A BIOLOGICAL INVENTORY OF EIGHT CAVES IN NORTHWESTERN GEORGIA WITH CONSERVATION IMPLICATIONS

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A 1995 biological inventory of 8 northwestern Georgia caves documented or re-confirmed the presence of 46 species of invertebrates, 35 considered troglobites or troglophiles. The study yielded new cave records for amphipods, isopods, diplurans, and carabid beetles. New state records for Georgia included a pselaphid beetle. Ten salamander species were in the 8 caves, including a true troglobite, the Tennessee cave salamander. Two frog, 4 bat, and 1 rodent species were also documented. One cave contained a large colony of gray bats. For carabid beetles, leiodid beetles, and millipeds, the species differed between the caves of Pigeon and Lookout Mountain. Diplurans were absent from Lookout Mountain caves, yet were present in all Pigeon Mountain caves. A comparison between 1967 and 1995 inventories of Pettijohns Cave noted the absence of 2 species of drip pool amphipods from the latter. One cave had been contaminated by a petroleum spill and the expected aquatic fauna was not found. Further inventory work is suggested and the results should be applied to management strategies that provide for both biodiversity protection and recreational cave use.

Georgia is a cave-rich state, with most caves occurring in two distinct physiographic regions, the Cumberland Plateau and the southwestern Coastal Plain. Caves in the Cumberland Plateau lie primarily in the counties of Dade, Walker, and Chattooga.

A comprehensive inventory of Georgia caves was conducted in 1967 (Holsinger & Peck 1971). Reeves *et al.* (2000) reported additional faunal records. Other scattered references to the cave fauna of Georgia can be found in Loomis (1939: millipeds), Hubricht (1943: amphipods), Chamberlin & Hoffman (1958: millipeds), Hyman (1954: planarians), Barr (1965, 1981: beetles), Cooper (1968: salamanders), Holsinger (1969, 1978: amphipods), Cooper & Iles (1971: fish), and Peck (1973: beetles). Dearolf (1953), Nicholas (1960), and Holsinger & Culver (1988) provide checklists of species and reviews of the regional biogeography of cave faunas.

The goals of this study were to conduct biological inventories for cave-adapted species of northwest Georgia caves that were under state management responsibility and receive varying levels of recreational use, and/or were believed to have significant biodiversity and conservation value. Results may be useful in the development of cave management and conservation plans and will contribute to knowledge of the distribution and biogeography of Georgia's cave fauna.

METHODS

Between 15 July and 14 October 1995, biological inventories were conducted in 8 caves within northwestern Georgia's Cumberland Plateau. Five caves were examined on Pigeon Mountain in Walker County: Pettijohns Cave [PJ] on 15 July (a), 5 August (b), and 14 October (c); Anderson Springs Cave [AS] on 30 July (a) and 6 August (b); Ellisons Cave [EC] on 29 July; Nash Waterfall Cave [NW] on 5 August; and Pigeon Cave [PC] on 16 July (a) and 30 July (b). One cave was examined in Chattanooga Valley in Walker County: Fricks Cave [FC] on 16 September. Two caves were examined in Cloudland Canyon State Park at the base of Lookout Mountain in Dade County: Case Cave [CC] and Sittons Cave [SI], both on 26 August (a) and 17 September (b) (Fig. 1).

The study followed methods used by Holsinger & Peck (1971) and Buhlmann (1992). Cave habitats sampled included streams, drip pools, phreatic lakes, decaying wood, cave walls, and mud banks. Bait, usually liver cat food, was left in terrestrial habitats and checked on a return visit. Aquatic fauna in cave streams and drip pools were collected with small aquarium dip nets and suction tubes; baited containers were set in deep pools. The first inventory of each cave included a search for all representative habitat types and collection of organisms. A second visit was made to some caves 1-2 weeks later to collect specimens from the bait stations and revisit selected habitats. Four caves (PC, AS, CC, and SI) were each visited twice during this study. Three caves (FC, EC, and NW) were visited once and 1 cave (PJ) was visited 3 times.

Invertebrates were preserved in 70% ethanol for later identification. Only a minimum number of specimens were collected for species identification. Invertebrate taxa were sorted and shipped to recognized experts of the various taxonomic groups (see ACKNOWLEDGMENTS) where they remain or have been deposited in museum collections. Data were collected on habitats, species abundance, and human disturbance. Simply documenting presence or absence was the greatest level of detail attainable for many species. Nomenclature used in the

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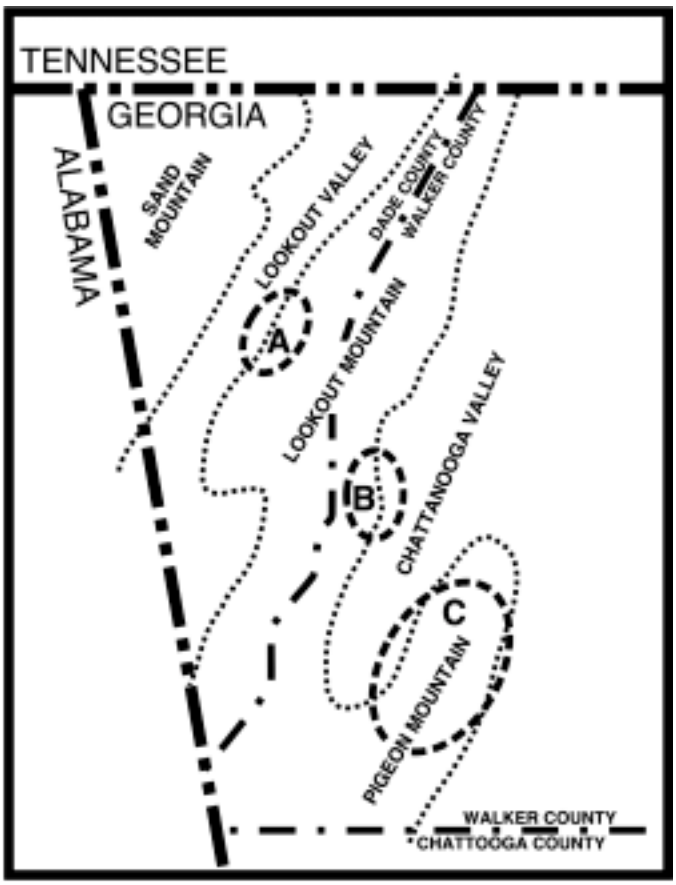

Figure 1. General location of eight caves inventoried during the study (in ellipses): A. - Cloudland Canyon State Park (Case Cave [CC] and Sittons Cave [SI]); B. - Chattanooga Valley (Fricks Cave [FC]); C. - Pigeon Mountain (Pettijohns Cave [PJ], Anderson Springs Cave [AS], Ellisons Cave [EC], Nash Waterfall Cave [NW], and Pigeon Cave [PC]).

Results follows Peck (1998), unless other literature was required.

Cave organisms were classified into one of four categories of cavernicoles (Barr 1963a, 1968). Troglobites (TB) are obligatory cave species with morphological adaptations for the cave environment and do not exist in surface environments. Troglophiles (TP) may frequent caves and are capable of completing all stages of their life cycle within a cave, but also occur in surface habitats. Trogloxenes (TX) are species that may use cave environments seasonally or for portions of their life cycle, yet must also be in association with surface environments. Accidentals (AC) are those species that are often found in caves but generally exist there only temporarily. Results focus on troglobitic and troglophilic species, with some exceptions.

RESULTS

Class Turbellaria (flatworms), Order Tricladida, Family **Kenkiidae:**
Sphalloplana sp. (TB): PJ(a). One specimen was collected in a pool at the base of a waterfall. The specimen may be *Sphalloplana georgiana* (Hyman) which was described from a cave in Dade Co., GA (Hyman 1954).
Class Malacostraca, Order Isopoda (isopods), Family **Asellidae:**
Caecidotea cyrtorhynchus Fleming and Steeves **(**TB): PJ(a); NW; AS(a,b). Individuals were especially abundant in the out-flowing, permanent stream in AS.
Caecidotea sp. (undescribed or possibly *Caecidotea catachaetus* Fleming and Steeves (TB): EC; SI(b). Specimens were collected in a pool in the drying cave stream in SI. Two species of aquatic troglobitic isopods are currently known from GA, *C. cyrtorhynchus* and *C. catachaetus* (Fleming & Steeves 1972).
Lirceus sp. (TP): NW. Specimens were collected from drip pools.
Family **Ligiidae**:
Ligidium elrodi Packard (TP): EC; PC(a). This terrestrial species was found around the entrance to NW. *L. elrodi* are perhaps becoming adapted to cave life (Schultz 1970). They inhabit wet, damp places, including the margins of springs and streams. The specimens found at NW are *L. elrodi hancockensis* (Schultz) (J. Lewis, pers. comm.).
Family **Trichoniscidae:**
Amerigoniscus sp. (possibly undescribed, TB): CC(a); SI(a). Prepared dissections of this terrestrial isopod did not match known species from the area (J. Lewis, pers. comm.).
Miktoniscus sp. (probably *Miktoniscus alabamensis* Muchmore, TP): PC(a). *M. alabamensis* is a widely ranging species known from AL, FL, and VA (Muchmore 1964).
Order Amphipoda (amphipods), Family **Crangonyctidae**:
Crangonyx antennatus Packard (TB): FC; SI(b); PJ(a); AS(a,b). Specimens in FC and AS were collected from streams with cobble bottom. Specimens from SI and PJ were collected from mud-bottomed streams. *C. antennatus* is widespread, and recorded from caves in southwest VA, eastern TN, northwestern GA, and northern Alabama (Holsinger & Culver 1988).
Stygobromus minutus Holsinger (TB): NW. One specimen was collected in a drip pool. The species was previously collected from mud-bottomed drip pools in PJ (Holsinger 1978).
Order Decapoda (crayfishes), Family **Cambaridae:**
Cambarus sp. (TX): EC; SI(a,b). Several specimens were observed in cave streams, but no troglomorphic species were found.
Class Arachnida, Order Pseudoscorpiones (pseudoscorpions)
No specimens were found. Troglobitic species of pseudoscorpions have been previously found in Chattooga, Dade, and Walker County, GA caves (Holsinger & Peck 1971), but not in any of the caves investigated during this study.
Order Acari (parasitic mites)
unknown sp. (AC): PC(a); CC(a); NW; FC. Several genera of mites were collected, but all are believed to represent surface species carried into caves by bats. Holsinger & Peck (1971) reported a cave-adapted mite from PJ.
Order Opiliones (harvestmen), Family **Phalangodidae:**
Bishopella sp. (TP): PC(a); EC; NW; CC(a,b); SI(b); FC; PJ(c). Adult and juvenile specimens of *Bishopella* were collected in seven caves during this study and Reeves *et al*. (2000) subsequently collected *Bishopella* in AS. *Bishopella* have well-developed eyes and have been collected occasionally from epigean habitats (Goodnight & Goodnight 1960). The genus *Bishopella* likely includes several species that have been reported as *Phalangodes laciniosa* (Crosby & Bishop**)** from northwestern GA caves, including SI, PJ, and also northern AL and central TN caves (Holsinger & Peck 1971).
Order Araneae (spiders), Family **Agelenidae:**
Calymmaria sp. (TP): NW. Adults of both sexes were collected and may represent *Calymmaria cavicola* (Banks), a species described from other Walker Co. caves, as well as caves in TN and AL (Heiss 1982).
Family **Amaurobiidae:**
Coras juvenilis Keyserling (TX?): FC. Female and immature specimens were collected and apparently represent a state record for the species (M. Draney, pers. comm.). *C. juvenilis* has not been reported from caves, although congeners (*Coras cavernorum* Barrows from NC and *Coras taugynus* Chamberlin from AL) have been found in caves (Muma 1946).

Family **Leptonetidae:**
Leptoneta sp. (TP): PJ(a,c). Immature specimens were collected. *Leptoneta* is represented in the western and southeastern U.S. by ~35 species; many are cave dwellers (Roth 1993). Holsinger & Peck (1971) collected an undescribed *Leptoneta* in PJ.
Family **Linyphiidae:**
Phanetta subterranea (Emerton) (TB): PC(a); FC; SI(a). *Phanetta* is a monotypic genus (Millidge, 1984). It has been reported from caves in PA, MD, WV, VA, TN, KY, IL, IN, and AL (Peck & Lewis 1978; Roth 1988). *P. subterranea* is known from GA caves in Floyd, Walker, and Dade Co., including SI (Holsinger & Peck 1971).
Family **Mysmenidae:**
Maymena ambita (Barrows) (TX): EC. This spider is not a strict cave-dweller. It has been found in caves in AL, TN, and KY (Gertsch 1960), as well as one other Walker Co., GA cave (Holsinger & Peck 1971).
Family **Nesticidae:**
Nesticus sp. 1 (TB): PC(a); AS(a). This was a small, eyeless purple spider (M. Draney, pers. comm.). More specimens are needed.
Nesticus sp. 2 (TP): CC(a,b). Several species of *Nesticus* with restricted ranges are known from caves in TN and VA (Holsinger & Culver 1988; Coyle & McGarity 1991) and recent genetic analyses indicate considerable genetic divergences among recognized taxa within the genus *Nesticus* (Hedin 1997). Distributional data from Hedin (1997) and a report by Reeves *et al*. (2000) of *Nesticus georgia* in Sittons Cave (SI) indicate that these specimens from CC may represent *N. georgia* Gertsch.
Family **Tengellidae:**
Liocranoides sp. (TP): PJ(a,c); AS(a). The specimens are likely *Liocranoides gertschi* Platnick (Platnick 1999). Specimens of this spider previously reported from several Walker County caves (Holsinger & Peck 1971) as *Liocranoides unicolor* Keyserling, are likely *L. gertschi.*
Family **Tetragnathidae:**
Meta menardi (Latreille) (TP): NW; PC(a); FC. This orb weaver was frequently seen in some cave entrances. It is also found under bridges, in damp ravines, and hollow logs (Marusik & Koponen 1992; M. Draney, pers. comm.). Reeves *et al.* (2000) reported *Meta* from FC and SI.
Family **Theridiidae:**
Achaearanea porteri (Banks) (TX): FC. This spider has been recorded from MD to TX (M. Draney, pers. comm.). The previous GA records are not from caves (Levi 1955).
Class Diplopoda (millipeds) Order Spirostrepida Family **Cambalidae:**
Cambala hubrichti Hoffman (TX): FC. These large pinkish-gray millipeds were abundant on gray bat (*Myotis grisescens*) guano in FC. *C. hubrichti* is also known from caves in western SC (Chamberlin & Hoffman 1958).
Order Chordeumatida Family **Cleidogonidae:**
Pseudotremia eburnea Loomis (TB): CC(a,b); PJ(b); EC. *P. eburnea* was described from a cave in Dade County, GA (Loomis 1939; Chamberlin 1946), and was reported from CC by Shear (1972) and from PJ by Holsinger & Peck (1971). Reeves *et al.* (2000) reported *P. eburnea* from several additional Georgia caves.
Pseudotremia sp. 1 (TB): NW. These female specimens probably represent *P. eburnea*, but could be a different species (R.L. Hoffman, pers. comm.).
Pseudotremia sp. 2 (TB): SI(a). Holsinger & Peck (1971) also collected an undescribed *Pseudotremia* from SI.
Pseudotremia aeacus Shear (TB): PC(a,b). *P. aeacus* was described from a cave in Dade Co., GA (Shear 1972); the PC specimens may represent a new subspecies (R.L. Hoffman, pers. comm.).
Family **Trichopetalidae:**
Scoterpes austrinus Loomis (TB): PJ(c); EC; NW; AS(a,b); SI(b). *S. austrinus* was previously found in several caves, including PJ (Holsinger & Peck 1971), and as well as caves in DeKalb Co., AL (Loomis 1943).
Scoterpes sp. (TB): NW; PC(a,b); FC; CC(b). These specimens are perhaps *S. austrinus* or represent a new species. Holsinger & Peck (1971) suggested that at least two subspecies (or species) of *Scoterpes* exist in GA caves. Additional specimens, specifically adult males, are required (R.L. Hoffman, pers. comm.).
Order Polydesmida Family **Xystodesmidae:**
Cherokia georgiana Bollman (AC): PC(a). Specimens were collected at the entrance to PC. *C. georgiana* is not usually considered a cave inhabitant.
Class Chilopoda (centipedes) Order Lithobiomorpha Family **Lithobiidae:**
Typhlobius ?caecus Bollman (TX?): FC. The posterior end of a female lithobiid centipede was found. An intact adult male would be very valuable since records for cave-dwelling centipedes are scarce and their status as troglobites has not been determined (R.L. Hoffman, pers. comm.).
Class Insecta, Order Collembola (springtails), Family **Entomobryidae:**
Pseudosinella christianseni Salmon (TB): PJ(a,b,c); PC(a); EC; NW; AS(a,b); FC; CC(a,b); SI(a,b). Springtails were found in every cave visited and were often abundant around damp and decaying wood. *P. christianseni* is an artificial taxon that will eventually be split into a series of species, all of which are highly troglomorphic (K. Christiansen, pers. comm.).
Pseudosinella n. sp. (TP): EC; NW; PC(a); FC. *Pseudosinella* n. sp. is not troglomorphic, but all of the *P.* n. sp. specimens collected are the same species (K. Christiansen, pers. comm.).
Family **Isotomidae:**
Folsomia candida Willem (TP): PJ(b). *F. candida* is an opportunistic troglophile and has been recorded from caves over a wide area of the United States (Christiansen 1982).
Family **Tomoceridae:**
Tomocerus bidentatus Folsom (TP): EC; NW; PC(a); CC(b). *T. bidentatus* is a common and widespread collembolan in caves in the eastern U.S. It is lightly pigmented with small eyes (Christiansen 1982; Holsinger & Culver 1988).
Order Diplura (diplurans or bristletails), Family **Campodeidae:**
Litocampa sp. "P" (TB): PJ(a,c); EC; AS(a,b); PC(a); NW; FC. Diplurans were found on undisturbed mud banks. *Litocampa* sp. "P" was previously known only from PJ and a cave in Chattooga Co., GA. This study found five new cave localities for this possible Georgia endemic (L. Ferguson, pers. comm.). *Litocampa* are not known from CC and SI. Three *Litocampa* species are known from GA caves (Ferguson 1981). The species designation of "P" corresponds with a coding system for unnamed species (L. Ferguson, pers. comm.).
Order Orthoptera, Family **Rhaphidophoridae** (cave and camel crickets):
Ceuthophilus gracilipes (Haldeman) (TX): The common "camel" cricket was found in the entrances of all 8 caves. Hundreds of camel crickets were observed under a ledge at the entrance to PC(b). *C. gracilipes* occurs throughout the eastern United States in forested habitats as well as cave entrances and no systematic effort was made to collect them.
Euhadenocecus puteanus Scudder (TP): PC(a); EC; AS(a); FC; CC(a). *E. puteanus* is widely distributed throughout the Appalachian region and the Interior Low Plateaus and is closely associated with cave environments (Holsinger & Culver 1988). It has been recorded from GA caves in Dade, Walker, and Polk Co. (Holsinger & Peck 1971).
Order Diptera (flies), Family **Heleomyzidae:**
undetermined Heleomyzidae (TP): These flies were observed on the ceilings and damp walls near the entrance zones of all caves. No systematic effort was made to collect cave flies.
Order Coleoptera (beetles), Family **Carabidae** (ground beetles)**:**
Pseudanophthalmus georgiae Barr (TB): PJ(a,c); EC. One of the PJ specimens collected was white. Holsinger & Peck (1971) collected this species, undescribed at that time, in PJ and Mountain Cove Farm Cave. It is also known from Blowing Springs Cave (Barr 1981). The EC specimen represents a new cave record for *P. georgiae*.
Pseudanophthalmus fulleri Valentine (TB): SI(a). *P. fulleri* was previously known from SI (Barr 1981). It was also collected in several Dade and Walker Co. caves by Holsinger & Peck (1971) and Reeves *et al.* (2000) and is also known from caves in Hamilton Co., TN.
Family **Leiodidae** (scavenger beetles)**:**
Ptomaphagus fiskei Peck (TB): PJ(a,b,c); EC; PC(b); AS(a,b). *P. fiskei* was especially abundant at bait stations in PJ. *P. fiskei* appears to be restricted to Pigeon Mountain. According to Peck (1973), no *Ptomaphagus* are known from caves in the valley between Pigeon and Lookout Mountains. No *Ptomaphagus* were found in FC.
Ptomaphagus whiteselli Barr (TB): CC(a,b); SI(a,b). *P. whiteselli* was previously known from SI (Barr 1963b) and CC (Peck 1973). It is the only *Ptomaphagus* known from caves between Sand and Lookout Mountains in DeKalb Co., AL and Dade Co., GA (Peck 1973).
Family **Pselaphidae** (pselaphid beetles)**:**
Batrisodes sp. (TX): PC(a). The specimens may be *Batrisodes globosus* (LeConte), a widely distributed species in eastern North America and record-

ed from caves in AL, GA, and VA (Barr 1964; Park 1947; Holsinger & Peck 1971).

Speleochus sp. (TB): PC(a). PC produced the only specimen of this undescribed species known from GA. The genus *Speleochus* is only known from central TN, northeast AL, and Walker Co., GA (T. Barr, pers. comm.). Species in this genus seem rare and they appear to be most abundant during cold, wet weather (Jan-Feb) when they may be more easily observed because their interstitial habitats are flooded. (T. Barr, pers. comm.).

Family **Staphylinidae** (rove beetles) (TX)**:**

Staphylinid beetles were collected in PJ, NW, PC, and FC and are in the possession of T. Barr. Staphylinid beetles were commonly found at bait traps. None of the species known are restricted to caves (Holsinger & Culver 1988).

Class Osteichthyes, Order Perciformes, Family **Cottidae:**

Cottus bairdi (mottled sculpin, TX): FC. Several sculpins were observed in the FC stream; 1 was collected and dissected, but no food items were found in the stomach.

Class Amphibia, Order Anura (frogs and toads), Family **Ranidae:**

Rana palustris LeConte (pickerel frog, TX): EC; AS(a); NW. 5 frogs were observed inside the entrance to EC; 1 frog each was found in AS and NW. Pickerel frogs have been commonly observed inside VA caves (K.A. Buhlmann, pers. obs.).

Rana clamitans Latreille (green frog, AC): EC; NW. 1 frog each was found near the entrances in EC and NW. Unlike pickerel frogs, green frogs are not commonly reported from caves.

Order Caudata (salamanders) Family **Plethodontidae**:

Gyrinophilus porphyriticus (Green) (northern spring salamander, TP): PJ(a); EC; AS(a,b); PC(a,b). The PJ specimen was a pale larva that was re-absorbing its gills. 1 adult individual was observed in the cave stream in EC. An adult and a larva were each observed in AS. In PC(a) 4 larval individuals and 1 adult were observed in the cave stream. Also in PC(b), 2 very large larval individuals were collected at the back of the cave, 370 m from the entrance, in the terminal siphon. These very pale larvae with seemingly reduced eyes were deposited in the U.S. National Museum of Natural History, Washington D.C. (USNM 497685, 497686).

Gyrinophilus palleucus McGrady (Tennessee cave salamander, TB): FC. 4 larval individuals were observed in the cave's out-flowing stream and 1 specimen was collected (USNM 497687). The nearest AL records for *G. palleucus* are ~16 km west of Chattanooga Valley on the AL/GA line near Rising Fawn, GA (Godwin 1995). Cooper (1968) reported a GA specimen but the locality is uncertain. The FC specimens confirm the presence of *G. palleucus* in GA (Buhlmann & Wynn 1996).

Eurycea lucifuga Rafinesque (cave salamander, TP): All individuals reported were observed and not collected: PJ(a), 3 adults; PC(a), 2 adults and several larvae in the cave stream; EC, 1 adult and several larvae in cave stream pools; AS(a), 9 adults and AS(b), 5 adults; NW, 5 adults; CC(a,b), 1 adult each; SI(a), 4 adults and SI(b), 1 adult. Cave salamanders are often encountered in caves throughout the Appalachian and Cumberland regions.

Eurycea longicauda (Green) (longtail salamander, TX): All individuals reported were observed, not collected: AS(a), 4 adults and AS (b), 5 adults; FC, 1 adult. Longtail salamanders, although closely related to cave salamanders (*E. lucifuga*), are occasionally, although not commonly found in caves.

Plethodon glutinosus (Green) (slimy salamander, TX): EC; PJ(b); AS(a,b); NW; CC(a). In EC, 64 slimy salamanders were seen inside the Historic Entrance in the first 50 m, and an additional 81 salamanders were seen between 51-60 m of this entrance. 20 more were observed inside the New Entrance to EC, totaling 165. 10 slimy salamanders were seen at the entrance to PJ(b); 9 were seen in AS(a) and 4 were observed in AS(b); 2 were observed in NW; and 1 was observed in CC(a). The large numbers of *P. glutinosus* in the entrance to Ellisons Cave seemed unusual and warrant further study.

Plethodon dorsalis (Cope) (zigzag salamander, AC): PJ(c). 1 specimen was observed 10 m inside the entrance.

Plethodon serratus Grobman (southern redback salamander, AC): AS(b). 1 adult was observed at the entrance.

Plethodon petraeus (Wynn, Highton, and Jacobs) (Pigeon Mountain salamander, TX): PJ(b). 1 very large adult was observed at the entrance. *Plethodon petraeus* was expected in larger numbers around the entrance to PJ. It was apparently very abundant around the PJ entrance when it was first discovered (Wynn *et al.* 1988), but may since have been collected for the pet trade (A. Wynn, pers. comm.). Incidental to the cave inventory, another location for *P. petraeus* was discovered, representing the northernmost locality for this Pigeon Mountain endemic. The locality is not reported here in order to protect the population.

Desmognathus fuscus (Green) (northern dusky salamander, AC): PC(a); EC; NW. At PC, several individuals were found near the entrance under rocks in the in-flowing cave stream. 2 salamanders were observed at the entrance to EC and 1 was observed at the entrance to NW.

Pseudotriton ruber (Latreille) (red salamander, AC): PC(b); AS(a,b). In PC, 2 adult red salamanders were seen in the cave stream. In AS(a), 1 adult was observed and in AS(b), 2 adults were observed. Red salamanders are not usually considered cave associates.

Class Mammalia, Order Chiroptera **(** Bats), Family **Vespertilionidae:**

Pipistrellus subflavus (Cuvier) (eastern pipistrelle, TX): PJ(a), 1 observed; PC(a), 1 obs; EC, 68 obs; AS(a), 36 obs; FC, several obs; SI(a), 1 obs. and SI(b), 5 obs. Eastern pipistrelles are the most common cave bat in eastern North America (Harvey 1992). They usually hang singly in the warmer parts of the cave. Martin & Bearden (1990) reported *P. subflavus* to be abundant in both EC and AS during inventories conducted Jan 1989-Feb 1990.

Myotis lucifugus (LeConte) (little brown bat, TX): EC, 1 was observed.

Myotis grisescens (Howell) (gray bat, TX): FC; SI(b). At FC, a bachelor colony of 10,000-15,000 individuals was observed. At SI(b), 4 gray bats were observed, 2 were females. Large piles of guano in FC indicate that the cave has been used by gray bats for many years. FC is relatively pristine, and has been closed to caving for nearly 30 years (A. Padgett, pers. comm.). Gray bats are listed as federally Endangered and ~95% of the global population of gray bats hibernates in 8 caves in TN, MO, KY, AL, and AR (Harvey 1992). The 4 gray bats observed in SI likely represent individuals on migration (C. Hobson, pers. obs.). However, a gray bat stain on the ceiling indicates that SI may have historically harbored a gray bat maternity colony.

Myotis septentrionalis (Trouessart) (northern long-eared bat, TX): CC(a), 1 long-eared bat was observed; SI(b), 3 male long-eared bats were observed.

Order Rodentia (gnawing mammals), Family **Cricetidae:**

Neotoma floridana (Ord) (eastern woodrat, TX): Although no woodrats were observed during the study, their presence within each cave was recorded as active or historic after investigating droppings and nests: PJ, historic; EC, active; PC, active; NW, active; CC, historic. No woodrat sign was found in AS, FC, and SI. Woodrat populations have been declining in the northeastern United States and the species is monitored by several state Natural Heritage Programs (C. Hobson, pers. comm.).

COMPARISON OF THE 1967 AND 1995 STUDIES OF PETTIJOHNS CAVE

The most comprehensive Georgia cave study was conducted in 1967 and one of the caves studied was PJ (Holsinger & Peck 1971). A comparison of the 1967 and 1995 studies found some faunal differences in PJ, primarily with regards to missing aquatic fauna in 1995 (Table 1). *Stygobromus minutus* and *S. dicksoni*, amphipods that inhabit drip pools (Holsinger 1978) were not found in 1995, nor were they found by Reeves *et al*. (2000).

The 1967 study also reported terrestrial isopods, pseudoscorpions, and cave-adapted mites, none of which were found by the 1995 study. Pseudoscorpions and mites are often difficult to detect in caves, yet terrestrial isopods (*Amerigoniscus*) should have been found by the methods used in 1995. The milliped, *Cambala hubrichti*, collected in 1967, was not found in 1995. Interestingly, this study found *C. hubrichti* abundantly in FC where it appeared to be associated with gray bat (*M. grisescens*) guano deposits. The 1995 study documented an additional species each of troglophilic spider, collembolan, and beetle from PJ, although all are known from other caves.

TABLE 1. A comparison of invertebrate troglobites (TB) and troglophiles (TP) collected from Pettijohns Cave, Walker County, Georgia, during June 1967 (Holsinger & Peck 1971) and this study, July-October 1995. Names used by Holsinger & Peck are given in parentheses.

SPECIES	Holsinger & Peck, 1971	This Study
Sphalloplana sp.		X
Caecidotea cyrtorhynchus	X (as *Asellus* sp.)	X
Amerigoniscus sp.	X (as *Caucasonethes* sp.)	
Crangonyx antennatus	X	X
Stygobromus minutus	X (as *Stygobromus* sp.)	
Stygobromus dicksoni	X (as *Stygobromus* sp.)	
Microcreagris sp.	X	
Rhagidia sp.	X	
Bishopella sp.	X (as *Phalangodes laciniosa*)	X
Leptoneta sp.	X	X
Liocranoides sp.		X
Pseudotremia eburnea	X	X
Scoterpes austrinus	X	X
Cambala hubrichti	X (as *Cambala minor*)	
Pseudosinella christianseni	X (as *Pseudosinella hirsuta*)	X
Pseudosinella n. sp .		X
Folsomia candida		X
Litocampa sp. P	X (as *Plusiocampa* sp.)	X
unidentified Heleomyzidae	X (as *Amoebalaria defressa*)	X
Pseudanophthalmus georgiae	X (as *Pseudanophthalmus* sp.)	X
Ptomaphagus fiskei	X (as *Ptomaphagus* sp.)	X
TOTALS	17	15

DISCUSSION

SPECIES AND DISTRIBUTION

A total of 46 invertebrate taxa were identified during the study. Of those, 21 are considered troglobites, 14 are troglophiles, and the remainder were classified as trogloxenes (9) or accidentals (2). Harvestmen (*Bishopella* sp.) and springtails (*Pseudosinella* sp.) are believed to represent several different species and further taxonomic work is needed. Other collected specimens, mainly non-troglobitic, have been given to others who are working with the material (W. Reeves, Clemson Univ.). The pselaphid beetle (*Speleochus* sp.) was found only in Pigeon Cave and represents a new, undescribed species for Georgia. The amphipod, *Stygobromus minutus* collected in NW, was previously known only from PJ (Holsinger 1978), but was not found there during this study. Possible new species of millipeds were also collected in NW and *Pseudotremia* sp. 2 is a possible endemic to SI. An undescribed springtail (*Pseudosinella*) was collected in three of the Pigeon Mountain caves, as well as in FC. The dipluran (*Litocampa* sp. "P") was previously known only from PJ, but was found in all Pigeon Mountain caves studied, as well as FC. EC yielded a new cave record for the beetle, *P. georgiae*. For vertebrate species, 10 salamanders, 2 frogs, 1 fish, 4 bats, and 1 rodent were encountered. In FC, the Tennessee cave salamander (*Gyrinophilus palleucus*) was re-confirmed as a component of Georgia's fauna and a large population of federally endangered gray bats (*Myotis grisescens*) was found.

Caves on Pigeon Mountain contained more species than the caves studied in Chattanooga Valley or on Lookout Mountain (PJ=17, EC=17, NW=17, PC=17, AS=14, FC=13, CC=13, and SI=11). The faunas of the Pigeon Mountain caves were similar, although several species were found in only 1 or 2 caves. However, faunal composition differed between the caves of Pigeon and Lookout Mountains. The terrestrial isopods (*Amerigoniscus* sp.) were found only in the 2 Lookout Mountain caves. Conversely, diplurans (*Litocampa* sp. "P") were found in all Pigeon Mountain caves and FC, but not the Lookout Mountain caves. The leiodid beetles were represented by 2 species with *P. fiskei* occurring in 4 of 5 Pigeon Mountain caves, while *P. whiteselli* was found in both Lookout Mountain caves. The troglobitic carabid beetles showed a similar 2 species distribution, with *P. georgiae* occurring in 2 Pigeon Mountain caves, and *P. fulleri* being found in CC. The apparent absence of both *Pseudanophthalmus* and *Ptomaphagus* from FC is interesting in terms of biogeography. Peck (1973) had previously hypothesized that the cave-adapted beetles may be restricted to the flat-bedded limestones of the Appalachian Plateau. Peck's hypothesis would explain the absence of beetles in FC and is also supported because different leiodid and carabid beetles are found on Lookout and Pigeon Mountains.

The habitats within each cave may determine the faunal composition. AS has an out-flowing cave stream that originates within Pigeon Mountain and contained large populations of aquatic isopods (*C. cyrtorhynchus*), as well as some amphipods (*C. antennatus*). Similarly, SI contained a large out-flowing stream and stygobitic crustaceans were also noted, although in smaller numbers. Few aquatic cave organisms were found in caves that contained in-flowing streams, notably EC and PC. Small drip pools were noted in NW and contained the amphipod, *S. minutus*, known previously only from PJ, as well as an undescribed isopod (*Lirceus* sp.), and illustrate the importance of these habitats. CC has deep connections to phreatic water and a 2.5 m change in water level was noted between the two visits. The phreatic lakes of CC were previously known to contain amphipods, isopods, and cave fish (A. Padgett, pers. comm.). Limited observations indicate that cave fish and Tennessee cave salamanders are most likely to be found in Georgia caves that have connections to phreatic waters. Cave stream mud banks represent habitat for many of the terrestrial invertebrates. Flooding streams deposit organic material that is scavenged by leiodid beetles, diplurans, millipeds and collembolans. The untrampled mud banks in AS and FC contained the largest numbers and diversity of terrestrial cave fauna.

MANAGEMENT IMPLICATIONS

All 8 caves inventoried are in public ownership or protected by private owners. Four of the Pigeon Mountain caves are on the Crockford-Pigeon Mountain Wildlife Management Area (CPMWMA) and 1 is immediately adjacent in private ownership. Cloudland Canyon State Park (CCSP) on Lookout Mountain contains CC and SI. The Georgia Department of Natural Resources owns both CPMWMA and CCSP and The

Southeastern Cave Conservancy owns FC. Therefore, the opportunity exists to effectively manage all of these caves for both biodiversity protection and recreation.

PJ is probably the most frequently visited recreational cave in Georgia. As many as 350 people have visited the cave in one month and as many as 75 on a given weekend (Georgia DNR, unpubl. data). There are many passages and although all receive human traffic, some are more heavily used than others. The greatest numbers of collembolans and diplurans were found in PJ rooms and passages that contained signs of heavy human use and garbage. It is unknown if the presence of additional food resources results in increased populations of cave fauna or if it serves to attract and concentrate cave organisms. If it serves to concentrate organisms, then are populations ultimately reduced by trampling? These questions could be addressed with future research. Few bats were observed in PJ and more Pigeon Mountain salamanders were expected based on discussions with biologists who had observed them in the past. Overall, PJ contained a great diversity of cave life, particularly terrestrial species. Aquatic organisms seemed rare in PJ, perhaps a result of trampling in drip pools and streams. No amphipods (*Stygobromus* sp.) were found during this study in PJ, yet two drip pool species, *S. dicksoni* and *S. minutus* were recorded previously (Holsinger & Peck 1971). However, not all stream passages were explored and refugia may exist, particularly in the less traveled passages. Protection of certain passages might provide refugia for cave organisms while continuing to provide recreational opportunities for cavers. *Stygobromus dicksoni* is also known from several caves in northeastern AL and northwestern GA (Holsinger 1978; Reeves *et al.* 2000).

CC was heavily abused during the 1960s as indicated by dates on discarded soda cans and batteries. The entrance to CC is currently gated with a steel pipe tunnel and solid door. The gate should be re-designed because it alters air flow and prevents access to bats. The expected aquatic fauna in CC was absent. The large, deep phreatic pools of CC should have yielded populations of troglobitic amphipods and isopods, which were present in the early 1970s (A. Padgett, pers. comm.). A cave fish (*Typhlichthes subterraneus*) had been collected from CC in 1971 and was deposited in the University of Georgia Natural History Museum, Athens. This study detected petroleum in the cave stream and mud sediments. A truck carrying petroleum products wrecked on Highway Rt. 136 in the late 1970s on Lookout Mountain above CC (A. Padgett, pers. comm.). It is probable that this spill accounts for the lack of aquatic cave fauna in CC and illustrates the fragile nature of cave ecosystems and the difficulty in protecting them.

The remaining caves studied did not appear to have any significant management concerns. Periodic monitoring should occur to assess long term trends in cave faunal populations. FC was the most pristine cave visited and is significant in terms of its fauna and should be a high priority site for long-term cave biodiversity protection in Georgia.

There are many limestone caves in northwestern Georgia. Further inventory and research should address the protection of the landscape around caves (e.g., Aley & Aley 1991) in order to protect cave habitats and fauna (e.g., Fong 1995; Jacobson 1995). Caves are unique natural habitats and contain endemic and rare species. Further study of the biota and ecology of Georgia caves is therefore warranted.

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