

Title of the project: Diversity and Distribution of Water Mites (Acari: Hydrachnidia) of the Interior Highlands of Arkansas

Project summary: The goal of this project is to build a geo-referenced database and photographic record of water mite species in headwater streams of the Interior Highlands of Arkansas. It is intended to address the gap in knowledge of the most abundant, diverse, and ecologically important group of freshwater arachnids. Outcomes are expected to facilitate greater inclusion of water mites in biodiversity inventories, biogeographic assessments, ecological studies, and evaluations of conservation status of freshwater invertebrates.

Project leader: Dr. Andrea J. Radwell, Research Assistant Professor

Affiliation: Department of Biological Sciences, University of Arkansas, Fayetteville

E-mail: aradwell@uark.edu

Mailing address: 26 Emporia Street, Eureka Springs, AR 72632

Telephone: 479-253-2883

Project partners:

Dr. Ian M. Smith, Principal Research Scientist, Systematic Acarology, Biodiversity, Environmental Health Program, Agriculture and Agri-food Canada, Ottawa.
Curator of water mites in the Canadian National Collection of Insects and Arachnids.
smithi@agr.gc.ca 613-759-1783

Dr. Henry W. Robison. Distinguished Professor of Biology (retired).
hwrobison@suddenlink.net 870-234-3013

Total amount of the project: \$104,900 (2-year grant period)

Total amount of SWG money requested: \$47,350

Matching funds and inkind services: \$57,550

Bader Foundation of Switzerland - contribution for capital equipment	\$6,800
Canacoll Foundation travel grants (2 trips) to Canadian National Collection of Insects and Arachnids for taxonomic work	\$2,800
University of Arkansas - laboratory facilities, website hosting including software	\$2,000
Dr. Andrea J. Radwell - 6 months of work (3 months per year) contributed without compensation for specimen collection, sorting and identification, maintenance of database and website, and photography. (Additional time to be compensated appears in the budget.)	\$20,000
Dr. Ian M. Smith - collection, curation, professional taxonomic expertise, and access to the Canadian National Collection of Insects and Arachnids for taxonomic work	\$20,000
Dr. Henry W. Robison - consultation for collection site selection and field assistance	\$5,000
Ouachita Mountains Biological Station housing and lab facilities	\$450
National Park Service, Buffalo River National Park housing	\$500
TOTAL	\$57,550

Diversity and Distribution of Water Mites (Acari: Hydrachnidae) of the Interior Highlands of Arkansas

a) Priority

This project is intended to address a data gap in knowledge of the biodiversity of headwater streams. The goal is to provide a geo-referenced database and photographic record of water mite species in the taxon Acari: Hydrachnidae that will be useful to resource managers for developing science-based strategies to assess, monitor, and conserve freshwater biodiversity.

Freshwater-dependent animals such as mussels, crayfishes, stoneflies, amphibians, and fish are known to be among the most vulnerable and threatened biota in North America. In contrast, little is known of the biodiversity and conservation status of smaller aquatic invertebrate taxa that play an integral role in maintaining healthy aquatic communities. Hydrachnidae, one of the largest and most ecologically important freshwater taxa, includes the water mites that are found in all freshwater habitats including streams, springs, ponds, lakes, and wetlands. Since most species strongly interact with other aquatic invertebrates through a life cycle including parasitic and predatory stages, they potentially influence the structure and dynamics of freshwater communities. Preliminary studies of physico-chemical and pollution ecology of the relatively well-known fauna of Europe have demonstrated that water mites are excellent indicators of habitat quality. Collecting for taxonomic work during the past century in North America has indicated that water mite species have highly specific habitat and host associations and that many of them have limited distributions, but the status of populations in the United States is generally inadequately documented.

Over 6000 species have been recognized worldwide, and over 2000 species in 140 genera and 42 families are currently estimated to occur in North America north of Mexico, but it is estimated that more than half of the North American species are not yet described. Inclusion of the group in freshwater research and in efforts to conserve biodiversity is currently hampered by lack of sufficient systematic and ecological information at the species level. This project is expected to establish a geo-referenced database of water mites of the Interior Highlands of Arkansas and to provide specimens for taxonomic and systematics research.

Emphasis on conserving familiar threatened fauna (e.g., mussels and crayfish) should remain a high priority. However, documenting the presence of less familiar biota and raising awareness of the role it plays in maintaining aquatic ecosystem integrity is a priority that warrants greater attention. Workshops, presentations, and dissemination of information via a website are expected to address this conservation priority.

b) Area of project: Ozark Highlands, Boston Mountains, and Ouachita Mountains Ecoregions

The Interior Highlands of Arkansas, including the Ozark Highlands, Boston Mountains, and Ouachita Mountains, served as an unglaciated refugium during the Pleistocene when biota migrated south as continental ice sheets advanced across North America. Geological history and collections made over the past century suggest that water mite species assemblages in unglaciated refugia are comprised of taxa with diverse origins. These taxa include endemics that have inhabited those regions since the Tertiary, species with north temperate origins that established populations there during glacial maxima, and immigrants representing more recent interchanges of warm temperate biota. Consequently, these water mite assemblages are expected to have high species richness and consist of unique mixtures of species that occur together nowhere else.

Few collections of water mites were made in the Interior Highlands of Arkansas prior to 2003 when I began to collect water mites in headwater streams of the White River and Arkansas River watersheds. These preliminary collections, with those obtained in watersheds in the Ouachita Mountains in 2007 and 2008, support the expectation of high diversity associated with unglaciated refugia. A comprehensive survey is expected to generate an estimated 50-60 genera, with the potential of 200 or

more species. Many of these species will be new to science. Given the unique geologic history of the region, the occurrence of endemic species is likely.

c) Methods

The sampling procedure involves digging and/or stirring substrates in aquatic habitats and collecting dislodged organisms and particles of substrate in a strong net with a mesh size less than 250 μm . The net contents are sieved to remove coarse inorganic material and concentrate organisms. The collected material is then returned to the laboratory for extraction of water mites. The collected material is placed in white photographic trays, and water mite specimens are captured with pipettes as they move about in the trays over a period of several hours. They are then preserved in vials containing modified Koenike's solution (50% glycerin, 40% water, and 10% glacial acetic acid by volume) or other suitable preservative. Preserved water mites are initially sorted to generic level in fluid, and selected specimens are cleared in 10% potassium hydroxide, dissected, and slide mounted for species identification which requires comparison to type specimens in the Canadian National Collection of Insects and Arachnids.

d) Measurable products or outcomes

- Geo-referenced data on genera: Based on experience with the All Taxa Biological Inventory of Great Smoky Mountains National Park, it is a realistic expectation to provide a geo-referenced database of water mite genera of the major watersheds of the Interior Highlands in the two-year grant period. Existing information on genera from collections made prior to the grant period will be included in the database, and at least 80 additional collections would be made during the grant period. Since many of the collected specimens are expected to be undescribed, only limited reporting of species will be possible. Data will be posted on the website <http://watermites.uark.edu>, transferred in the appropriate format to the Arkansas Natural Heritage Commission, and made available to other interested entities.
- Research and peer-reviewed publication: Collected specimens will contribute to on-going taxonomic revisions and descriptions of new species to be published during the grant period. Specimens will also be used in research involving the use of genetic molecular analysis to facilitate species identification.
- Photographic record of water mites of Arkansas: A research-grade microscope with camera and Auto-Montage software is requested in this grant to facilitate the development of a photographic record of water mites of the Interior Highlands. A 50% match for the cost of this equipment has been secured from the Bader Foundation of Switzerland.
- Dissemination of information: Pages at <http://watermites.uark.edu> will be dedicated to this project including photographs of water mites collected in the Interior Highlands, information on the progress of this project, and announcements of presentations and workshops. A minimum of two presentations per year will be made to report the progress of this project and to increase public awareness of the need to conserve freshwater biodiversity. A presentation will be made at the Arkansas Academy of Sciences meeting in April 2010, and other presentation opportunities will be sought with interested organizations (e.g., Arkansas Game and Fish Commission, U.S. Forest Service, National Park Service, Sierra Club, and Ozark Society).
- Citizen involvement: A workshop will be conducted each year to engage all interested parties including state and federal agency personnel, students, and citizens. I have conducted successful workshops in 2006, 2007, and 2008 in Great Smoky Mountains National Park that have included Discovering Life in America and Park staff, Park volunteers, students, and interested citizens. Proposed workshops to be held in the Ozarks and Ouachitas will be publicized and organized with assistance from the National Park Service (Buffalo River) and the U.S. Forest Service (Ouachitas).

- A summary report of findings will be completed at the end of the two-year grant period.

e) Taking advantage of existing resources

My position as Research Assistant Professor at the University of Arkansas provides access to laboratory facilities and website host capabilities. I purchased an IMac computer in 2008, and it will be used for maintaining a database and photographing specimens using Auto-Montage techniques. Housing provided to researchers at no cost by the National Park Service (Buffalo River) and the Ouachita Mountains Biological Station will be utilized during fieldwork. The Bader Foundation of Switzerland, dedicated to supporting water mite research worldwide, will contribute \$6,800 to be used as a match for capital equipment.

Since 2003, I have had a cooperative research association with the Canadian National Collection of Insects and Arachnids (CNC), the depository for most of the water mite specimens collected in North America over the past century. Through my work with Dr. Ian M. Smith at the CNC, I have access to the current state of knowledge of water mites in North America, as well as to the collections and research facilities in Ottawa. I have received a yearly grant since 2005 and expect to receive grants in 2009 and 2010 for travel expenses to Ottawa from Canacoll, a foundation that provides support to researchers interested in utilizing the CNC. Dr. Smith traveled to Arkansas in 2008 to collect water mites in Ozark and Ouachita streams and data from these collections will be contributed to the database. He has offered to dedicate time equivalent to at least \$20,000 of his compensation to work on this project through 2011.

Dr. Henry W. Robison has agreed to contribute consultation for site selection and assistance in the field to support this project. He is widely recognized for his knowledge of the biota of freshwater ecosystems and his familiarity with the watersheds of the Interior Highlands.

f) Proposed budget

	1 Sept 2009 - 31 Aug 2010	1 Sept 2010 - 31 Aug 2011	Total
Salary for A.J. Radwell - as a research assistant professor, my research is funded by grants. I am requesting 3 months compensation per year; I will contribute an additional 3 months of work per year.	\$10,000 (3 months pay)	\$10,000 (3 months pay)	\$20,000
Operating expenses			
Travel to collection sties			
10 trips (5 per year) to Ouachitas (550 miles) x \$.50	\$1,375	\$1,375	\$2,750
16 trips (8 per year) to Ozarks (125 miles) x \$.50	\$500	\$500	\$1000
Travel for I.M. Smith from Ottawa, Ontario, Canada	\$2,500	\$2,500	\$5,000
Per diem for A.J. Radwell - food only			
60 days (\$30 per day) x \$30	\$900	\$900	\$1,800
Supplies for curation of specimens and maintenance of collecting equipment	\$1,100	\$1,100	\$2,200
Technical support - website maintenance and mapping	\$500	\$500	\$1,000
Capital expenses			
Research microscope, camera, AutoMontage software	\$13,600		\$13,600
TOTAL	\$30,475	\$16,875	\$47,350

ANDREA J. RADWELL, B.A., M.A., M.S., Ph.D.

EDUCATION Ph.D. Biological Sciences, 2005. University of Arkansas, Fayetteville
M.S. Biological Sciences, 2000. University of Arkansas, Fayetteville
M.A. Secondary Teaching, 1972. Northwestern University, Evanston, Illinois
B.A. Biological Science, 1971. Northwestern University, Evanston, Illinois

CURRENT POSITION

Research Assistant Professor, Department of Biological Sciences, University of Arkansas, Fayetteville

CURRENT RESEARCH PROJECTS

“Hydrachnidae - Water Mites of North America”, a collaborative research effort initiated in 2003 between the University of Arkansas and Ian M. Smith, Canadian National Collection of Insects and Arachnids - see <http://watermites.uark.edu>

“Diversity and Distribution of Water Mites of Great Smoky Mountains National Park”, participation in All Taxa Biological Inventory since 2005 in collaboration with Dr. Ian M. Smith, funded by Discovering Life in America

“Testing Water Mite Species Hypotheses using Molecular Genetics” initiated in Sept 2008 in collaboration with Dr. Ashley Dowling, Acarology and Molecular Genetics, Department of Entomology, University of Arkansas, funded by Honors College, University of Arkansas, Fayetteville

PROFESSIONAL AFFILIATION

American Acarological Society, national membership

AWARD

Discovering Life in America Scientist of the Year, for sharing knowledge of water mite diversity of Great Smoky Mountains National Park with students, educators, and Park visitors, awarded December 2006

PRESENTATIONS RELATED TO ACAROLOGY

Diversity of Water Mites in Unglaciaded Refugia of North America. 12th International Congress of Acarology, Amsterdam, The Netherlands. August 2006

Water Mites (Acari: Hydrachnida) of Ozark Streams - Abundance, Species Richness, and Potential as Environmental Indicators. North American Benthological Society 2005 National Meeting, New Orleans, LA. May 2005

RECENT PUBLICATIONS

Radwell, A. J. and N. B. Camp. (accepted pending minor revision). Comparing chemiluminescent and LED light sources for trapping water mites and aquatic insects. Southeast Naturalist.

Radwell, A. J. and A. V. Brown. 2008. Benthic meiofauna assemblage structure of headwater streams: density and distribution of taxa relative to substrate size. Aquatic Ecology 42 (3): 405-414.

Radwell, A. J. and A. V. Brown. 2006. Influence of fine sediments on meiofauna colonization densities in artificial stream channels. Archiv für Hydrobiologie 165:63-75.

Radwell, A. J. and T. J. Kwak. 2005. Assessing ecological integrity of Ozark rivers to determine suitability for protective status. Environmental Management 35:799-810.