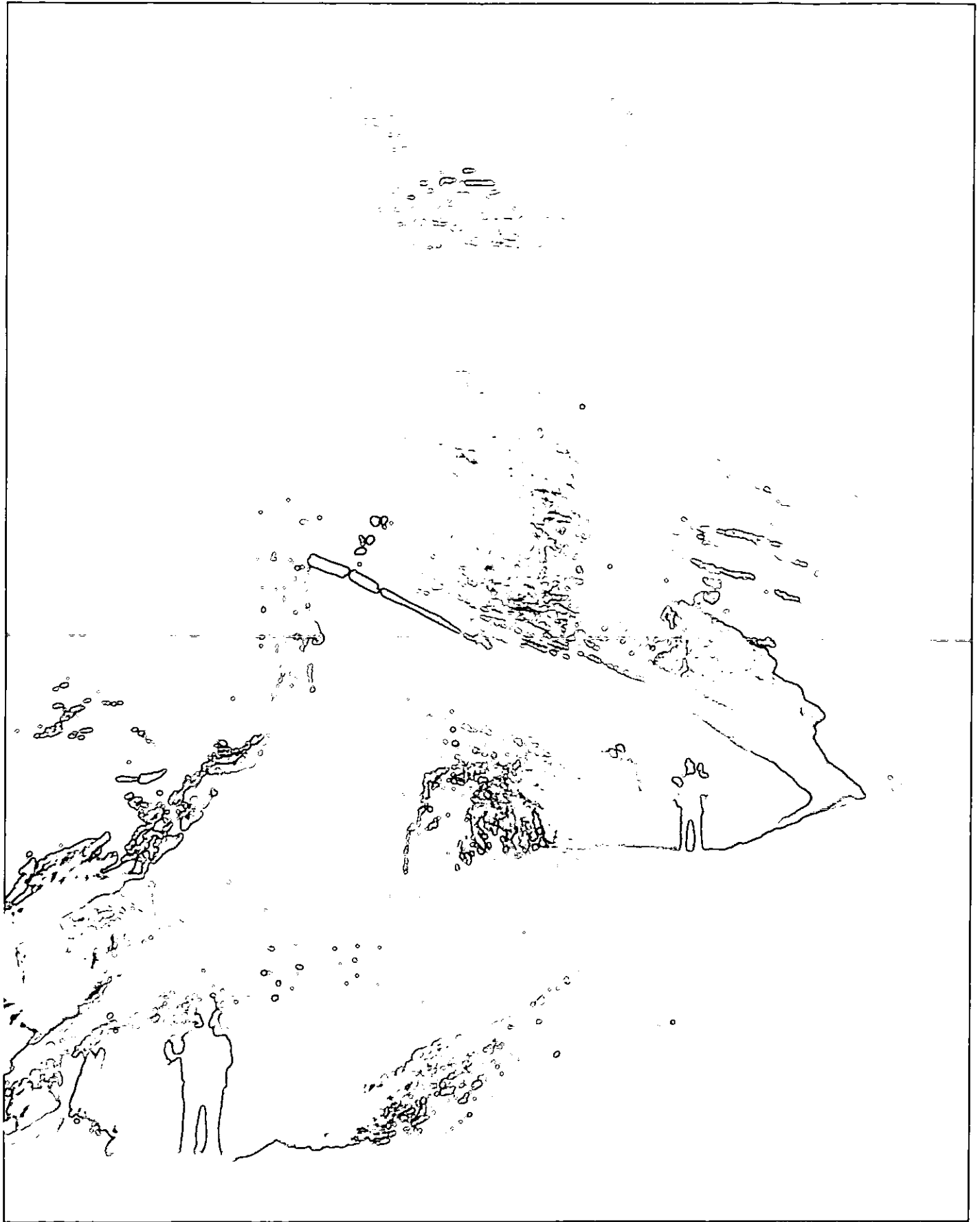


Figure 10. Mainstem passage in Mystery Cave.

OMETE CREEK

Perry County, Missouri

This site is located 46 m upstream of the C bridge which crosses Omete Creek between Crosstown and Farrar. On 24 April 1992, Steve Taylor, Diane Krejca, and myself seined this creek in search of sculpins. No sculpins were found here.

Description: 6.1 m wide gravel and rubble bottom stream riffles and stream pools, to 15 cm deep. This site seemed like good sculpin habitat.

Parameters

Measured*:
pH = 8.48 @ 19.2 C
Cond. = 571 uS @ 19.4 C
TDS = 268 mg/L @ 19.2 C
Therm. = 19 C

Notes on fish

Collected: One large (3.85 L) Nalgene jar of fishes preserved in formalin. Variety of fish, including stone cats, minnows, rainbow darters, etc.

* pH, Cond. (= Specific Conductivity), and TDS (= Total Dissolved Solids) measured using Dr. Burr's Corning Checkmate Meter (SIU # 341227). We did not calibrate meter. Last calibrated? Therm. = measurement obtained from regular thermometer, property of Jean Krejca and Steve Taylor.

Weather was partly sunny, breezy, high 60's.

OSTEOLOGY PIT

Perry County, MO (PRY-)

(in the Swan School Karst)

On 11 April 1993, Steve Taylor and I explored and mapped the entirety (approx 6.1 m) of this small pit cave. There was no stream, and hence no sculpins.

RAGING BULL PIT

Perry County, MO (PRY-)

(in the Apple Creek Karst)

On 14 June 1992, John Lloyd, Myron Mugele, Steve Taylor and I (not all at one time) explored and mapped the entirety of this 7.6 m pit cave. There was no water, and hence no sculpins.

RIMSTONE RIVER CAVE

Perry County, MO (PRY-)

On 3 July 1992, the Flaming River entrance to Rimstone River Cave was visited by Brooks Burr, Gina Paul, Jeff Swayne, Philip Moss, Steve Taylor, and Jean Krejca. Sculpins have been collected from between the gravel bar downstream of the low air (67 m from Flaming River entrance) and the Southwest Discovery Passage (671 m into cave from Flaming River entrance). Figure 11 shows rimstone dams typical of the passage between the Candle Canyon entrance and the Junction Room.

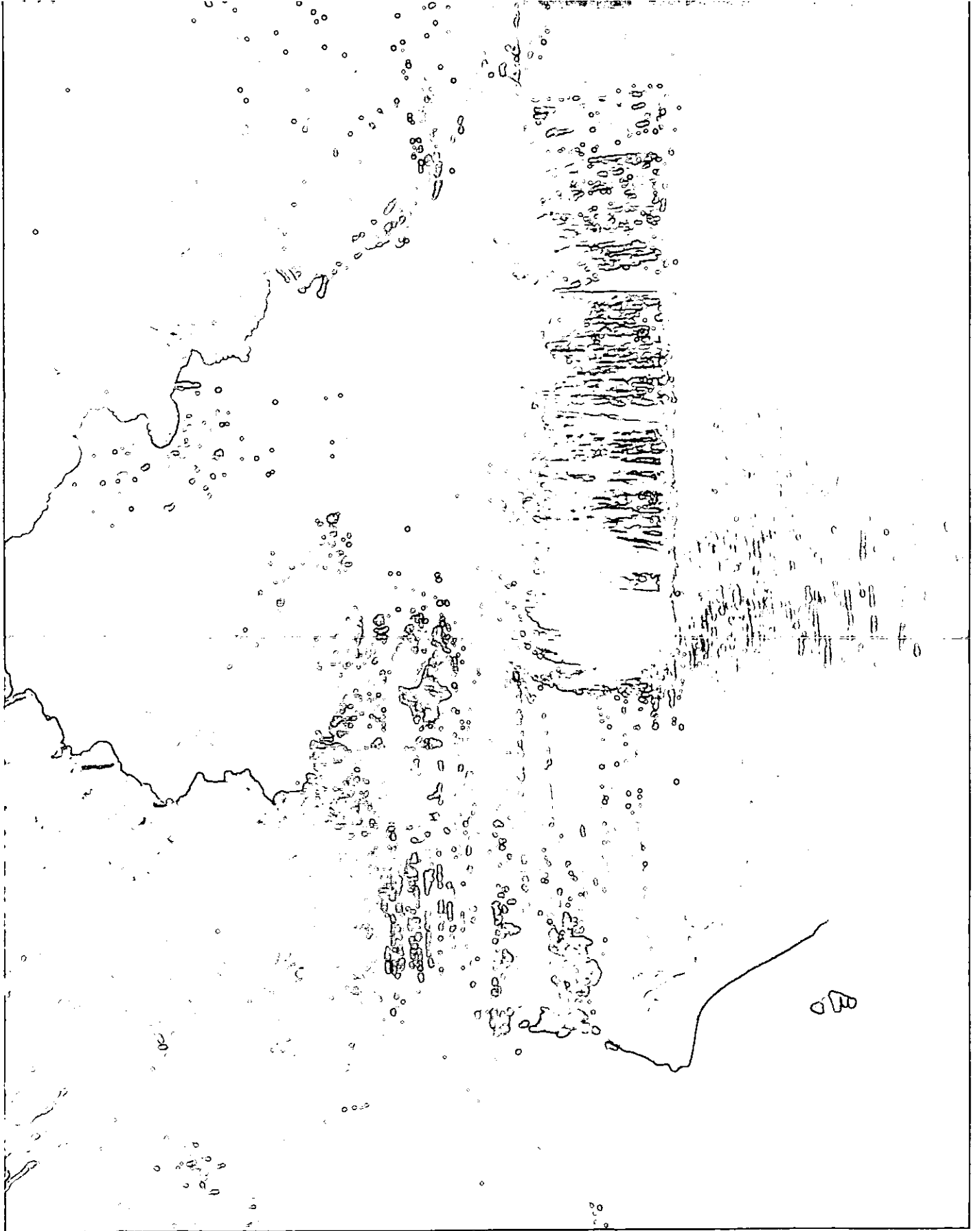


Figure 11. Rimstone River Cave.

RUNNING BULL CAVE

Perry County, MO (PRY-037)

(in the Mystery-Rimstone drainage)

In the afternoon and evening of 5 Sept 1992 Steve Taylor and I searched Running Bull Cave of Perry County, Missouri, for sculpins. This cave has a large sinkhole walk-in entrance with a talus slope leading down about 12.2 m to the stream which flows through the rest of the cave. The stream ranged from 0.6-2.4 m wide and up to 1.2 m deep. Unfortunately, on our visit, the visibility was extremely poor. In a few stream pools the maximum visibility was one inch, but for the most part there was no visibility. From what we could feel, there were areas of gravel and rubble bottom as well as bedrock and some mud bottom.

As we travelled farther into the cave, we began coming across small drip pools (or overflow pools) that contained clear water on the banks of the stream. In one such isolated pool that was 46 cm by 30 cm by 6.4 cm deep we found a small (2.5 cm long) sculpin. The bottom of this pool was mud over bedrock. This isolated pool would be connected to the stream when the water raises about 60 cm, and this area does appear to flood frequently.

According to a gentleman who lives nearby, there was a rain in that area the previous day, explaining the muddy stream water we encountered. The size of the sculpin that was collected, which indicates a probable breeding population in the cave, along with the fact that we found the sculpin in a relatively small

isolated pool certainly warrants a return trip to check the mainstem when visibility is better.

Other life noted:

troglobitic isopods (abundant--seen in both clear drip pools and on wet rocks exposed in shallow riffles)

one tiger salamander on moist clay bank

one larval salamander (*Eurycea* sp.) in drip pool

a group of colonial bats (on 9 m high ceiling)

flies on bat guano

Outside air temp: 28 degrees C

Cave air temp: 14 degrees C

Cave water temp (in pool where sculpin was collected):

14 degrees C

RUNNING BULL CAVE

Perry County, MO (PRY-037)

(in the Mystery - Rimstone Karst area)

On the 25 of October 1992, Myron Mugele and I looked for sculpins throughout Running Bull Cave. We were successful, finding them in gravel and bedrock covered with silt bottomed stream pools that were 0.3-1.2 m wide and 2.5-15.2 cm deep. We collected 6 smaller and 2 somewhat larger sculpins alive and approximately 5 in formalin. They were seen from within 30 m of the entrance (horizontally) through the rest of the cave. About 12 more sculpins were seen but not collected. The ratio of smaller ones to larger ones seemed to be a bit larger than normal

on this visit to this cave (perhaps due to time of year?).

Other life noted:

abundant isopods

amphipods

flatworms (white)

colony of bats (noted on previous trip as well)

1 frog

unidentified organisms: these were attached to rocks in the bottom of the stream (2.5-15.2 cm deep), submerged, apparently sessile, varied from 1.3-3.8 cm in diameter, nearly spherical in shape, white to nearly transparent in colour, not solid in consistency (when picked up out of the water their shape was not maintained, rather they became nearly flat against the rock to which attached, and they could be easily penetrated with a finger), several thicker "lines" from pole to pole of the organism indicated radial symmetry, they were abundant in certain spots of the cave stream.

Underground temperatures (taken just downstream of the bottom of the entrance breakdown):

air: 13 C

water: 14 C

RUNNING BULL CAVE

Perry County, MO (PRY-037)

(in the Mystery - Rimstone Karst area)

On 5 December 1992, I returned to Running Bull Cave with Steve Taylor and Don & Kay Bittle in order to attempt to collect an unidentified organism seen on the 25 October 1992 trip. Though the water was fairly clear and I traversed most of the distance of the cave, none of the aforementioned organisms that were previously abundant were seen. There is a possibility that their presence is season dependant, and I will attempt a return trip to find them again. I did, however, note 16 sculpins with reduced eyes and pigment on the way in (downstream) and saw four more on the way out (though it is possible some or all of these last four were the same ones seen on the way in).

RUNNING BULL CAVE

Perry County, MO (PRY-037)

(in the Mystery - Rimstone Karst area)

On 22 September, 1993, Steve Taylor, Jitka Villamova and myself visited Running Bull Cave in order to attempt to collect an unidentified organism seen on the 25 October 1992 trip. The visibility was good, many sculpins were seen, and some bryozoans (probably of the genus *Fredericella*) were seen and collected.

RUNNING BULL CAVE

Perry County, MO (PRY-037)

(in the Mystery - Rimstone Karst area)

On 11 October, 1993, Steve Taylor, Brooks Burr, Gena Paul

and myself visited Running Bull Cave to make sculpin and bryozoan population estimates. For the first time I saw the "glass eye" phenomenon, where one eye (that is usually enlarged) has a reflective quality to it.

A summary of the population estimates: Stream temperature was 14 C near the entrance and over 100 m in the cave. Of the 101 m of stream intensely surveyed there was approximately one sculpin every 2 meters. We surveyed (Table 7) nearly all of the easily accessible stream in the cave. Running Bull Cave has a significantly higher proportion of small-eyed sculpins (84%) when compared to Mystery Cave (40%) and most were of a much smaller total length.

SALINE CREEK

Perry County, MO

This site is located 45 m downstream of a bridge which crosses Saline Creek/South Fork. As you are driving SW on T west of Perryville, this bridge is on the first gravel road to the left after junction with N. It is about 3.2 km from the N junction, and 5.6 km W-SW of Perryville. On 24 April 1992, Steve Taylor, Diane Krejca, and myself seined this creek in search of sculpins. No sculpins were found here.

Description: 7.6 - 9.1 m wide gravel and rubble bottom stream riffles and stream pools, up to 61 cm deep, mostly \leq 30 cm in depth. This site seemed like ideal sculpin habitat.

 Table 7. Numbers of cavernicolous sculpins from Running Bull Cave, Perry County, Missouri. Survey date: 11 October 1993. Sites are downstream to upstream in order. Bed = bedrock; slt = silt; bkd = breakdown; grv = gravel; cob = cobble.

| <u>Site</u> | <u>Length</u> (m) | <u>Width</u> (cm) | <u>Depth</u> (cm) | <u>Number of Cottus</u> | |
|--|----------------------|----------------------|----------------------|-------------------------|----------------|
| | | | | <u>Norm eye</u> | <u>Reduced</u> |
| 1. pool [Substrate (%), bed: 40; slt: 40; bkd: 20] | 7.62 | 61.70 | 12.65 | 0 | 0 |
| 2. pool [Substrate (%), bed: 20; slt: 70; bkd: 10] | 5.49 | 50.63 | 10.18 | 0 | 0 |
| 3. raceway [Substrate (%), bed: 60; slt: 10; grv: 30] | 9.75 | 63.08 | 5.21 | 0 | 1 |
| 4. pool [Substrate (%), bed: 25; grv: 75] | 2.44 | 68.75 | 9.50 | 1 | 3 |
| 5. riffle [Substrate (%), bed: 25; grv: 75] | 1.83 | 86.25 | 4.00 | 1 | 0 |
| 6. pool [Substrate (%), bed: 15; slt: 80; grv: 5] | 11.58 | 162.73 | 17.01 | 3 | 6 |
| 7. pool [Substrate (%), slt: 80; grv: 20] | 3.35 | 246.67 | 21.78 | 0 | 4 |
| 8. pool/riffle [Substrate (%), bed: 10; slt: 10; grv: 80] | 10.05 | 149.71 | 10.04 | 0 | 2 |

Table 7. Continued.

| | | | | | |
|--|--------|--------|-------|----------|-----------|
| 9. pool | 15.54 | 155.75 | 10.45 | 1 | 7 |
| [Substrate (%), bed: 10; slt: 60; grv: 30] | | | | | |
| 10. pool | 8.53 | 132.75 | 17.80 | 1 | 2 |
| [Substrate (%), bed: 20; slt: 70; grv: 10] | | | | | |
| 11. pool | 3.05 | 110.00 | 10.33 | 1 | 4 |
| [Substrate (%), bed: 10; slt: 90] | | | | | |
| 12. pool | 6.10 | 99.80 | 9.77 | 0 | 4 |
| [Substrate (%), bed: 20; slt: 80] | | | | | |
| 13. pool | 3.05 | 138.33 | 5.44 | 0 | 1 |
| [Substrate (%), bed: 10; slt: 80; grv: 10] | | | | | |
| 14. pool/rif. | 3.05 | 146.00 | 8.11 | 0 | 6 |
| [Substrate (%), grv: 100] | | | | | |
| 15. pool | 9.75 | 206.67 | 16.53 | 0 | 3 |
| [Substrate (%), cob: 40; slt: 50; bkd: 10] | | | | | |
| ----- | ----- | ----- | ----- | ----- | ----- |
| Mean | 6.75 | 125.25 | 11.25 | | 3.4 |
| ----- | ----- | ----- | ----- | ----- | ----- |
| Totals | 101.18 | | | <u>8</u> | <u>43</u> |
| ----- | ----- | ----- | ----- | ----- | ----- |
| | | | | | 51 |
| ----- | ----- | ----- | ----- | ----- | ----- |

Parameters

Measured*:
pH = 8.71 @ 17.7 C
Cond. = 280 uS @ 17.8 C
TDS = 139 mg/L @ 17.7 C
Therm. = 17 C

Notes on fish

Collected: One large (3.85 L) Nalgene jar of fishes preserved in formalin. Variety of fish, including darters, stone roller, etc.

* pH, Cond. (= Specific Conductivity), and TDS (= Total Dissolved Solids) measured using Dr. Burr's Corning Checkmate Meter (SIU # 341227). We did not calibrate meter. Last calibrated? Therm. = measurement obtained from regular thermometer, property of Jean Krejca and Steve Taylor.

Weather was partly sunny, breezy, high 60's.

SEVENTY SIX CAVE

Perry County, MO (PRY-495)

(in the Swan School Karst Drainage)

On 11 April 1993 I visited portions of this cave in search of sculpins. None were seen, though it is possible that this cave stream dries up enough during the summer that it could not support fish. On my visit the stream was of a large enough size to support fish.

Downstream Seventy Six, Karst Window Entrance:

The stream averaged 90 cm wide by 10.2 cm deep, bedrock, gravel, rubble bottomed pools, riffles and raceways. Some parts had a thin layer of silt over this bottom, and organic debris was commonly encountered through the cave stream observed. This stream appeared to be similar to other streams where sculpins have been observed. Aquatic life observed:

snail

surface amphipods

surface/intermediate isopods

troglobitic isopods

1 *Eurycea lucifuga* (cave salamander with odd pigment-
collected)

Upstream Seventy Six, Karst Window Entrance:

The stream here was 30-90 cm deep and silt bottomed from the entrance to the sump, so that the water was too deep and murky to see any aquatic life.

Upstream Seventy Six, Slippery Pit Entrance:

The stream was the same as that of the downstream Seventy Six (Karst Window Entrance). Aquatic life observed:

troglobitic isopods

troglobitic amphipods

1 black salamander (prob. *Plethodon glutinosus*)

SEVENTY SIX SPRING CAVE

Perry County, MO (PRY-510)

(in the Swan School Karst Drainage)

On 11 April 1993 Steve Taylor and I visited the spring to Seventy Six Cave, and carefully examined the spring and upstream and downstream of its confluence with a tributary of Clines Branch (which is a direct tributary of the Mississippi River) for sculpins. None were seen, though the habitat seemed suitable. The spring was about 46 cm deep by 61 cm wide, gravel and rubble bottomed pool, riffle and raceway (Figure 4). The creek averaged 2.4 m wide by 15.2 cm deep, with a full variety of substrates, depths, and overhangs. Amphipods were abundant in the stream, along with a variety of insects. Two small fish, one crayfish, and one crayfish claw were seen.

SUTTERER SPRING CAVE

Perry County, MO (PRY-268)

(in the Central Perryville Drainage)

On 5 December 1992, Steve Taylor and I visited Sutterer Spring Cave in search of sculpins. No sculpins were seen. The water (which, according to the locals, drains Mertz Cave and Crevice Cave) had fairly good visibility to about 20 cm, though there was very little area where it was that shallow. The cave is a major spring resurgence, though only enterable about 15.2 m, and the majority of the water is a fairly deep stream pool. In order to collect sculpins out of this cave, it would probably need to be seined, which would be difficult if not impossible to do due to wary landowners. Several years ago there was a dam, lake, and campsite proposed to be built in that area in order to

attract tourism. The approach by the government to carry through with this was not well accepted by the landowners, and involved some "snooping around" in the caves, making the landowners cautious about allowing visitors.

Other life noted:

- 1 crayfish (collection attempted, but failed)
- 2 small perch-like fishes (probably swam in from surface-not collected)
- 1 crayfish claw (collected)
- several small clam shells (collected)
- 1 water boatman (Coritidae) (collected)

TOM MOORE CAVE

(Main entrance) Perry County, MO (PRY-001)

(In the Central Perryville Karst Area)

On the 25 of October, 1992 Myron Mugele, John Lloyd, Philip Moss and myself visited Tom Moore Cave to look for sculpins. None were found in the entrance passage, though other life was noted:

- 1 cave salamander (with unusual pigmentation)
- amphipods
- abundant isopods
- one 7" long catfish
- one pickerel frog

We travelled downstream of the "T" intersection from the entrance passage, managing to keep ahead of the silt we stirred

up. Between this intersection and the first large side passage on the right is where we collected all of the sculpins. The stream we found them in was bedrock or gravel bottom covered with a layer of silt in 5.1-15.2 cm deep stream pools that averaged 0.9-1.8 m wide. The passage is mainly large, 1.2-4.6 m tall by 2.4-7.6 m wide with occasional deep (1.1 m) pools.

Approximately 7 were preserved in formalin, and 2 smaller sculpins and 3 larger ones were kept alive. Besides these 12 we collected, we saw but did not collect another 5 or so. The sculpins here are fairly common. Another note is that 3 of the small ones (two of which were taken alive, one was taken in formalin) were all found within the same 1.2 m area and they were extremely difficult to detect.

Underground temperatures (taken just downstream of the "T"):

air: 13.5 C

water: 13 C

TWISTING HEIFER HOLE

Perry County, MO (PRY-)

(in the Apple Creek Karst)

On 30 August 1992, Philip Moss, Myron Mugele and I explored and mapped the entirety of this cave. There is about 9.1 m of stream passage, none of which had sculpins. The upstream end was a pool about 10.1 m wide and over 0.3 m deep. Downstream was a stream riffle over cobble 61 cm wide and up to 15.2 cm deep. This water is probably from Bovine Beauty Cave, and it is heading

southeast toward Apple Creek.

ZAHNER CAVE

Perry County, MO (PRY-557)

(in the Central Perryville drainage)

On the 22 Sept 1993 Steve Taylor, Jitka Villamova and I visited Zahner Cave in search of sculpins. The entrance is a well hidden hole in tall grass that the landowner has laid several logs across as a "gate". About 6.1 m of climbdown leads to the stream.

The stream we explored was 15.2-90 cm (avg. 75 cm) wide and 3 mm to 10.2 cm (avg. 2.5 cm) deep-- not very suitable for fish. The stream bottom was mainly bedrock with some gravel and contained little trash or sediment. After traversing about 90 m of passage, varying from bellycrawl in water to narrow stoopwalk, it became evident that the stream was not large enough to support sculpins (unless farther downstream it joins more water).

Terrestrial life noted:

cave spiders (*Meta americana?*)

diptera larvae (*Macrocera nobilus*)

cave crickets (*Ceuthophilus*)

beetles - Staphylinidae and Carabidae

cow (*Bos taurus*) and woodchuck (*Marmota monax*) bones

were also seen

Aquatic life noted:

troglobitic amphipods

troglobitic isopods (abundant)
intermediate isopods (abundant)

BERRY CAVE

Pulaski County, MO

On 17 October, 1993, Myron Mugele, John Lloyd, John Dahlin, Brad Hibdon, Amy Hibdon, Steve Taylor, Sean Bittle, Kay Bittle, Don Bittle, Brian Schaffner, Jennie Diaz, Jen Nitz, Austin Jones, Jeff Swayne and myself visited Berry Cave. It was determined that there was no enterable stream passage, therefore no sculpins were seen.

ANDREW BRUMFIELD PIT

Ste. Genevieve Co, MO (SGE-)

On 10 April 1993, Aaron Addison, Don Bittle, Amy Hibdon, Brad Hibdon, Myron Mugele, Steve Taylor and I explored and mapped this blind pit. There was no stream, and hence no sculpins.

ARNOLD'S CAVE

Ste. Genevieve Co, MO (SGE-)

On 25 January 1992, Aaron Addison, Philip Moss, Brian Shaffner and I completed the exploration and mapping of this cave. The only stream found was a 30 cm wide, 2.5-5 cm deep stream riffle over gravel that was too small to support sculpins.

KOHMS CAVE

Ste. Genevieve Co, MO (SGE-007)

On 20 June 1992, Dr. Dave Ashley, Tom Demasa (sp?), Pam Saberton, Ron Jones, Steve Taylor and I visited Kohms Cave. No sculpins were seen. Among the life noted was one foot long yellow catfish and abundant intermediate isopods (prob. *Caecidotea brevicauda*). The upstream passage was explored in its entirety.

PITS OF LITTLE EGYPT PIT

Ste. Genevieve Co, MO (SGE-)

On 10 April 1993, Aaron Addison, Don Bittle, Amy Hibdon, Brad Hibdon, Myron Mugele, Steve Taylor and I explored and mapped this small pit cave. The only stream found was a 30 cm wide, 2.5-5 cm deep stream riffle over gravel that was too small to support sculpins.

JACK'S FORK RIVER

Texas County, MO

On 2 May 1993, Sean Bittle and I seined for surface sculpins and found none. The habitat appeared suitable: gravel and rubble bottomed stream pool, 15-60 cm deep, 9.1 m wide.

HAMILTON CAVE

Washington County, MO (WSH-)

On 26 September, 1992, Hamilton Cave was searched for sculpins. None were seen in the stream issueing out of the cave,

though only the first 30 m or so were enterable due to a large cave gate. Access was restricted at this time of year.

GREEN CAVE

Washington County, MO (WSH-006)

On 26 September, 1992, Green Cave was visited in search of sculpins. None were seen. The stream passage of all but the last 60 m of the 1.07 km long cave was searched. The stream was of ample size to support sculpins, 1.2-3.1 m wide, up to 75 cm deep, with gravel, rubble, and silt bottom. This cave has a large entrance (boasting the largest riverbank cave entrance in the nation at 28.4 m high by 34 m wide) located 4.6 m above and 9.1 m from the Meramec River. The cave stream issues out of the entrance and feeds the Meramec River.

SPRING NEAR HAMILTON

Washington County, MO (WSH-)

On 26 September 1992, this spring cave was visited in search of sculpins, and several were seen. They were fully pigmented and appeared to have normal eye size. Attempts were made, but none were collected.

Tennessee

RAPIDS RESURGENCE

Robertson County, TN (RB083)

This cave is a large, swift, spring resurgence that is 2 m wide and 0.3 m deep, with 0.3 m of air over the water at the entrance. Proceeding into the cave, rimstone dams are encountered. These dams pool up the water such that the cave becomes unenterable after about 9 m. No suitable bat habitat is present. This cave, or, more likely, Swirling Spring Cave (RB089) is the resurgence of Head Cave (RB063).

Fauna seen:

Sculpin (Cottus sp.) - 1 fish seen at the entrance of the cave, troglaxene or troglophile.

YATES CAVE

Robertson County, TN (RB013)

This is a large, well known cave. The entrance is a stream resurgence. A small house, complete with concrete floor and stairs going down to the cave stream, was built in the cave entrance, apparently in the 1920's, and is still standing. The majority of the passage is 15-20 feet tall and 5 to 10 feet wide. In some places the passage is wider and taller. A large cave stream flows on the floor. Several areas with high ceilings fairly deep in the cave seem suitable for colonial bats (i.e., Gray and Indiana Bats).

Fauna seen:

12 Eastern Pipistrelles

1 Unidentified *Myotis*

Sculpin (*Cottus carolinae*) 1 specimen, troglophile or troglaxene.

Crayfish (*Cambarus* sp.) 1 male, troglophile or troglaxene

Phoebe (*Sayornis phoebe*) 1 individual at entrance, troglaxene

Woodchuck (*Marmota monax*) 1 individual in den in entrance, troglaxene

DISCUSSION

It has been determined that cave-adapted sculpins are probably unique to a small area within Perry County, Missouri, though much field work remains to determine more precise boundaries. The other cave-dwelling sculpin populations found elsewhere in Missouri and surrounding states do not exhibit obvious cave adaptations as noted earlier for sculpins from Perry County caves. Several topics that warrant discussion are as follows: 1) What is the history of caves in Perry County? 2) How long have sculpins been in these caves? 3) What is their current distribution and why? 4) Is the future of these sculpins in jeopardy?

Past

The development of caves is a gradual process (it continues to occur at this moment), and the exact age of a cave cannot be accurately determined. Evidence suggests, however, that the Perry County cave passages of today were in existence in the early Pleistocene, 2 million years before present (see "Study Area" for more). A priority for the future involves research into cave ages of sites where non cave-adapted sculpin populations are found in caves.

Walsh (1988, 1989) and Knox (1976a) theorize that at one point a giant cave system existed whose mainstem was the present Cinque Hommes Creek. Mystery and Rimstone River Caves were

southern tributaries, and Crevice Cave was a northern branch. If this is true, one would expect a higher likelihood for more recent gene flow among cave sculpin populations in the Crevice, Mystery, and Rimstone River Caves than the Moore Cave System, which drains north to Blue Spring Branch rather than into Cinque Hommes Creek (Figure 5). Many other factors, such as the ability of cave-adapted sculpins to pass through surface streams, or the distance that fish might be carried during floods would also affect genetic communication.

Present

The distribution of cave-adapted sculpins is limited to two karst areas in Perry County, Missouri (Figure 7). Sites in Indiana, Illinois, and other areas of Missouri were visited, and though a few sites contained populations of sculpins deep in a cave, no individuals showed the obvious morphological cave adaptations found in Perry County fish (Figure 12). It is also interesting to note the variability of traits, such as eye size, in the cavernicolous Perry County sculpins (Figure 13). Several factors account for the limits of the in-cave sculpin populations within Perry County. First, there are a limited number of caves in the county that contain a large and constant enough stream to support fish. Perry County has the four longest caves in the state, each one exceeding 16 km in length, and containing a sizeable stream. Sculpins have been found in all four of these major caves. Another factor is that the caves are formed beneath



Figure 12. Cave adapted *Cottus carolinae* have been found only in Perry County, Missouri, and look obviously different than those from other areas of Missouri. Left specimen is from Blowing Spring Cave, Laclede County, Missouri, right specimen is from Mystery Cave, Perry County, Missouri.

a sinkhole plain that provides a large amount of organic input, supporting a wealth of organisms on which the sculpin could feed. Invertebrates such as isopods, amphipods, flatworms, and snails are abundant (Figure 14). Peck and Lewis (1978) inventoried the invertebrate cave fauna in this area.

The reason why cavernicolous sculpin populations in other areas do not show similar adaptations to life in a cave remains unclear. Research regarding geological history and life history of the non-cave adapted populations versus the cave adapted populations of Perry County would shed more light on this issue.

Future

The cave-adapted sculpins of Perry County are unique. Cave adaptation has not been reported in this family of fishes (Groombridge 1992), and the opportunity to study and protect this fish is of great value. Unfortunately, the future of these sculpins is in jeopardy because of their limited distribution and the impacts of human activity on the surface.

The small range of these fishes (limited to two regions within one county, less than 260 km² area), increases the chance that some catastrophic event could severely deplete or extirpate these populations.

The cave-dwelling organisms present in Perry County caves are particularly vulnerable to human activity on the surface. Two of the most likely negative influences on the sculpin populations are contamination of the water (from farming and

urban runoff) and destruction of habitat due to sedimentation (primarily caused by farming). Vandike (1985) studied the directions of shallow groundwater (cave water) movement in the Central Perryville Karst area. He showed through dye tracing that the urban runoff from and adjacent to the city of Perryville enters cave systems, and an event such as a chemical spill threatens aquatic life. Some water quality analysis determined that urban runoff, agricultural practices, and rural waste disposal contaminated the karst groundwater of the Central Perryville Karst area (Vandike 1985). In particular, ammonia, nitrite + nitrate, chloride, and potassium levels were found to occur at high enough levels to be detrimental to aquatic life (Vandike 1985).

The nature of aquifers in karst terranes make them exceptionally sensitive, having a higher potential for contamination than other aquifers (Field 1989, Helling 1986). One characteristic of the karst aquifer is the discrete conduit through which the water flows. These latticed conduits increase the chances for concentration of contaminants and complicate the hydrology (Field 1989, Quinlan 1982, Palmer 1986). In a study by Vandike (1985) of shallow groundwater movement in Perry County, many dye traces reappeared at several springs, often widely separated.

Another characteristic of karst aquifers that threatens the health of organisms relying on the water is turbulent flow. Turbulent flow does not allow for the filtration that is



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Figure 13. Variability of eye size in populations of sculpins from Perry County caves. These two sculpins are from Mystery Cave.

a sinkhole plain that provides a large amount of organic input, supporting a wealth of organisms on which the sculpin could feed. Invertebrates such as isopods, amphipods, flatworms, and snails are abundant (Figure 14). Peck and Lewis (1978) inventoried the invertebrate cave fauna in this area.

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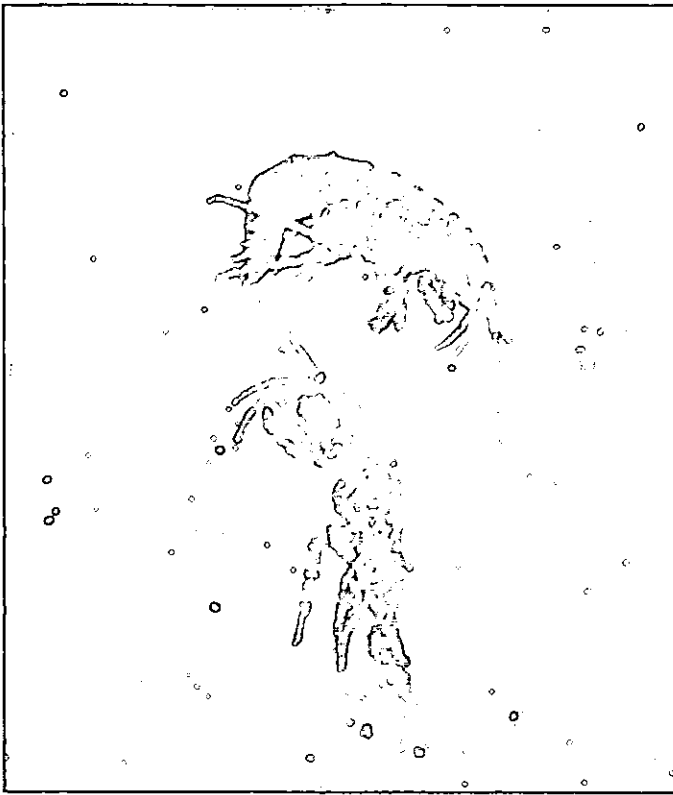
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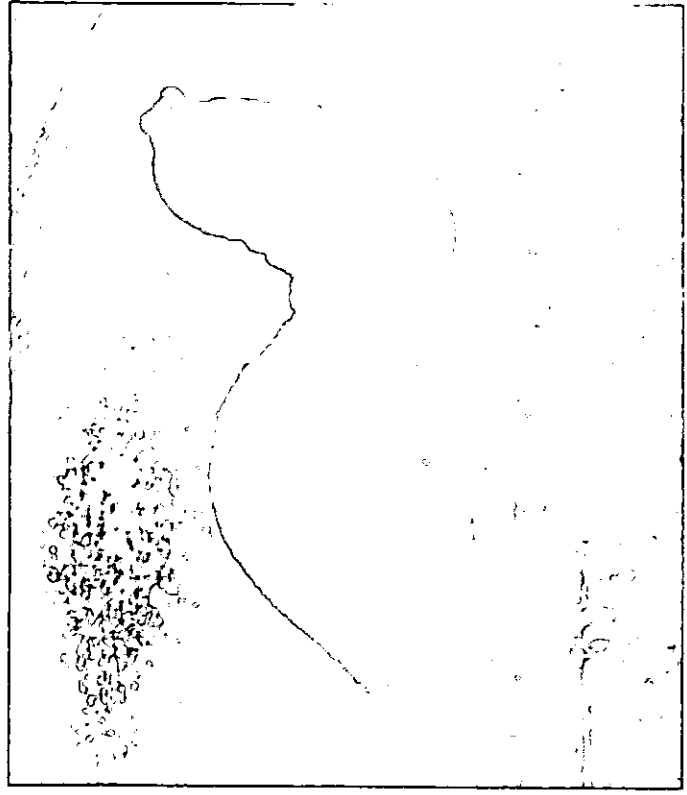
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A.



B.



C.

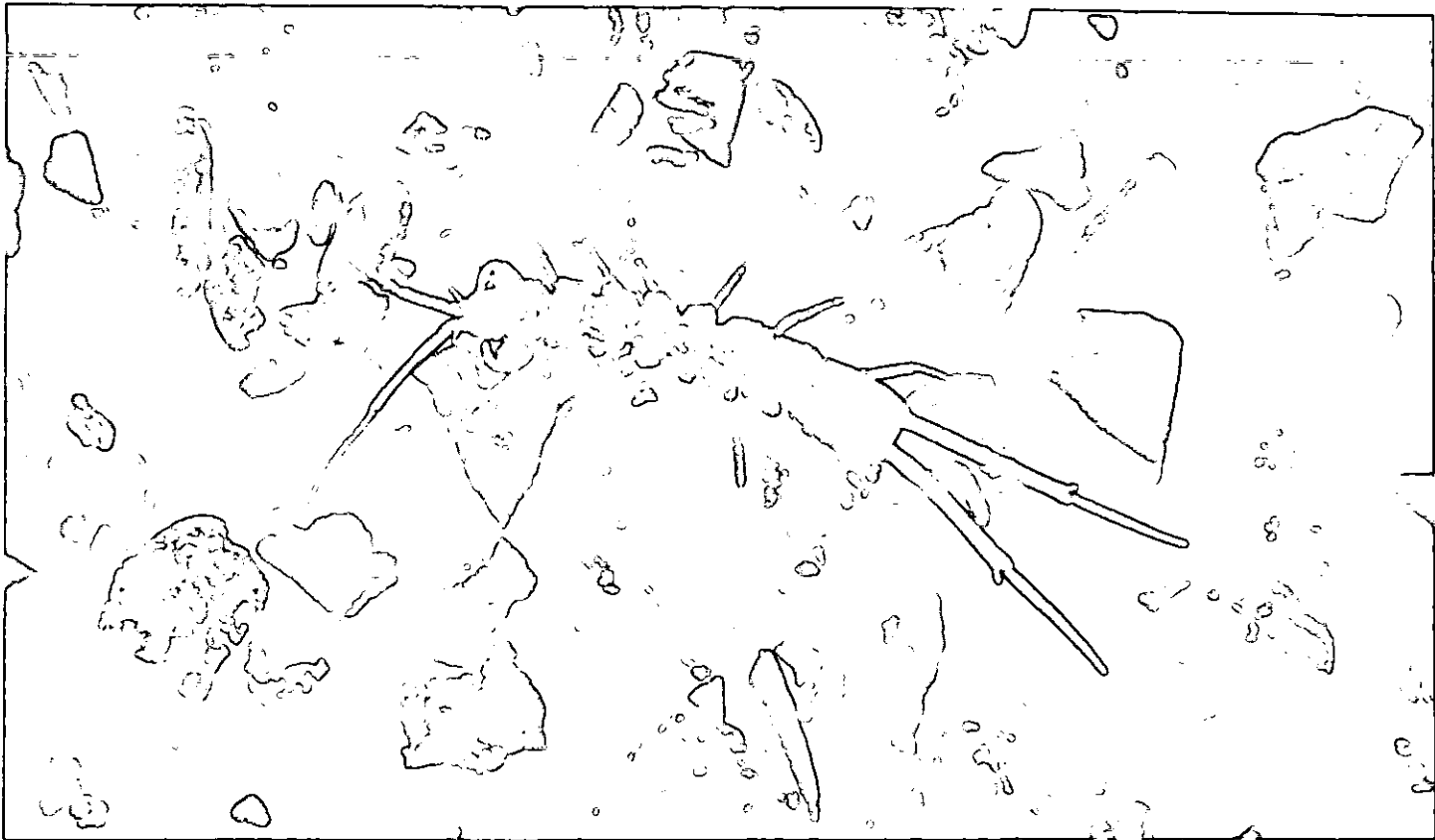


Figure 14. Invertebrates from Perry County, Missouri caves that are potential food sources for sculpins: A. Amphipods from Mystery Cave, B. Isopod from Mystery Cave, C. Flatworm from Angry Cow Cave.

urban runoff) and destruction of habitat due to sedimentation (primarily caused by farming). Vandike (1985) studied the directions of shallow groundwater (cave water) movement in the Central Perryville Karst area. He showed through dye tracing that the urban runoff from and adjacent to the city of Perryville enters cave systems, and an event such as a chemical spill threatens aquatic life. Some water quality analysis determined that urban runoff, agricultural practices, and rural waste disposal contaminated the karst groundwater of the Central Perryville Karst area (Vandike 1985). In particular, ammonia, nitrite + nitrate, chloride, and potassium levels were found to occur at high enough levels to be detrimental to aquatic life (Vandike 1985).

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Another characteristic of karst aquifers that threatens the health of organisms relying on the water is turbulent flow. Turbulent flow does not allow for the filtration that is

generally associated with groundwater, and has the potential to spread contaminants over great distances very quickly (Quinlan and Ewars 1985, Smart and Hobbs 1986). Sensitivity to quick flooding after a rain event causes high concentrations of contaminants that create brief, but hazardous water quality problems (Hallberg et al. 1985).

A third characteristic of karst aquifers are the varied and unique means of recharge that can affect the quality of the cave water. Sinkholes allow sediments and chemicals to be directly injected into the groundwater without the filtration associated with non-karst regions (Field 1989, Mitchem et al. 1988). It is not uncommon to see sinkhole "trash-cans" in Perry County that contain everything from household garbage and sewage to pesticide containers (Figure 15). Another means of recharge is from the soil and epikarst zone. In these places contaminants can amass during dry periods to be recharged into the cave water later (Field 1989, Hobbs and Smart 1986, Smart and Friederich 1987, Williams 1985). Pollutants can also infect upper level passages when contaminated water travels down vertical shafts and walls before reaching stream level. Kurtz and Parizek (1986) describe another type of contaminant storage where a sort of "bathtub ring" film of chemical contamination was left on the walls of Lost River Cave System, Kentucky, after a flood pulse receded. Regardless of whether or not there are conduit features, chemicals with certain physiochemical properties will be temporarily stored on substrates (Field 1989), and these

A.



B.



Figure 15. Sinkhole usage at two Perry County, Missouri cave sites: A. Entrance to Disappointment Doline Dump Cave, B. A sinkhole near Osteology Pit.

substrates are often important microhabitats for subterranean organisms.

Yet another manner of recharge is slow seepage (similar to that in non-karst regions) which can affect the aquifer in more traditional ways (Field 1989). In some cases, seepage through soil and glacial deposits constitutes the greatest contributor of nitrate and pesticides in the groundwater, in spite of the presence of karst terrane (Libra et al. 1986).

Because of the sensitive nature of karst groundwater (outlined above), and the determination that the cavernicolous sculpins of Perry County, Missouri, are unique, great efforts should be made to protect these fish. Several things should be considered for the immediate future. Additional research (with limited collecting) should be done to answer the plethora of basic life history questions remaining. Efforts should be made to cooperate with local landowners to maintain access to the caves and to attempt to reduce chemical contamination and sedimentation of the cave streams. Communication with and assistance from organized cavers should be maintained in order to keep access to the caves and resources that cavers have to offer. Educating the people of Perry County would help local citizens understand how karst systems work and might reduce contamination of the cave water.

Future Objectives

Keeping in mind the goal to define the boundaries of where

the unusual sculpins are found, the sites listed below are in drainage basins of Perry County, Missouri, and are adjacent to those in which sculpins have already been found.

Swan School Karst:

Soehl Cave

Kassel Spring and nearby creek (seine)

Central Perryville Karst:

Blue Spring (seine)

Klump's Cave

Mertz Cave

Sutterer Spring (seine)

Streiler City Cave

Crosstown Karst:

Fritche Caverns

And in Monroe County, Illinois:

Couch Cave

Creek by Couch Cave

Other objectives include: 1) Obtain maps of all caves that contain sculpins, indicate on map where sculpins were seen. 2) Obtain information on the geological history and cave age of caves where non cave-adapted sculpins have been found deep in caves. 3) Perform more population estimates, including penetrating farther into some of the caves with known populations. 4) Create a study site in an easy access cave with known populations of sculpins

(e.g., Running Bull Cave, Mystery Cave). Visit site regularly, obtain data. 5) Begin some basic laboratory experimentation with exposing Perry County surface sculpins and surface sculpins from other areas of the state to a cave-like environment, and exposing Perry County cave sculpins to an epigeal environment. 6) Assimilate descriptions of Perry County caves written by cavers, and use them to determine which other caves (not visited during this study) have streams that are large enough to support sculpins.

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VITA

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5 May 1994

EDUCATION

Voyageur Outward Bound School
Ely, MN, July 1989

St. Charles High School
St. Charles, Illinois, June 1990
Graduated with honors

Southern Illinois University at Carbondale
August 1990 - present
Bachelor of Science: Zoology
82 hours completed, GPA: 3.843/4.0

HONORS AND AWARDS

Illinois State Scholar Recognizes outstanding academic achievement in High School.

SIU Academic Scholarship A one year (fall 1990, spring 1991) waiver of tuition based on academic performance in High School and standardized test scores.

SIU Dean's list Fall 1991 and spring 1992 semesters, 4.0 and 3.9 GPA respectively.

SIU Zoology Alumni Scholarship Spring 1993, a departmental scholarship based on academic achievement, recommendation, and career goals in zoology.

Mitchell Award (National Speleological Society) August 1993, awarded for the best scientific paper presented at the NSS annual convention by a member of the Society age 25 or younger.

Illinois Beta Association of Phi Beta Kappa, the Southern Illinois University Liberal Arts and Sciences Honor Society for outstanding scholarship. April 10, 1994.

EXPERIENCE

Pollution Control: Project Manager. Performed the field and laboratory aspects of environmental monitoring of drinking water, storm runoff, groundwater, and industrial and municipal waste. August 1990 - January 1992.

Illinois Environmental Protection Agency, Class Four Wastewater Treatment Works Operator Certification, May 1991.

Cave Mapping: Project Coordinator. Mapping of some southern Illinois caves to fulfill a Memorandum of Understanding with the Illinois Department of Conservation and a cost share project with the United States Forest Service. 1991 - Present.

Illinois Natural History Survey: Jr. Technical Assistant. Field team leader, conducting research regarding the status and distribution of bats in Illinois. May 1991 - August 1991.

Illinois Natural History Survey: Mammalogist, Jr. Technical Assistant. Conducting faunal inventory of Illinois caves and other subterranean environments in relation to groundwater quality. February 1992 - October 1993.

Illinois Department of Conservation: Field assistant. Performing a status survey of an Illinois endemic cave amphipod, *Gammarus acherondytes*. May 1993 - September 1993.

Southern Illinois University: Extra help/ paraprofessional. Performing an inventory of bats at Horseshoe Lake Conservation Area, Illinois Department of Conservation. June 1993 - August 1993.

Honors Research, Department of Zoology, SIUC: Conducting field research in caves in Missouri on the distribution of a potential new species of cave adapted fish. August 1991 - Present.

PRESENTATIONS AND PUBLICATIONS

Gardner, J. E., J. E. Hofmann, J. D. Garner, J. K. Krejca, and S. E. Robinson. 1992. Distribution and status of *Myotis austroriparius* (Southeastern Bat) in Illinois. Unpublished report, Illinois Natural History Survey. 38pp.

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Krejca, J. K., and S. J. Taylor. Illinois Caves and Cave Life. Presented 4 April, 1992 at Staerkel Planetarium, Parkland College, Champaign, Il, as part of the World of Science Lecture Series.

Krejca, J. K. 1992. Mistnetting and bat handling. Field demonstration presented at a southern Illinois site to a University of Illinois mammalogy class.

Gardner, J. E., S. J. Taylor, and J. K. Krejca. 1993. The Biological Resources of Illinois' Caves and Other Subterranean Environments. Draft final report submitted to the Environmental Protection Trust Fund Commission. v + 88 Pages.

Krejca, J. K. and S. J. Taylor. 1993. A Faunal Inventory of Illinois Caves. Presented April 7 at the Mississippi Karst Tour in Monroe County, IL.

Krejca, J. K., B. M. Burr, M. L. Warren Jr., R. J. Paul. 1993. Cavernicolous sculpins of the *Cottus carolinae* species group (Pisces: Cottidae) from Perry County, Missouri. Presentation given at the 1993 National Speleological Society convention (August 2-6, Pendleton, OR).

Taylor, S. J., J. K. Krejca, and D. W. Webb. 1993. Biological resources of Illinois' caves and other subterranean environments. Presented at the National Speleological Society Convention, Biospeleology Section (August 2-6, Pendleton, OR).

Taylor, S. J., J. K. Krejca, D. W. Webb, J. E. Gardner. 1993. Poster session entitled: Caves and Bats: fragile resources of the Cache River basin. Presented at the Cache River Workshop, Southern Illinois University at Carbondale.

Taylor, S. J. and J. K. Krejca. 1994. Geographic Distribution. *Notophthalmus viridescens louisianensis*. Submitted to Herpetological Review.

Taylor, S. J. and J. K. Krejca. 1994. Geographic Distribution. *Rana catesbiana*. Submitted to Herpetological Review.

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Taylor, S. J., J. K. Krejca, D. W. Webb, and J. E. Gardner. 1994. A biological inventory and water quality analysis of Illinois caves and other subterranean environments. Presented at the Missouri Academy of Science annual meeting cosponsored by the Missouri Speleological Survey. Cape Girardeau, MO. April 29-30.

Krejca, J. K., B. M. Burr, M. L. Warren, and R. J. Paul. 1994. Cavernicolous sculpins of the *Cottus carolinae* species group (Pisces: Cottidae) from Perry County, Missouri. Presented at the Missouri Academy of Science annual meeting cosponsored by the Missouri Speleological Survey. Cape Girardeau, MO. April 29-30.

MANUSCRIPTS IN PREPARATION:

Taylor, S. J., M. Bavetz, and J. K. Krejca. Unusual Coloration in the Cave Salamander *Eurycea lucifuga* Rafinesque (Amphibia: Caudata: Plethodontidae). To be submitted to the NSS [National Speleological Society] Bulletin.

RESEARCH IN PROGRESS

Survey of cave invertebrates of Illinois caves and other subterranean habitats, with preliminary investigations of relationship between water quality parameters and presence of chemical compounds in aquatic troglobites. with D. Webb, J. E. Gardner and S. Taylor.

First record of the phylum Bryozoa from a cave in the United States. with S. Taylor and T. S. Wood.

ACTIVITIES AND SOCIETIES

Member Alpha Lambda Delta, academic sorority
Member Golden Key National Honor Society
2nd Dan Blackbelt, Tae Kwon Do
Bike touring, Cancer and MS society charities
National Speleological Society Member
Missouri Speleological Survey Member
Missouri Academy of Science Member

References Available Upon Request