

**Project Title: Determining distribution and population status of tiger beetles and other riparian species of ecological importance in Arkansas**

**Project Summary:** Tiger beetles and other riparian insect species are considered excellent bioindicators of changes in the environment. Arkansas Wildlife Action Plan (AWAP) lists nine species of tiger beetles and several other insects as “species of greatest conservation need”. Arkansas, known as a biodiversity hotspot due to its varied geography, may likely have more species of tiger beetles and other bioindicator riparian species than the documented species. In the proposed research project, a state-wide survey using multiple sampling methods will be conducted to obtain distribution and population status of tiger beetles and riparian species of ecological importance. Collected species will be identified and distribution maps with species diversity and abundance will be developed.

**Project Leaders:**

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**SWG amount requested:** \$74,559

**Match amount:** \$56,308

**Total Project Cost (SWG + Match):** \$130,867

**Need:**

Tiger beetles (Coleoptera: Carabidae: Cicindelinae) are generally considered important bioindicator taxa for detecting changes in the local/regional environment, particularly due to their occurrence in various types of habitat, and their correlation with species richness and biodiversity of other invertebrates in the ecosystem they are often found<sup>1,2</sup>. Larvae and adults of many species of tiger beetles are predatory in nature, and generally considered beneficial species as they prey upon other insects, including some pest species. Tiger beetles are diverse with over 2000 species from 129 countries<sup>2</sup>, and there are 109 species of tiger beetles reported from North American region<sup>3</sup>. In the past, 31 species of tiger beetles had been documented from the tri-state region (Arkansas, Louisiana and Mississippi)<sup>4</sup>, with 21 known to occur in Arkansas<sup>3,5</sup> (MacRae 2012). Considering the presence of different eco-regions, various suitable habitats (from the hilly regions of northwest to lowland areas in the south) and many species with ranges right up to the Arkansas border, it is highly likely that more species of tiger beetles are present in the state, but have not been documented yet. Therefore it is important to conduct state-wide field surveys in different habitats and eco-regions, and establish base-line information on tiger beetles.

There are 50 species of tiger beetles that are endemic to the United States<sup>6</sup>. Several factors (e.g. environmental changes) can influence population and distribution of endemic and bioindicator species<sup>7</sup>. Biodiversity and abundance of tiger beetles and other riparian invertebrate species are threatened by anthropogenic activities causing habitat fragmentation and degradation. Many species of tiger beetles are very sensitive to such changes in their habitats<sup>8,9</sup>. Consequently, ecological distribution patterns and population dynamics of known species may change over time, and need regular monitoring.

The Arkansas Wildlife Action Plan (AWAP) of 2016 lists “tiger beetles and other riparian species” as one of the priority areas. The primary action associated with this priority is “to obtain baseline distribution and population status for multiple species”. The AWAP’s latest list of “species of greatest conservation need” (SGCN) has nine species of tiger beetles listed and several other ground beetles such *Scaphinotus inflectus*, *Scaphinotus parisiana*, *Rhadine ozarkensis* and *Rimulincola divalis*. Little is known about the current status of populations and

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<sup>1</sup> Rainio, J. and Niemelä, J., 2003. Ground beetles (Coleoptera: Carabidae) as bioindicators. *Biodiversity & Conservation*, 12, 487-506

<sup>2</sup> Pearson, D.L. and Cassola, F., 1992. World-wide species richness patterns of tiger beetles (Coleoptera: Cicindelidae): indicator taxon for biodiversity and conservation studies. *Conservation Biology*, 6, 376-391

<sup>3</sup> Pearson, D.L., Knisley, C.B., Duran, D.P. and Kazilek, C.J., 2015. *A Field Guide to the Tiger Beetles of the United States and Canada: Identification, Natural History, and Distribution of the Cicindelinae*. Oxford University Press

<sup>4</sup> Graves, R.C. and Pearson, D.L., 1973. The tiger beetles of Arkansas, Louisiana, and Mississippi (Coleoptera: Cicindelidae). *Transactions of the American Entomological Society* (1890), 99,157-203

<sup>5</sup> MacRae, T. 2012. Occurrence of *Cicindelia ocellata rectilatera* (Chaudoir)(Coleoptera: Cicindelidae) in Arkansas. *Cicindela* 44(3/4): 49-54

<sup>6</sup> Cassola, F. and Pearson, D.L., 2000. Global patterns of tiger beetle species richness (Coleoptera: Cicindelidae): their use in conservation planning. *Biological Conservation*, 95, 197-208

<sup>7</sup> Lövei, G.L. and Sunderland, K.D., 1996. Ecology and behavior of ground beetles (Coleoptera: Carabidae). *Annual Review of Entomology*, 41, 231-256

<sup>8</sup> <http://www.cdpr.ca.gov/docs/endspec/estext/fr100301.txt>

<sup>9</sup> Knisley, C.B. and Hill, J.M., 1992. Effects of habitat change from ecological succession and human impact on tiger beetles. *Virginia Journal of Science*, 43, 133-142

geographic distribution of these nine tiger beetles or any other species in Arkansas. The proposed study will provide valuable data towards better understanding tiger beetle diversity, distributions, and potential conservation status.

### **Location of Work:**

Field work will be conducted in various habitats across the state. Sampling and survey sites will include different types of ecosystems, mainly comprised of prairies, forests, glades, rock outcrops, river basins, and farmland. Survey and sampling sites will be located in all eco-regions listed in the AWAP (Ozark Mountains, Ouachita Mountain, Arkansas Valley, Mississippi Alluvial Plain, West Gulf Coastal Plain and Crowley's Ridge). Known localities of species in the state based upon the literature and museum specimens in the University of Arkansas Arthropod Museum will be sampled to determine if populations are still present and appropriate habitats around the eco-regions will be sampled to identify previously unknown distributions and species.

### **Objective:**

The main objective of this project is to obtain population and distribution pattern status of tiger beetles and other riparian species of ecological importance from various eco-regions/habitats in Arkansas. In addition, field studies will be designed in order to find any new state records of tiger beetles and other riparian fauna from this region. Research in Dowling's lab on previous SWG projects using a similar sampling design has identified new state records for 32 Coleoptera species<sup>10,11</sup>, 32 Hymenoptera (Symphyta) species<sup>12</sup> (unpublished), and 11 Hemiptera (Heteroptera) species (unpublished - in review), indicating how little is known about Arkansas insects and how important it is to conduct these sampling projects. These objectives will help us to better understand the current state of tiger beetles and other species of ecological importance in Arkansas. Based on the proposed two year survey, an online guide containing color pictures and a short description of tiger beetles of Arkansas will be developed. Availability of such online resources will help to increase public awareness regarding the biodiversity and importance of these species. Sample identification efforts will be focused on tiger beetles and other riparian beetle species; however, efforts will be made to identify other insect samples collected from survey sites when possible.

### **Approach:**

For the proposed survey work, we will use a combination of sampling methods that are currently used for surveying tiger beetles and other riparian insect fauna. These methods

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<sup>10</sup> Skvarla, M.J., Fisher, D.M., Schnepf, K.E., Dowling, A.P.G. 2015. Terrestrial arthropods of Steel Creek, Buffalo National River, Arkansas. I. Select beetles (Coleoptera: Buprestidae, Carabidae, Cerambycidae, Curculionoidea excluding Scolytinae). *Biodiversity Data Journal* 3: e6832. doi: 10.3897/BDJ.3.e6832

<sup>11</sup> Skvarla, M.J., Bertone, M.A., Fisher, J.R., Dowling, A.P.G. 2015. New information about the cypress weevil, *Eudocimus mannerheimii* (Boheman, 1836) (Coleoptera: Curculionidae: Molytinae): redescription, range expansion, new host records, and a report as a possible causative agent of tree mortality. *Coleopterists Bulletin* 69(4): 751-757

<sup>12</sup> Skvarla, M.J., Tripodi, A., Szalanski, A., and Dowling, A.P.G. 2015. New records of *Orussus minutus* Middlekauff, 1983 (Hymenoptera: Orussidae) represent a significant western range expansion. *Biodiversity Data Journal* 3: e5793. doi: 10.3897/BDJ.3.e5793

include the use of different types of traps (such as pitfall traps and light traps,) sweep net sampling, and hand collection. These collection methods are known to be effective in sampling tiger beetles<sup>13</sup>, and the pitfall and light traps are easy to operate for long-term sampling. Trapping and sampling will be conducted during seasons with expected high activity levels. At each survey site, we will use multiple trapping methods and these trap stations will be rotated at different locations to avoid any “hot-spot’ effect in sampling. Though the frequency of trapping will depend on the habitat type, pitfall traps will be checked every two weeks (more frequently during times of frequent rain). Insect samples will be collected from all traps and will be immediately stored in 80% ethanol until further processed in the lab. Tiger beetle species and other samples of ecologically important taxa will be pinned and photographed using a high resolution camera. Processed specimens will be entered in the Dowling lab database, and later deposited in the University of Arkansas Arthropod Museum.

**Expected Results and Benefits:**

From our state-wide survey, we will know about the population and distribution status of existing species of tiger beetles and riparian insect species including the SGCN list (e.g., *Cicindela lepida*, *C. obsoleta*, *C. unipunctata*, *C. duodecimguttata*, *C. purpurea*, *C. hirticollis*, *C. macra*, *C. cursitans*, and *C. formosa pigmentosignata*). The findings of this survey will allow us to categorize tiger beetles and riparian insect species as per their ecological distribution across the state. Due to the exploratory nature of the project, we will have additional information on diversity and abundance of several species of arthropods associated with various eco-regions of the state. In the long term, results from this survey project will lead to the development of guidelines for conservation and management of tiger beetles and riparian insect species of ecological importance. After field surveys and collections, an online field guide to tiger beetles of Arkansas will be produced, and publications documenting state-wide information on tiger beetles and other riparian insect species will be submitted. Specimens from this project will be available for use in other research projects and for teaching, extension, and outreach activities designed for various stakeholder groups in Arkansas.

**Proposed Budget:**

Budget Items	SWG Funds	UA Match
Personnel and Fringe: PI- Joshi (equivalent 5 months over 2 yrs)	0	\$30,890
Personnel and Fringe: full-time technician (2 years) (UA pays part of salary and fringe benefits)	\$47,031	
Sample Collection and Curation Supplies (e.g., vials, ethanol, different traps, insect pins, drawers, cabinets etc.)	\$3,500	
Travel: mileage (based on UA mileage rate of \$0.42/mile)	\$9,750	
Travel: food and lodgings (2 people/~40 days in the field sites)	\$7,500	
Indirect Costs (10% to SWG and unrecovered indirect to UA)	\$6,778	\$25,418
<b>Totals</b>	<b>\$74,559</b>	<b>\$56,308</b>

**Qualifications:**

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<sup>13</sup> Pearson, D.L. and Vogler, A.P., 2001. *Tiger beetles: the evolution, ecology, and diversity of the cicindelids*. Cornell University Press.

## **Dr. Neelendra K. Joshi**

### **Professional Preparation:**

Ph.D. Entomology, 2011, Pennsylvania State University, Department of Entomology, University Park, PA

M.Sc. Ag. Entomology, 2001, GB Pant University of Agriculture & Technology, Pantnagar, UK, India.

B.Sc. (Botany, Zoology & Chemistry), 1999, Kumaun University, Nainital, UK, India

**Current Appointment:** Assistant Professor, 2015-present, Dept. of Entomology, University of Arkansas

### **Recent Grants:**

- 2014-2015: Co-PI on **\$50,525 Specialty Crop Grant (PA Department of Agriculture)** on “Developing ecologically-based apple IPM programs that conserve managed and wild pollinators”.
- 2014-2015: Co-PI on **\$29,810 State Hort. Assoc. of PA Research Grant** on “Integrating pollinators into Integrated Pest Management: Understanding the impacts of pre-bloom insecticide sprays and fall Brown Marmorated Stink Bug control can affect bees”.
- 2013-2014: Co-PI on **\$22,060 State Hort. Assoc. of PA Research Grant** on “A cooperative survey to determine the importance of the spotted wing drosophila and other invasive fruit flies in various tree and small fruit crops in Pennsylvania and Maryland”.

**Publications:** Research Articles: 19, Extension Articles: 20, Technical Research Reports: 17

**Recent Paper on Arthropod Biodiversity:** Joshi N. K., T. Leslie, E. G. Rajotte, M. A. Kammerer, M. Otieno, D. J. Biddinger. (2015). Comparative trapping efficiency to characterize bee abundance, diversity and community composition in apple orchards. *Annals of the Entomological Soc. America*, 108 (5), 785-799.

**Student Advising:** Currently advising one Ph.D. student in pollinator health and diversity work.

**Research Expertise and Taxonomic Experience:** Arthropods sampling techniques, Insect population monitoring, Biodiversity, Hymenoptera, Coleoptera, Lepidoptera

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## **Dr. Ashley P.G. Dowling**

### **Professional Preparation:**

Ph.D., 2005, University of Michigan, Department of Ecology and Evolutionary Biology, Ann Arbor, M

B.S., 1997, University of Arizona, Department of Ecology and Evolutionary Biology, Tucson, AZ

### **Appointment:**

Associate Professor, 2014-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: Hydrachnidiae)”. Lead PI with Co-PI A. Radwell, (\$725,557), 2012-2017
- Arkansas Game and Fish Commission. “Surveying endemic and relict insect fauna in Arkansas with an emphasis on biogeographically important regions and unique habitats”. PI (\$63,327), 2014-2017

### **Peer Reviewed Publications:**

Currently 50 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 having graduated five graduate students in the past few years.

**Expertise:** Acari, Hymenoptera, Coleoptera, biogeography, taxonomy

### **Taxonomic expertise among technician and students:**

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