

Project Title: Surveying endemic and relict insect fauna in Arkansas with an emphasis on biogeographically important regions and unique habitats.

Project Summary: Arkansas, as part of the greater Interior Highlands, is an understudied biodiversity hotspot in the US. Due to its geological history, much of the state has served as a refugium during major climatic events such as ice ages, and therefore contains high levels of endemism and many relict species. Despite its history, little is really known about the arthropod fauna of the state. Extensive surveys of unique, undisturbed habitats throughout several ecoregions in the state will be sampled for arthropods. Taxa within major focal groups will be identified, distributions mapped, and new species described.

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SWG amount requested: \$63,329

Match amount: \$86,830

Total Project Cost (SWG + Match): \$150,159

Need:

The Interior Highlands of North America are primarily composed of the Ozark Mountains in Missouri and Arkansas, and the Ouachita Mountains in Arkansas and Oklahoma. Three low-relief regions are also included: the Illinois Ozark Mountains in Illinois and the Arbuckle and Wichita Mountains in Oklahoma. The Interior Highlands have several attributes that justify investigation. For example, unlike surrounding areas, they have remained exposed during glaciation and flooding events throughout biological history, and have thus acted as a refugium for species displaced during such events. As a result, the Interior Highlands have high numbers of endemic taxa, with well over 200 species already known^{1,2}, 110 of these endemic to Arkansas³. Additionally, the refugial aspect of the region has resulted in numerous plant and animal relict populations in Arkansas^{4,5,6}. Lastly, although predominately composed of widespread eastern species, the state contains many species reaching their distributional extremes from the south or west (e.g., Texas brown tarantulas, striped bark scorpions, Greater roadrunners, Western diamondback rattlesnakes).

Despite the important placement within North America and its refugial history, Arkansas, and the rest of the Interior Highlands, remain grossly under-investigated with few active researchers tackling species composition or conducting surveys. The situation is amplified with regard to arthropods, which have received almost no attention beyond a few scattered taxa (e.g., ground beetles², caddisflies⁷, stoneflies⁸). Recent efforts by graduate students in Project Leader Dowling's lab have begun to rectify this problem by describing new mite species^{9,10,11} and documenting regional records for ants¹². Although currently unpublished, collection efforts over the last year as part of a state wildlife funded project in western Arkansas by Dowling's lab have resulted in the discovery of dozens of new, rare, or endemic insect species. Overall, insect biodiversity in Arkansas is grossly understudied and our recent efforts have only begun to crack the surface.

The 2014 Arkansas Wildlife Action Plan (AWAP) lists the emerging issue to understand "Arkansas's unique biogeography" including the "status of disjunct and relict populations". The associated action is to "obtain baseline distribution and population status on multiple species" of insects. This is the appropriate starting point for any insect diversity work, because until baseline data on insect diversity, distributions and population status are determined, trying to conserve Arkansas's unique insect fauna may be futile. As it currently stands, there is a desperate need to survey the insect fauna across the state's unique habitats and regions to establish the baseline data to determine endemism, potential conservation status of species, and most importantly, to put Arkansas on the map as a biodiversity hotspot in the US.

¹ Redfearn, "Mosses of the Interior Highlands of North America."

² Allen, "Insect Endemism in the Interior Highlands of North America."

³ Robison et al., "The Arkansas Endemic Biota: An Update with Additions and Deletions."

⁴ Carlton and Cox, "A New Species of *Arianops* from Central Arkansas and Biogeographic Implications of the Interior Highlands *Arianops* Species (Coleoptera: Pselaphidae)."

⁵ Carlton and Robison, "Diversity of Litter-Dwelling Beetles in the Ouachita Highlands of Arkansas, USA (Insecta: Coleoptera)."

⁶ Alexander and Perkin, "Notes on the Distribution and Feeding Ecology of a Relict Population of the Cardinal Shiner, *Luxilus cardinalis* (Teleostei: Cyprinidae), in Kansas."

⁷ Moulton and Stewart, "Caddisflies (Trichoptera) of the Interior Highlands of North America."

⁸ Poulton and Stewart, "The Stoneflies of the Ozark and Ouachita Mountains (Plecoptera)."

⁹ Fisher et al., "*Trachymolgus purpureus* Sp. N., an Armored Snout Mite (Acari, Bdellidae) from the Ozark Highlands: Morphology, Development, and Key to *Trachymolgus* Berlese."

¹⁰ Skvarla, Fisher, and Dowling, "A New Species of *Neoscirula* (Acari: Cunaxidae: Coleoscirinae) from the Ozark Highlands (USA), with a Note on Biogeography."

¹¹ Skvarla and Dowling, "Some New Armascirine Cunaxids (Acari: Prostigmata: Cunaxidae) from the Eastern United States."

¹² MacGown, Hill, and Skvarla, "New Records of Ants (Hymenoptera: Formicidae) for Arkansas with a Synopsis of previous Records."

Location of Work:

Biodiversity and endemism in the state can also be attributed to the large number of unique habitats including various types of hardwood and pine forests, prairies, glades, expansive cypress and water tupelo swamps, higher elevation habitats and an extensive karst system. Terrestrial habitats in the Ozark Highlands, Boston Mountain, Ouachita Mountain, Arkansas River Valley, and Crowley's Ridge eco-regions listed in the AWAP will be sampled. Specific localities within these eco-regions will focus on virgin or well-protected habitats with an emphasis on areas known for unique and endemism flora and fauna¹³. As part of a previous project, we have already sampled numerous habitats in several of these ecoregions (Fig 1, red/white dots), however, this represents only a small portion of the hundreds of unique habitats in the state. Our sampling will include new sites in un-sampled areas (Fig 1, crosshatched areas) and we expect widespread sampling across these eco-regions in order to adequately inventory and discover species, and establish distributions for endemic and rare species.

Objective:

The primary objective is to expand our survey of the above-mentioned ecoregions and work through existing samples in order to establish an inventory of species present, with special emphasis on discovering new, relict, and endemic taxa. Efforts will focus on additional sampling of unique habitats within these regions and areas identified as hosting rare or endemic species. This project will also serve to help establish distributions for rare or restricted species. In order to make this primary objective feasible, specific identification efforts will be limited to insect groups identified as containing Arkansas endemics and groups in which Dowling and his students have expertise. The primary objective will be to identify species in particular families of Diplura, Protura, Coleoptera, Hemiptera, Lepidoptera, Hymenoptera and Orthoptera, and other arthropod groups including Diplopoda and Acari. Other by-catch will be identified as possible or sent to experts for identification. Dowling's lab routinely works with taxonomic specialists around the country and will enlist their help as needed with identifications.

Approach:

We will use a combination of pitfall traps (targeting ground running insects) and malaise traps (targeting flying insects) along with hand collection and leaf litter extraction. The primary collection technique implemented for this project will be litter extraction using a litter sifter and modified Berlese-Tulgren funnels. We have found this technique to produce the highest diversity of ground dwelling arthropod taxa. The trapping component described herein involves Malaise traps, which are passive traps that primarily target flying insects, but are also effective at collecting climbing species, and pitfall traps, which capture ground dwelling species active at night and those not commonly collected in litter. Malaise traps and pitfalls need to be run for extended periods of time and checked every few weeks, and because of this, the two trap types will be run in tandem. Trapping stations will be moved around the state over the course of the project in order to sample all major regions. Litter will be sampled at all trapping stations and also across numerous habitats that will not be sampled by other means. Additionally, three graduate students in Dowling's lab are working on Arkansas arthropods and their sampling regimes and expertise in insect identification will greatly complement the proposed inventory project. While this project is not directly related to their dissertations, it will provide some necessary specimens as well as serve to further train them in insect systematics. Additionally, their collections will provide a greater breadth of localities across the state. All collected specimens will be stored in ethanol until they can be properly prepared (mostly pin mounted). Species will be photographed and entered in the lab database.

¹³ Zachry and Dale, "Potential National Natural Landmarks of the Interior Highlands Natural Region, Central United States."

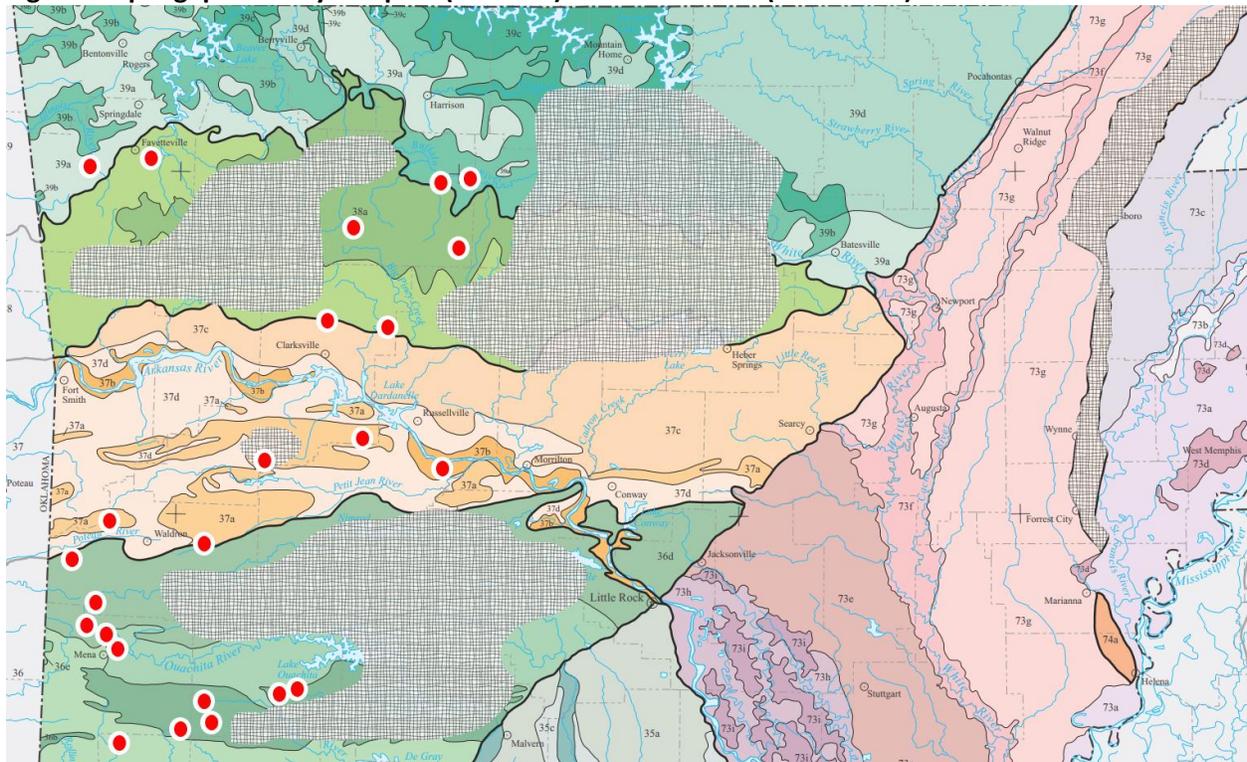
Expected Results and Benefits:

Known endemics and relicts of the state will be collected and distributions expanded (or distributions confirmed to be restricted to very specific localities). More importantly, because this is a survey based project, an extensive list of identified insect species will be obtained with rates of occurrence and distributions. This will allow rare or unique species to be identified and may lead to establishing conservation priorities for particular insect species or habitats. Additionally, we anticipate description of new species from this project. A photographic guide of rare and unique species will be produced by the PI and the database with collection information and distributions will be accessible to the public via the internet. Additionally, numerous scientific papers will be published on Arkansas species.

Proposed Budget:

Budget Items	SWG Funds	UA Match
Personnel and Fringe: PI Dowling (3.6 months over 2 yrs)	0	\$28,692
Personnel and Fringe: technician (2 years) (UA pays part of salary and fringe benefits)	\$42,572	\$37,412
Collection and Curation Supplies (e.g., vials, ethanol, traps, insect pins, drawers, cabinets)	\$3,000	\$0
Travel: mileage (based on UA mileage rate of \$0.42/mile)	\$8,500	\$0
Travel: food and lodgings (2 people/~40 days in the field)	\$3,500	\$0
Indirect Costs (10% to SWG and unrecovered costs to UA)	\$5,757	\$20,726
Totals	\$63,329	\$86,830

Fig. 1 Sampling: previously sampled (red dots) new focal areas (crosshatch)



Qualifications:**Dr. Ashley P.G. Dowling****Professional Preparation:**

Ph.D., 2005, University of Michigan, Department of Ecology and Evolutionary Biology, Ann Arbor, MI
B.S., 1997, University of Arizona, Department of Ecology and Evolutionary Biology, Tucson, AZ

Appointment:

Assistant Professor, 2008-present, Department of Entomology, University of Arkansas

Current Grants:

National Science Foundation. "PEET: Using monographs, cybertaxonomy, and phylogenetics to train a future generation of water mite systematists (Acari: Hydrachnidia)". Lead PI with Co-PI A. Radwell, (\$725,557), 2012-2017

Arkansas Game and Fish Commission. "Inventory of the insect fauna from the western ecoregions of Arkansas, with special emphasis on surveying distributions of known insect endemics". PI (\$64,376), 2012-2014

Peer Reviewed Publications:

Currently 38 publications on arthropod biodiversity and taxonomy.

Student Advising:

Currently training and advising three Ph.D. and three M.S. students in arthropod systematics, biodiversity, and ecology, as well as working with several UA undergrads on honors thesis projects.

Expertise:

Acari, Hymenoptera, Diptera, biogeography, taxonomy

Taxonomic expertise among technician and students:

Hymenoptera, Coleoptera, Lepidoptera, Hemiptera, Acari, Diplopoda, Araneae, Pseudoscorpiones, Opiliones