12-2011

A Survey of the Ants (Hymenoptera: Formicidae) of Arkansas and the Ozark Mountains

Joseph O'Neill
University of Arkansas, Fayetteville

A Survey of the Ants (Hymenoptera: Formicidae) of Arkansas and the Ozark Mountains

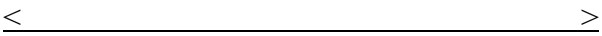
An Undergraduate Honors Thesis
at the
University of Arkansas

Submitted in partial fulfillment of the requirements for the
University of Arkansas
Dale Bumpers College of Agricultural, Food and Life Sciences
Honors Program

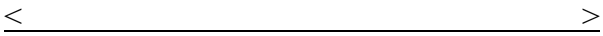
by

Joseph C. O'Neill
and
Dr. Ashley P.G. Dowling

December 2011

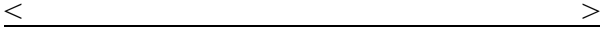


Dr. Curt R. Rom



Dr. Ashley P.G. Dowling

Dr. Donn T. Johnson



Dr. Duane C. Wolf

ABSTRACT

Ants are among the most abundant animals in most terrestrial ecosystems, yet local fauna are often poorly understood due to a lack of surveys. This study separated and identified ant species from arthropod samples obtained during ongoing projects by the lab of Dr. A.P.G. Dowling, Professor of Entomology at the University of Arkansas. More than 600 ants were prepared, 284 of which were identified to genus and 263 to species. From this collection, 33 species and one morphospecies were identified, comprising 18 genera in total. Additionally, 28 new distributional records were recorded for Benton, Madison, Newton, and Washington Counties in Arkansas.

A Survey of the Ants (Hymenoptera: Formicidae) of Arkansas and the Ozark Mountains

Joseph O'Neill and Ashley Dowling December 2011

INTRODUCTION

As basic knowledge of organismal distributions within the United States has increased, biogeographers have identified areas with appreciably high numbers of endemic taxa. As a result, a few regions, including the Florida peninsula, the Southern Appalachians, and the Pacific Northwest, have been well studied (Allen 1990). However, other areas of suspected high endemism have received little attention. The Interior Highlands of the United States — which includes the Arbuckle Mountains, Illinois Ozark Mountains, Ouachita Mountains, Ozark Mountains, and Wichita Mountains — are such areas (Fig. 1). Regardless of the comparatively little amount of attention, research in the area has already uncovered several hundred endemic species, including 68 endemic insects (Allen 1990).

For more than 320 million years, much of the Interior Highlands have remained unsubmerged during times of ocean flooding, and unglaciated during ice ages (Allen 1990). This is a similar history to the Florida peninsula and the Southern Appalachians during glacial movement in the Pleistocene (Allen 1990; Hollingsworth and Near 2009). As glaciers impeded from the North, ecological ranges of many North American plants and animals were reduced to the Florida peninsula and Mexico. Some plants and animals remained in pockets at higher elevations that acted as small ecological islands, such as the Southern Appalachian Mountains and the Interior Highlands. Subsequently, these

species were splintered in small ecological islands for quite some time, producing great genetic diversity (Allen 1990; Tilley 1997; Crespi et al. 2003; Brown and Ferree 2007; Hollingsworth and Near 2009). Therefore, studying the flora and fauna of the Interior Highlands will not only lead to new discoveries in species richness and genetic diversity but can also be used to trace the biological history, diversity and evolution of North American insects.

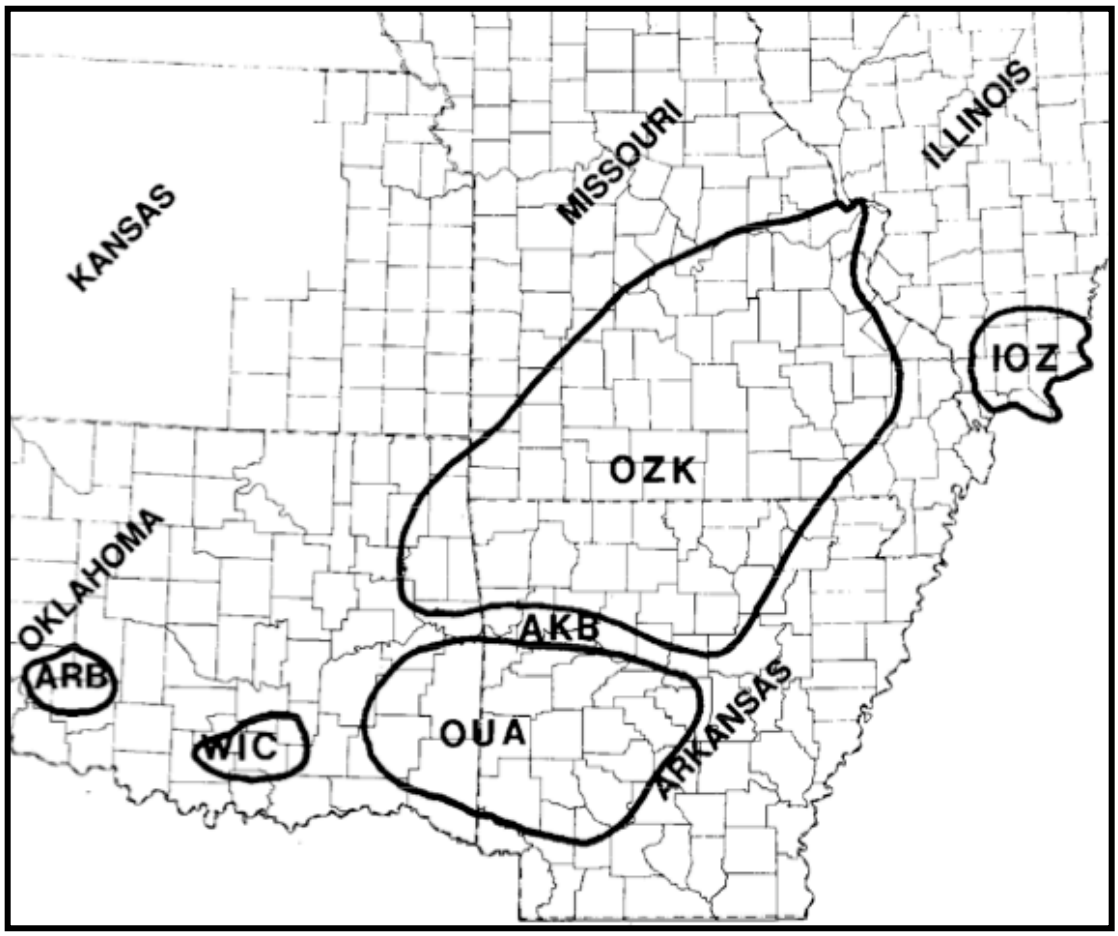


Figure 1: The Interior Highlands: AKB = Arkhoma Basin, ARB = Arbuckle Mountains, IOZ = Illinois Ozark Mountains, OUA = Ouachita Mountains, OZK = Ozark Mountains, WIC = Wichita Mountains. (modified from Allen 1990)

Furthermore, as international and interstate trade and tourism have increased, new exotic species have been introduced to the area. Several of these species, such as the red imported fire ant (*Solenopsis invicta),* and the Argentine ant (*Linepithema humile),* currently have limited distributions in Arkansas, but have immense potentials for displacing local species and drastically altering local ecosystems (MacGown et al. 2011). It is possible that invasive species could drive out certain endemic or unknown taxa or drastically alter their populations before there is ever a chance to record and study them.

Arkansas has a proud history of conservation that has benefited strongly from biological study. In 1972 the Buffalo National River was established and 135 miles of the river and surrounding areas fell under the protection of the National Park Service (National Park Service Online 2011). Without extensive biological surveys and indexing, it is hard to understand and maintain the uniqueness of the region (General and Thomson 2008a).

Formicidae (Hymenoptera), commonly known as ants, is a megadiverse family with more than 14,000 described species found in many terrestrial habitats. Research has shown repeatedly that ants are worthy of attention due to their high diversity and the role they play in terrestrial ecosystems. Ants have been found tending to aphids; farming fungus; building complex structures out of their own bodies, soil and leaves; patrolling and protecting territory; waging wars and raids; enslaving other ants; and exhibiting many complex behaviors (Hölldobler and Wilson 1990, 2009). For example, leaf-cutter ant colonies can exceed 10 million individuals and their nests can occupy 600m^2 of soil and extend 6m underground (Juan 2003; Wetterer et al. 1998; O'Neill 2010). Leaf-cutter ants are descendants of ants that first performed "agriculture," starting with the care of

many different types of fungi, and evolving to the situation today in which ants tend to one specific species of fungus (Schultz and Brady 2008; O'Neill 2010). The similarities many of these behaviors share with human societies have stimulated sociological and philosophical discussion (Warren and Rouse 1969). Furthermore, ants often perform irreplaceable ecological functions. For example, ants are often more important in soil turning than earthworms and are the leading predators of most invertebrates (Hölldobler and Wilson 1990, 2009). They have formed symbiotic relationships with other organisms like fungi, thus affecting the evolution of other organisms (Warren and Rouse 1969; Hölldobler and Wilson 1990; Schultz 2000; BugGuide 2004).

Depending on the ecosystem, ants typically account for 15-25% of terrestrial animal biomass (Schultz 2000). Ants within Arkansas and the Interior Highlands of the United States are no exception and are among the most common insects in every type of terrestrial habitat (Warren and Rouse 1969). According to Antweb, (http://www.antweb.org), a website listing the ant species of states and countries around the world, Missouri has 148 ant species, Texas has 283, Louisiana has 128 and Mississippi has 173 (Fisher 2002). Based on proximity to these states, it is reasonable to assume that Arkansas would have similar numbers of ant species (MacGown et al. 2011). Based on previous research, Arkansas is known to have 132 species in 34 genera (Warren and Rouse 1969; General and Thompson 2007, 2008a, 2008b, 2009; MacGown 2010; MacGown et al. 2011). However, there is little doubt that Arkansas contains additional species.

It was hypothesized that upwards of 100 different species of ants could be collected in the Ozark Mountain region of Interior Highlands of the United States. This was

hypothesized primarily because Arkansas and Missouri support 132 and 148 species, respectively, and the collections took place along the border of the two states. Furthermore, it was also hypothesized that new records could be found and added to Arkansas and Missouri ant faunal lists. The two states have not been fully surveyed and surveys done recently in both states have consistently added new ant records. In addition, the overall aim of this research was to better study the distribution of ants within Arkansas, Missouri, and the Interior Highlands of the United States.

METHODS

Collection Sites:

Collections were made from March to October of 2010. Benton, Madison, Newton and Washington Counties in Arkansas and Taney County in Missouri were surveyed (Fig. 2). Samples collected were taken from five areas: Hercules Glade in Mark Twain National Forest (Taney Co., MO.); Devil's Den State Park (Washington Co., AR.); Steel

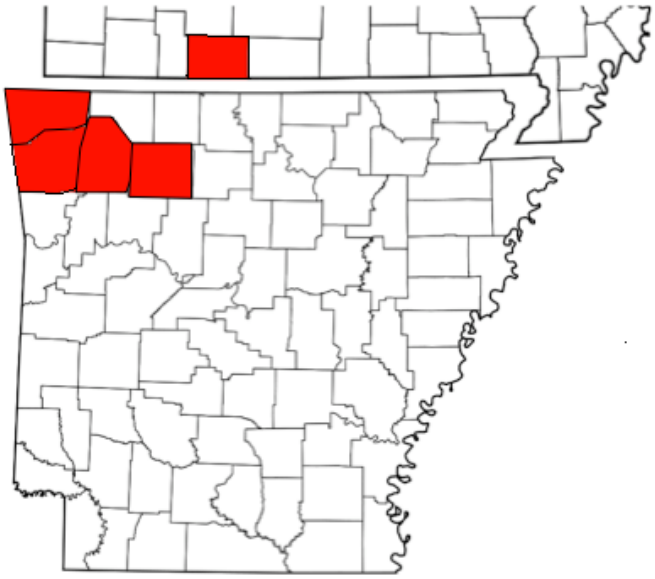


Figure 2. Benton, Madison, Newton, and Washington Counties, AR., and Taney County MO., surveyed for arthropods (modified from Wikipedia)

Creek and Boen Gulf Transect (Newton Co., AR.); and Ozark National Forest (Washington/Benton Co., AR.).

Sampling Techniques:

This project was part of a larger arthropod biodiversity study by Dr. A.P.G Dowling, Professor of Entomology at the University of Arkansas. In order to catch large and diverse samples of arthropods, two methods were utilized.

Malaise traps were used to capture flying insects. A Malaise trap is a tent-like structure that passively collects arthropods by exploiting negatively geotaxic behavior in flying insects met with an impediment or, less effectively, in crawling insects that crawl up the trap into the collection jar (Sokolova et al. 2010). Samples from Malaise traps can be among the most diverse samples taken from any ecosystem.

To sample leaf litter, a 4-liter Ziploc® bag was filled approximately 2/3 full with leaf litter and humus found between the soil and the top dry leaf layers. Organisms were extracted from this material using modified Berlese-Tullgren funnels. These funnels use incandescent light as a heat source to dry the litter from the top down. The threat of desiccation forces the arthropods deeper into the sample until ultimately falling through a screen on which the sample sits and into a collection jar filled with ethanol positioned below the funnel.

Storage:

Once collected, arthropod samples were transferred to 95% ethanol and stored at room temperature until prepared.

Identification:

After being prepared, ants were first sorted by genus using Fisher and Cover (2007), and then identified to species using a combination of sources (Fisher 2002; Fisher and Cover 2007; MacGown 2010). Once identified, specimens were checked and verified by Michael Skvarla of the Dowling lab at the University of Arkansas. Although alate queen and male ants were collected and prepared, useful keys are lacking; thus, only workers were identified.

RESULTS

More than 600 ants were prepared, of which 284 were sorted by genus and 263 identified to species. This collection comprises 33 species and one morphospecies in 18 genera (Table 1). The most frequently trapped ant was *Aphaenogaster carolinensis* Wheeler, with 41 specimens. Five species were identified from a single specimen each, including *A. tennesseensis* (Mayr), *Camponotus sansabeanus* (Buckley), *C. snellingi* Bolton, *Proceratium croceum* (Roger) and *P. pergandei* (Emery). *Nylanderia* identification is more involved than most ants in the region as differentiation generally relies on the presence of micro-setae on the antennae (MacGown 2010). Thus, *Nylanderia* were not identified to species due to time constraints of the project.

A total of 33 species and one morphospecies were collected. Eight species were collected exclusively by Malaise traps. Six of these eight species were in the genus *Camponotus*. Seventeen species were collected exclusively from litter, including all *Amblyopone, Aphaenogaster, Myrmecina, Myrmica, Nylanderia, Ponera, Proceratium,*

Pyramica, Solenopsis and *Stenamma*. Eight species and one morphospecies were collected with a combination of Malaise trap and leaf litter sampling, including *Brachymyrmex*, two *Camponotus*, *Formica*, *Prenolepis* and two of three *Temnothorax*.

Twenty-eight new county records were found for Benton, Madison, Newton and Washington Counties in Arkansas (Table 2). Three new records were identified for Benton County, bringing the total to 21 species. One new record was identified for Madison County, bringing the total to 30 species. Eighteen new records were found for Newton County, bringing the total to 35 species. Six new records were recorded for Washington County, bringing the total to 65 species. At this point, time constraints prevent confirmation that specimens found in Taney County are new county records, but it is assumed due to lack of literature that all 13 records recorded may be new county records. All county species totals are a combination of Warren and Rouse (1969), General and Thompson (2008b) and the present survey. Of course, many of these records may have been known or assumed for some time but have simply not been recorded or published.

Table 1. Number of ant species caught by malaise trap or litter sampling (X) in northwest Arkansas and Taney County (Mo.) in 2010.

Species	Number	Malaise Trap	Litter Sampling
Amblyopone pallipes (Haldeman)	14		X
Aphaenogaster carolinensis Wheeler	41		X
Aphaenogaster fulva Roger	9		X
Aphaenogaster tennesseensis (Mayr)	1	X	
Brachymyrmex depilis Emery	9	X	X
Camponotus americanus Mayr	5	X	X
Camponotus castaneus (Latreille)	3	X	
Camponotus chromaiodes Bolton	5	X	
Camponotus decipiens Emery	5	X	
Camponotus nearcticus Emery	3	X	X
Camponotus pennsylvanicus (DeGeer)	3	X	
Camponotus sansabeanus (Buckley)	1	X	
Camponotus snellingi Bolton	1	X	
Crematogaster ashmeadi Emery	2	X	X
Crematogaster lineolata (Say)	12		X
Forelius mccooki (McCook)	3	X	
Formica pallidefulva Latreille	2	X	X
Formica subsericea Say	24	X	X
Myrmecina americana Emery	14		X
Myrmica punctiventris Roger	8		X
Nylanderia	21		X
Ponera pennsylvanica Buckley	31		X
Prenolepis imparis Say	2	X	X
Proceratium croceum (Roger)	1		X
Proceratium pergandei (Emery)	1		X
Pyramica ornata (Mayr)	5		X
Pyramica rostrata (Emery)	14		X
Pyramica ohioensis (Kennedy & Schramm)	10		X
Solenopsis carolinensis Forel	4		X
Stenamma impar Forel	6		X
Strumigenys louisianae Roger	2		X
Temnothorax curvispinosus Mayr	7	X	X
Temnothorax schaumii Roger	8	X	X
Temnothorax pergandei (Emery)	7		X
Total	284	17	26

Table 2. New 2010 county records (X) with a synopsis of previous records (~) in Arkansas from Warren & Rouse (1969) and General & Thompson (2008b), and possible Taney County (Mo.) records (?).

Species	Benton	Madison	Newton	Taney	Washington
Amblyopone pallipes			~	?	
Aphaenogaster carolinensis			X	?	~
Aphaenogaster fulva			X	?	~
Aphaenogaster tennesseensis		~	~		~
Brachymyrmex depilis			X		X
Camponotus americanus		~	~		~
Camponotus castaneus				?	~
Camponotus chromaiodes			X		X
Camponotus decipiens			X		X
Camponotus nearcticus			~		~
Camponotus pennsylvanicus	~	~	X		~
Camponotus sansabeanus			X		
Camponotus snellingi			~		
Crematogaster ashmeadi	~	~	X		~
Crematogaster lineolata	~	~	~	?	~
Forelius mccooki				?	
Formica pallidefulva		~	~		~
Formica subsericea			X		X
Myrmecina americana			~	?	~
Myrmica punctiventris		~		?	~
Nylanderia					
Ponera pennsylvanica	X*		~	?	~*
Prenolepis imparis	~	~	X		~
Proceratium croceum			X		
Proceratium pergandei			~		X
Pyramica ornata			~	?	
Pyramica rostrata			X	?	
Pyramica ohioensis			X	?	
Solenopsis carolinensis				?	
Stenamma impar		X	X		
Strumigenys louisianae			X		
Temnothorax curvispinosus	~	~	X		~
Temnothorax schaumii	X*		X		X*
Temnothorax pergandei	X*	~	X		~*
Warren and Rouse 1969	18	29	1	0	59
General and Thompson 2008b	0	0	16	0	0
New Records for County	**3**	**1**	**18**	**13**	**6**
Number of Species in County	21	30	35		65

* Samples caught on Benton/Washington County lines; counted for both counties.

DISCUSSION

At the beginning of this survey, we hypothesized that more than 100 different ant species could be collected. This estimate was reached based on previous work done in Missouri and Arkansas that found 148 and 132 state supported species, respectively (Fisher 2002; MacGown 2010). This survey recorded 33 species and one morphospecies. It was also hypothesized that new state and distributional records could be found for Missouri and Arkansas. At least 28 new county records were found. No new state records were found. However, there are likely undiscovered species in the region. Our overall species counts and lack of new state records are almost certainly an underestimation of the regions potential, primarily due to two factors.

The first reason to assume an underestimation is the relatively small collection range of this survey; only five counties were surveyed and all five counties were part of the southwest corner of the Ozark Mountain region. Although different habitats were sampled, collection efforts primarily focused on oak-hickory forest arthropods. Surveying additional regions and focusing on a more diverse range of ecosystems would more than certainly increase the number of species found (Agosti et al. 2000).

The second reason to assume an underestimation is that effectively collecting diverse and abundant samples of ants requires multiple collection approaches (Agosti et al. 2000; General and Thompson 2008a); this survey only used two. A diverse approach is important because even closely related species of ants are often separated by a variety of factors including spatial and temporal distribution (Hölldobler and Wilson 1990; General and Thompson 2008a). Ants are known to inhabit diverse habitats and fill many

different niches within an ecosystem. Arboreal ants, for example, are hidden in trees or shrubs and are usually only caught by on site collection or tree bating (Hölldobler and Wilson 1990; General and Thompson 2008a). Effective ant collection should involve at least litter sampling (combined with Berlese funnel extraction), pitfall trapping, baiting with peanut butter or tuna, debris disturbing (such as breaking open sticks), and on-site-collection (Agosti et al. 2000; General and Thompson 2007, 2008a). Of the best-choice collection methods, only litter samples combined with Berlese funnels were used; pitfall traps, baiting, debris disturbing and on-site collection were not used. Without tree-baiting and on-site collection, many arboreal ants were simply ignored; furthermore, pitfall traps and baiting would have been important in catching many species of foraging ants (Agosti et al. 2000).

Malaise traps, while not a replacement for these other methods, are helpful for understanding ant reproductive cycles (Kaspari et al. 2001). However, it is often hard to identify ant species from alate queens or males, which make up the large majority of ants caught in Malaise traps, and therefore this survey declined to identify alate ants. In general, Malaise traps are rarely if ever used to survey ant populations and diversity, thus oftentimes they go completely unmentioned in the literature (Agosti et al. 2000). Because of these reasons, it was originally thought that very few species would be identified from Malaise traps. However Malaise trapping did recover enough apterous specimens to identify species. Just under a quarter of the ant species identified were caught solely by Malaise trap. Six out of eight species caught solely by Malaise traps were in the genus *Camponotus*, a group that contains many explorative foragers often noted for their shepherding behavior of aphids (Fisher 2002; BugGuide 2004; Fisher and

Cover 2007). It is likely that their curious nature and attempts to find aphids caused them to climb the vertical surfaces of the Malaise traps and fall into the collection jars. In other surveys performed in the lab of Dr. Dowling, Malaise trapping has also been useful for collecting *Neivamyrmex* males, as the workers are almost exclusively subterranean and are rarely collected.

Of the aforementioned best-choice methods, only litter sampling was used. Processing litter samples with Berlese-Tullgren funnels is an effective method for collecting an abundant number of ant species. *Ants: Standard Methods for Measuring and Monitoring Biodiversity* (Agnosti et al. 2000), ranked Berlese funnels second only to Winkler extraction for catching high ant species numbers. Many ants either utilize leaf litter to make nests or to forage for food (Silvia and Brandao 2010). As expected, this method caught the majority of ant species in this survey.

CONCLUSIONS

The understudied nature of the Interior Highlands is both an exciting opportunity and an unfortunate reality. Almost any study of the region will contribute new biological understanding. However, as invasive species move in and humans impact their surroundings, ecosystems can change dramatically.

There is some understanding of what ant communities were like previously in Arkansas thanks to Warren and Rouse (1969). However, nearly four decades have passed between the surveys of Warren and Rouse (1969) and the more recent surveys of General and Thompson (2007, 2008a, 2008b, 2009) and Macgown et al. (2011). Recent surveys

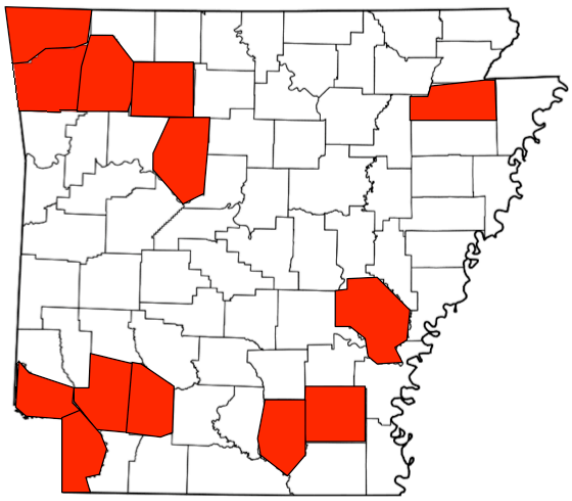


Figure 3. Arkansas Counties surveyed for ant distributions since 1969 according to General and Thompson (2007, 2008a, 2008b, 2009) and MacGown (2011). (modified from Wikipedia)

have only been done in 13 of 75 counties in Arkansas including Arkansas, Benton, Bradley, Craighead, Drew, Hempstead, Little River, Madison, Miller, Nevada, Newton, Pope, and Washington Counties. This survey is an example of how even a limited study can still add a deal of knowledge to what is known about the ants of Arkansas and the Interior Highlands of the United States.

LITERATURE CITED

Agosti, D., Majer, J.D., Alonso, L.E., and T.R. Schultz (eds.). 2000. Ants: Standard methods for measuring and monitoring biodiversity. Washington (DC): Smithsonian Institution Press.

Anonymous. 2011. Buffalo National River. National Park Service, U.S. Department of the Interior. http://www.nps.gov/buff/contacts.htm. [accessed 4 November 2011].

Anonymous. 2004. BugGuide. Iowa State University http://bugguide.net [accessed 4 November 2011].

Allen, R.T. 1990. Insect endemism in the Interior Highlands of North America. Florida Entomologist 73(4): 539-569.

Brown, R.A., and P.M. Ferree. 2007. Genetic structure of Southern Appalachian "sky island" populations of the southern red-backed vole (*Myodes Gapperi*). J. Mammal. 88(3): 759-768.

Crespi, E.J., Rissler, L.J., and R.A. Browne. 2003. Testing Pleistocene refugia theory: phylogeographical analysis of *Desmognathus wrighti*, a high-elevation salamander in the southern Appalachians. Mol. Ecol. 12: 969–98.

Fisher, B.L. 2002. Antweb. The California Academy of Sciences, San Francisco, U.S.A. http://www.antweb.org [accessed 12 October 2011].

Fisher, B.L., and S.P. Cover. 2007. Ants of North America: A guide to the genera. Berkeley (CA) University of California Press.

General, D.M., and L.C. Thompson. 2007. Ants (Hymenoptera: Formicidae) of Arkansas Post National Memorial. J. Arkansas Acad. Sci. 61: 59-64.

General, D.M., and L.C. Thompson. 2008a. Ants of Arkansas Post National Memorial: how and where collected. J. Arkansas Acad. Sci., 62: 52-60.

General D.M. and L.C. Thompson. 2008b. New distributional records of ants in Arkansas. J. Arkansas Acad. Sci. 62: 148-150

General, D.M and L.C Thompson. 2009. New distributional records of ants for 2008. J. Arkansas Acad. Sci. 63: 182-184.

Hölldobler, B., and E.O. Wilson. 2009. The superorganism: The beauty, elegance, and strangeness of insect societies. W.W. Norton and Company, Inc. New York, N.Y.

Hölldobler, B., and E.O. Wilson. 1990. The ants. Cambridge (MA): The Belknap Press of Harvard University Press.

Hollingsworth, P.R., and T.J. Near. 2009. Temporal patterns of diversification and microendemism in eastern highland endemic barcheek darters (Percidae: Etheostomatinae). Evolution 63(1): 228-243

Juan, A.S. 2003. What are leaf cutter ants. http://www.blueboard.com/leafcutters/index.htm [accessed 11 April 2010].

Kaspari, M., Pickering, J., and D. Windsor. 2001. The reproductive flight phenology of neotropical ant assemblage. Ecological Entomology 26(3): 245-257

MacGown, J. A. 2010. Ants of the Southeastern United States (species list). http://www.mississippientomologicalmuseum.org.msstate.edu/Researchtaxapages

/Formicidaepages/faunal.lists/Southeastern.species.htm [accessed 12 October 2011].

Macgown, J.A., JoVonn, G.H., and M. Skvarla. 2011. New records of ants (Hymenoptera: Formicidae) for Arkansas with a synopsis of previous records. Midsouth Entomologist 4: 29-38

Messedrocker. 2011. Arkansas. Wikipedia. http://upload.wikimedia.org/wikipedia/ Commons/d/df/Map_of_Arkansas.png. [accessed 4 November 2011].

O'Neill, J.C. 2010. Atta mutualism: cooperation between ant, fungus and bacteria. Student research project, Chemical and Behavioral Ecology, University of Arkansas, Fayetteville, AR.

Read, R.A. 1952. Tree species occurrence as influenced by geology and soil on an Ozark north slope. Ecology 33: 239-246

Schultz, T.R. 2000. In search of ant ancestors. Natl. Acad. of Sciences 97 (26): 14028-14029.

Schultz, T.R. and S.G. Brady 2008. Major evolutionary transitions in ant agriculture. Natl. Acad. Sciences 105(14): 5435-5440

Silvia, R.R., and C.R.F. Brandao. 2010. Morphological patterns and community organization of leaf litter ant assemblages. Ecol. Mono. 80:107-124.

Sokolova, Y.Y., Sokolov, I.M., and C.E. Carlton. 2010. New microsporida parasitizing bark lice (Insecta: Psocoptera). J. of Invert. Path. 104(3): 186-194.

Tilley, S.G. 1997. Patterns of genetic differentiation in Appalachian Desmognathine salamanders. J. Hered. 88: 305-315.

Warren, L.O., and E.P., Rouse. 1969. The ants of Arkansas. University of Arkansas (Fayetteville) Agricultural Experiment Station Bulletin 742.

Wetterer, J.K., Gruner, D.S., and J.E. Lopez. 1998. Foraging and nesting ecology of *Acromyrex octospinosus* (Hymenoptera: Formicidae) in a Costa Rican tropical dry forest. Florida Entomologist 81(1): 61-67.