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Survey of Salamanders in Mississippi Limestone Caves

JOHN G. HIMES1,2, DAVID C. BECKETT1,*, AND AUSTIN W. TROUSDALE1

Abstract - During 2000–2002 we surveyed for salamanders in the larger limestone caves of Mississippi, all within the Vicksburg Group rock unit. We found four species: Plethodon mississippi was the most abundant, followed by Eurycea guttolineata, Eurycea cirrigera, and Desmognathus conanti. We did not find Pseudotriton montanus in any of the caves, and question the validity of an investigator’s statement made nearly 45 years ago that, “it is one of the most numerous salamanders in Mississippi limestone caves.” The salamander fauna we found is similar to that of the only other comprehensive survey of salamanders in Mississippi caves, conducted almost thirty years ago.

Introduction

The caves of Mississippi have received little scientific attention, perhaps because Mississippi has far fewer caves than some of its neighboring states. For example, whereas over 3000 caves are known in Alabama (Best et al. 1992), the only comprehensive cave survey in Mississippi (in the early 1970s) located approximately 40 caves (Knight et al. 1974). Despite this relative paucity of caves, a lime-bearing rock unit called the Vicksburg Group (VG) extends near the surface in Mississippi as a narrow belt east to west from Wayne County to Hinds County (Murray 1961) (Fig. 1). The VG contains approximately 16 known caves in Mississippi (Knight et al. 1974), including the state’s best-developed limestone caves (May et al. 1974).

The earliest published reports of salamanders from caves in Mississippi are from Brode’s (1958) and Brode and Gunter’s (1958) investigations of Pitts Cave and Eucutta Cave (two of the larger caves of the VG) in the mid-1950s. They reported the same three taxa from both caves: Eurycea longicauda guttolineata (now E. guttolineata (Holbrook), the three-lined salamander), Pseudotriton ruber vioscai Bishop, the southern red salamander, and Plethodon glutinosus glutinosus (now P. mississippi Highton, the Mississippi slimy salamander). Surprisingly, in a later publication, Brode (1960) remarked that another taxon, Pseudotriton montanus flavissimus Hallowell, the Gulf Coast mud salamander, was “one of the most numerous salamanders in Miss. limestone caves.”

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In the early 1970s the Southern Mississippi Grotto (a local chapter of the National Speleological Society) conducted the first comprehensive cave survey of Mississippi. In 1973 and 1974, two of the grotto’s members, S.D. Carey and A.L. Middleton, conducted an extensive study of the salamanders in Mississippi’s caves and found five species in the caves of the VG: *E. longicauda guttolineata* (= *E. guttolineata*), *P. glutinosus glutinosus* (= *P. mississippi*), *Eurycea bislineata cirrigera* (= *E. cirrigera* (Green), the southern two-lined salamander), *Desmognathus fuscus* (= *D. conanti* Rossman, the spotted dusky salamander), and *Pseudotriton ruber vioscai* (Carey 1982, Cliburn and Middleton 1983, Middleton 1976). Middleton (1976) stated that *E. guttolineata* was the most common salamander in caves in Mississippi. These earlier cave surveys were conducted well before the global decline in amphibians noted by herpetologists in the late 1980s (Blaustein and Wake 1990, Pechmann and Wilbur 1994). Furthermore, the caves in Mississippi have since been vandalized to various degrees (personal observation). Our survey of salamanders in the larger of the Mississippi caves of the VG, conducted during 2000–2002, was the first survey.
since the 1973–1974 study. Our objectives were therefore to ascertain the present-day assemblages of salamanders in the caves, and to compare them to those noted in the 1950s and 1970s.

**Study Sites**

During 2000–2002, we conducted surveys of seven caves within the VG (Pitts, Triple H, Eucutta, Waddell, Belding’s, Lamar Graham, and Graham Waterfall - the first five are the largest known caves of the VG) (Fig. 1). We also surveyed the immediate vicinity outside each cave (within 50 m of the cave entrances) to determine whether the same or different species of salamanders occurred outside as well as inside the caves. Waddell Cave is in Smith County, Belding’s Cave is in Jasper County, and the remaining five are in Wayne County (Fig. 1).

Pitts Cave is the largest known cave in Mississippi with approximately 400 m of passageways, more than twice that of any other known cave in the state. A small stream enters Pitts Cave and flows through much of the cave.

Triple H is one of the larger caves in Mississippi, with approximately 160 m of passageways, and is located about 860 m north of Pitts Cave. Although accounts of Triple H Cave from 1973 and 1974 describe the cave as possessing “a shallow stream with a sand and gravel bottom flowing in parts of the main passageway” (Middleton 1976), no stream flowed in it during 2000–2002, and the only aquatic habitat was a small area in which the floor had broken through exposing a small pool of water.

Waddell Cave is the second longest known cave within the VG. It is a linear cave with a negotiable passageway of approximately 185 m. A stream flows through the cave toward the cave entrance. Near the back of the cave the ceiling drops to within a few cm of the surface of the stream, preventing further exploration.

Eucutta Cave is approximately 115 m in length. It has a stream which flows from the back of the cave, dropping underground immediately inside the entrance, then re-emerging aboveground about 35 m beyond the cave entrance. Gaining access to Eucutta Cave was difficult and we were able to survey it for salamanders on only one date.

Belding’s Cave is approximately 60 m in length and also has a stream that runs through it. A large room is located at the rear of the cave.

Lamar Graham Cave is approximately 40 m in length and contains a stream which enters the cave entrance from a ravine outside and then flows toward the back of the cave.

Graham Waterfall Cave appears to be the remnant of an earlier, larger cave that has now mostly eroded. This cave is small, with a low ceiling (ca. 0.7 m), and a stream that flows through the cave and out its entrance.
Sampling Methods

We sampled for non-larval salamanders by overturning surface cover objects, particularly pieces of loosened limestone, which were subsequently returned to their original positions. We sampled for larval salamanders by dip-netting in cave streams.

We estimated the developmental state (larva vs. juvenile vs. adult) of salamanders based on the presence/absence of larval characteristics and body size. Salamanders possessing gills were classified as larvae. Those individuals which we characterized as juveniles lacked gills and were, according to our visual estimation, smaller than the minimum size at sexual maturity for that particular species, as reported in Petranka (1998). The first individual of each species that we captured in or near each cave was euthanized (following IACUC guidelines) in a chloroform-treated container, preserved in 70% ethanol, and deposited in the Mississippi Museum of Natural Science herpetology collection. We released all other salamanders at the site of their capture.

Results

We found four species within the caves: *P. mississippi*, *E. guttolineata*, *E. cirrigera*, and *D. conanti*. Three of these species were present in Pitts Cave. *Plethodon mississippi* was the most abundant species in Pitts Cave, followed by *E. cirrigera*, and *E. guttolineata* (Table 1). Individuals of all three species were observed in the twilight zone of this cave. However, members of two of the species were also observed deep in the cave, well beyond the twilight zone, including *P. mississippi* on several occasions and a single larva of *E. cirrigera* in the cave stream in July 2000. Larval salamanders, presumably of *Eurycea* spp., were observed in the stream in July of both 2000 and 2001. The only salamander we observed immediately outside of Pitts Cave was a single individual of *E. cirrigera* in a sink area near the point where the stream enters the cave (Table 2).

We observed only *P. mississippi* and *E. guttolineata* in Triple H Cave (Table 1). *Plethodon mississippi* was the more abundant species and was found both in the twilight zone and the dark portion of the cave. About one-third of the individuals of *P. mississippi* were juveniles. One *P. mississippi* was observed immediately outside the cave (Table 2).

We found adults of two species, *E. guttolineata* and *D. conanti*, within Waddell Cave (Table 1). In June 2000 we also observed a recent metamorph of *E. guttolineata* within the cave, as well as larval *E. guttolineata* and *D. conanti* in the cave stream. Adult *E. guttolineata* and *D. conanti* were also present outside the cave on that same date (Table 2).
Our search of the inside of Eucutta Cave yielded four individuals of *E. guttolineata*; two were in crevices close to the cave opening, the others were at the very back of the cave (Table 1). However, immediately outside the cave entrance we found *E. cirrigera* and *P. mississippi*. *Desmognathus conanti* and *E. cirrigera* were present in the stream that emerges outside the cave (Table 2).

Table 1. Species of salamanders reported by Brode (1958), Carey (1982), and the present study from caves in Mississippi. Total number of individuals are shown for Carey’s study and the present study. Numbers within parentheses for the present study are numbers of larvae, juveniles, and adults, respectively. For Carey’s study, A = additional individuals (the exact number of individuals was not reported for all cave visits in Carey [1982]). Brode’s survey included only Pitts and Eucutta caves. Graham Waterfall Cave was not surveyed by Carey. n/a = not applicable.

<table>
<thead>
<tr>
<th>Cave</th>
<th>Brode</th>
<th>Carey</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitts</td>
<td><em>P. m.</em></td>
<td><em>P. m.</em> = 55 + A</td>
<td><em>P. m.</em> = 90(n/a,17,73)</td>
</tr>
<tr>
<td></td>
<td><em>E. g.</em></td>
<td><em>E. g.</em> = 6</td>
<td><em>E. c.</em> = 14 (1,0,13)</td>
</tr>
<tr>
<td></td>
<td><em>P. r.</em></td>
<td><em>E. g.</em> = 7</td>
<td><em>E. g.</em> = 2 (0,1,1)</td>
</tr>
<tr>
<td>Triple H</td>
<td><em>E. g.</em> = 1</td>
<td><em>P. m.</em> = 29 (n/a,9,20)</td>
<td><em>E. g.</em> = 4 (0,0,4)</td>
</tr>
<tr>
<td>Waddell</td>
<td><em>P. m.</em> = 5 + A</td>
<td><em>E. g.</em> = 12 (10,1,1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>E. g.</em> = 22</td>
<td><em>D. c.</em> = 12 (10,0,2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>D. c.</em> = 6 + A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eucutta</td>
<td><em>P. m.</em></td>
<td><em>P. m.</em> = A</td>
<td><em>E. g.</em> = 4 (0,0,4)</td>
</tr>
<tr>
<td></td>
<td><em>E. g.</em></td>
<td><em>E. c.</em> = 1 + A</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>P. r.</em></td>
<td><em>E. g.</em> = 35</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>D. c.</em> = A</td>
<td></td>
</tr>
<tr>
<td>Belding’s</td>
<td><em>E. g.</em> = 13</td>
<td><em>P. m.</em> = 1 (n/a,1,0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>P. r.</em> = 1</td>
<td><em>E. g.</em> = 1 (0,0,1)</td>
<td></td>
</tr>
<tr>
<td>Lamar Graham</td>
<td><em>E. g.</em> = 4</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Graham Waterfall</td>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1*P. m.* = *Plethodon mississippi*, *E. g.* = *Eurycea guttolineata*, *P. r.* = *Pseudotriton ruber*, *E. c.* = *E. cirrigera*, *D. c.* = *Desmognathus conanti*.


Table 2. Numbers of individuals of each species of salamander found outside each cave (within 50 m of entrance). Numbers are expressed as totals, followed, in parentheses, by numbers of larvae, juveniles, and adults, respectively. No salamanders were found outside Belding’s Cave or Lamar Graham Cave. n/a = not applicable.

<table>
<thead>
<tr>
<th>Species</th>
<th>Pitts</th>
<th>Triple H</th>
<th>Waddell</th>
<th>Eucutta</th>
<th>Graham Waterfall</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. mississippi</em></td>
<td>1(n/a,1,0)</td>
<td>1(n/a,1,0)</td>
<td>2(n/a,2,0)</td>
<td>6(0,1,5)</td>
<td></td>
</tr>
<tr>
<td><em>E. cirrigera</em></td>
<td>1(0,1,0)</td>
<td>1(0,0,1)</td>
<td></td>
<td>6(0,1,5)</td>
<td>3(0,2,3)</td>
</tr>
<tr>
<td><em>E. guttolineata</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>D. conanti</em></td>
<td>4(0,0,4)</td>
<td>6(0,1,5)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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We observed two species in Belding's Cave, *E. guttolineata* and *P. mississippi* (Table 1). We did not find any salamanders near the outside of the cave. Our searches inside Lamar Graham Cave and Graham Waterfall Cave did not yield any salamanders. However, several individuals of *D. conanti* were in the stream that exits from Graham Waterfall Cave’s entrance (Table 2).

**Discussion**

Our results were similar to those of Carey's survey of 1973–1974 (Carey 1982). In both his study and ours, *E. guttolineata* was found to be the most widespread salamander in caves in Mississippi. This species was present in each of the five largest caves of the VG in the 1970s survey, as well as in our 2000–2002 investigation (Table 1). In addition, all of the species we found in the caves in our survey were also found by Carey. The one species found by Carey, but not by us, *Pseudotriton ruber*, was represented by only a single specimen in his investigation. Hence, this species is apparently uncommon in caves in Mississippi.

It is interesting that for Pitts Cave, the cave visited most often by Carey and by us, the composition and relative abundance of the species has remained quite similar over time, with *Plethodon mississippi* the most abundant, followed by either *E. guttolineata* or *E. cirrigera*. Similarly, *D. conanti*, which was relatively common in Waddell Cave, both in the 1970s and in our study, has never been collected in Pitts or Triple H Cave. The report of this species in Pitts Cave in Middleton (1976), repeated in Cliburn and Middleton (1983), is due to a typographical error in Middleton (1976); Carey (1982) presents a more accurate listing of species. It appears that in Pitts Cave *P. mississippi* has been, and continues to be, the dominant salamander (with *D. conanti* absent), whereas Waddell Cave remains occupied by *D. conanti*.

Brode's account (1958) of *P. mississippi*, *E. guttolineata*, and *P. ruber* as the extant taxa in Pitts Cave in the 1950s is puzzling on two counts. Since he stated that he was in this cave “about 50 times” over a five-year period, it seems odd that he never observed *E. cirrigera* during these surveys. Carey (1982) frequently found this species in this cave in the 1970s, and we have seen it often as well. We think it probable that Brode failed to distinguish between *E. guttolineata* and *E. cirrigera*. Secondly, although it is possible that Brode could have collected *P. ruber* in Pitts and Eucutta Cave (because Carey [1982] did collect one individual of this species from Belding’s Cave), we have never observed this taxon in either of those caves (or any other caves we have surveyed in Mississippi). Unfortunately, Brode never reported the actual number of salamanders of any species (including *P. ruber*) he observed in any of his publications regarding Mississippi caves (see Brode 1958, 1960;
Brode and Gunter 1958). In addition, we have been unable to find specimens from Brode’s cave surveys in any museum collections. It is therefore impossible to estimate how often he found this species in Mississippi’s caves. Consequently, the question as to whether the absence of *P. ruber* in our survey reveals an actual change in the fauna since the 1950s remains unanswered.

We doubt the validity of Brode’s cryptic statement that *Pseudotriton montanus flavissimus* “is one of the most numerous salamanders in Mississippi limestone caves” (Brode 1960). Neither Carey nor we have found this taxon in caves in Mississippi. Secondly, the range of *P. montanus* does not include the VG within Mississippi, and caves are not a usual habitat for this species (Petranka 1998). Finally, we have been unable to find Brode’s specimens, despite his statement that they “are deposited in the Vertebrate Collection of the Gulf Coast Research Laboratory” (Brode 1960). Therefore, this species is not a member of the VG cave fauna at present, nor do we believe that it was “numerous” in the caves fifty years ago.

None of the species we found inside the caves are obligate cave dwellers. We found all of our “cave” species outside of at least one of the caves we surveyed. The extent to which the salamanders move between subterranean and surface habitats is unknown. It is clear, however, that these caves are used at various stages within the lives of salamanders. We found gravid *D. conanti* within Waddell Cave, and Brode and Gunter (1958) and S.D. Carey (pers. comm., Mobile, AL) reported individuals of *P. mississippi* brooding eggs within Pitts Cave. We found larvae of *E. cirrigera, E. guttolineata*, and *D. conanti* within the cave streams, and juveniles (as well as adults) of *E. guttolineata, E. cirrigera, and P. mississippi* within the caves. Some of the salamanders were found well back in the caves, and hence they may spend much or all of their lives within the caves.

None of the larger caves in Mississippi are protected by easement or ownership by a state or conservation agency, and hence they are very vulnerable to anthropogenic disturbances. Numerous acts of vandalism have occurred within Pitts Cave during the past two years (personal observation), and the forest surrounding Eucutta Cave was clear-cut in spring 2002, very shortly after we surveyed it. Since caves in Mississippi are infrequent, and offer unique habitats for salamanders and other animals, they merit protection.

**Acknowledgments**

We thank the owners of the cave sites for graciously permitting us to survey the caves. We appreciate the financial support of the Mississippi Wildlife Heritage Fund, which is administered through the Mississippi Museum of Natural Science. We also thank David Ufnar for his help in producing the map of cave locations.
Literature Cited


