

**EFFECTS OF INVASIVE PLANTS ON ARTHROPOD
COMMUNITIES AND POLLINATOR VISITS TO NATIVE
FLOWERS**

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ABSTRACT

Invasive species pose a serious threat to the biodiversity of native communities. Spotted knapweed (*Centaurea biebersteinii*) and baby's breath (*Gypsophila paniculata*) are two invasive angiosperms that compete with the endemic, federally threatened Pitcher's thistle (*Cirsium pitcheri*) for space and resources on the dunes of the Great Lakes. These invasive species may also compete with native plants for pollinators, or alter the pollinator community composition on the dunes. The proposed project will examine the effects of baby's breath and spotted knapweed on i) pollinator visits to native plants and ii) arthropod abundance, richness, and diversity on the dunes of Lake Michigan in Sleeping Bear Dunes National Lakeshore. We will observe pollinator visits to native species in areas with and without invaders, and use sweep-netting to collect arthropods in these areas. We will examine the abundance, richness, and diversity of both visitors to the native flowers, and of pollinators and other arthropods that are collected. The results of this study will inform park managers' decisions for controlling invaders and preserving native biodiversity by increasing our understanding of how invasive plants interact and compete with native plants, especially those that are already threatened. In addition, few studies have examined the changes that invasive plants may cause in arthropod communities.

Keywords: invasive plants, pollination competition, arthropod community, biodiversity, sand dunes

OVERVIEW

Statement of Issue

Invasive species pose a serious threat to biodiversity of native communities. A thorough understanding of the mechanisms and impacts of invasions is critical to effectively control invasions and protect native ecosystems. Two angiosperms that are listed as noxious by several states have spread across the meadows and dunes of Sleeping Bear Dunes National Lakeshore: baby's breath (*Gypsophila paniculata*) and spotted knapweed (*Centaurea biebersteinii*). These plants compete with the threatened Pitcher's thistle (*Cirsium pitcheri*) for space and resources, and they stabilize the dunes, thereby reducing habitat for Pitcher's thistle, which requires shifting sands for new colonization (U.S. Fish and Wildlife Service, USFWS). Pitcher's thistle is endemic to the dunes of the western Great Lakes in exposed, sandy areas. Many insect species use the plant's pollen, nectar, and seeds for food, and it serves as an indicator of the ecological health of the complex dune ecosystem (USFWS). Pitcher's thistle is listed as Threatened by the U.S. Fish and Wildlife Service, due to shoreline development, recreation, dune stabilization, and invasive plants and insects (USFWS).

Baby's breath and spotted knapweed may also compete with Pitcher's thistle and other native plants such as horsemint (*Monarda punctata*) for pollinators, contributing to their rapid spread. Last summer I performed an experiment to determine if the presence of baby's breath, spotted knapweed, or horsemint significantly affects the abundance or composition of pollinators visiting Pitcher's thistle. Flowering stems of each of the three species were arranged around a Pitcher's thistle at three densities, since plant density can affect pollinator visitation (Feinsinger et al.). I recorded pollinator visitation per plant and movements of pollinators between plants for each treatment. Baby's breath reduced pollinator richness (number of species) to the system compared to horsemint. Compared to native horsemint, spotted knapweed and baby's breath increased pollinator visitation to the system as a whole. However, a significantly lower proportion of these visitors landed on Pitcher's thistle in the presence of spotted knapweed compared to horsemint. It is possible that this trend causes increased deposition of foreign pollen on Pitcher's thistle when near spotted knapweed, which could negatively affect seed set. However, none of the treatments showed effects on the absolute number of pollinators to Pitcher's thistle.

If the results of the proposed study show negative effects of invasive species on native plants via pollination competition, park officials may use this knowledge to more efficiently control invasions. For example, in areas where there are too many invasive plants to remove, conservation efforts could focus on regularly cutting flowering stems of these plants, which would prevent pollination competition in addition to reducing seed production of invaders. Or, control efforts could focus on areas that contain threatened and endangered species if effects are more severe for these plants.

Few studies have examined the effects of invasive plants on the abundance, richness, and diversity of the entire arthropod community. Significant changes in the arthropod community could impact the dune ecosystem as a whole because arthropods interact extensively with plants as herbivores, mutualists (especially pollinators), and parasites.

Literature Summary

Invasive species pose a threat to the biodiversity of native communities that is second only to direct habitat destruction and incur major ecological and economic costs worldwide (Mack et al., Pimental et al.). It is estimated that, in total, invaders cost \$138 billion per year in the U.S. alone (Mack et al.). Invasive species exact a heavy toll on biodiversity as well: competition, predation, parasitism, and herbivory by exotic species threaten 40% of the species on the U.S. Endangered list (Ricklefs). Because biodiversity helps natural communities withstand disturbances, a diverse ecosystem is a healthy one. Some plant species in a diverse community may survive drought while others can resist surges in herbivore populations; as a whole, a diverse community is resistant to a variety of possible threats. For example, Tilman and Downing observed that the negative impacts of drought on productivity were reduced when communities had more plant species.

Pollination competition causing a reduction in seed set has been documented between the invasive purple loosestrife (*Lythrum salicaria*) and the native *L. alatum* (Brown and Mitchell). Pollination competition can reduce seed set of a focal species by either decreasing pollinator visits or by increasing deposition of foreign pollen (Brown and Mitchell). The latter can cause stigmatic interference (blocking the stigma from receiving its own pollen), or simply reduce the amount of conspecific pollen received (Waser and Fugate, Campbell and Motten).

One way that invasive species impact biodiversity of native communities is through the arthropod community. De Groot et al. observed reduced richness, abundance, and diversity in butterflies and in hover flies during part of the season, and reduced abundance in carabid beetles in plots dominated by Canada goldenrod (*Solidago canadensis*), an invasive species in Europe.

Scope of study

The proposed study is non-manipulative and consists only of insect collection and observation in uninvaded sites and sites invaded by baby's breath and/or spotted knapweed, which will be determined by talking with park officials.

The study is valuable as ecological research. Studies that have examined pollination competition so far have found varied effects of pollination competition: negative, neutral, or positive impacts of one species on pollinator visitor rates of another. Furthermore, there are few studies examining pollination competition involving invasive species. More studies are needed to reveal an overall trend, especially concerning invaders. Only a handful of studies have examined the effects of invasive plants on arthropod communities, so an arthropod survey will help us understand how these plants impact native biodiversity.

A more thorough understanding of the interactions between invasive and native species may aid park managers in controlling invaders and restoring native communities, especially the oft-overlooked arthropod community and the threatened Pitcher's thistle. For example, depending on the results, cutting flowers of invaders may be a cost-effective strategy for increasing seed set of native plants and diversity of native arthropods in areas where invaders are too dense to remove soon.

Intended use of results

The results will be useful to land managers; as mentioned above, new strategies for invasive control could be developed. In general, adding to existing knowledge of the mechanisms and impacts of invasions is crucial to effective invasion management and to protect native biodiversity.

HYPOTHESES TO BE TESTED

The proposed research aims to examine the effects of invasive plants on pollination of native plants and on the pollinator community.

Hypotheses:

1. The abundance of pollinators visiting native plants will be lower in invaded areas compared to uninvaded areas.
2. Pollinator and overall arthropod richness and diversity will be lower in invaded areas, but abundance may be higher (based on previous results).
3. Therefore, richness and diversity of pollinators visiting native flowers will also be lower in invaded areas.
4. The proportion of pollinators and arthropods that are native will be higher in uninvaded areas.
5. There may also be area differences in the pollinator and arthropod community at the family level.

METHODS***Description of study area***

The study areas will be determined after discussions with Sleeping Bear Dunes Research Coordinators.

Procedures

The study consists of two parts. Insect collections in invaded and uninvaded areas will address hypotheses 2, 4, and 5. Pollinator observations will address hypotheses 1, 3, and 5.

The sites themselves will be surveyed for plant diversity, percent cover, richness, and diversity. Invader density and native plant densities will also be measured. These data will be used as co-variables when analyzing the collection and observation data.

In the field we propose to use sweep netting to collect insects in the two types of sites, and we will pin and identify the insects (at least to family level) in order to analyze the arthropod abundance, richness, diversity, and community composition. We will also focus on pollinators by running a separate analysis of all collected insects that are also observed visiting flowers.

To observe pollinators, a plant will be observed for twenty minutes and records will be made of how many and which insects visit native flowers (Pitcher's thistle, horsemint, and milkweed) in both types of sites and visitors to invaders (spotted knapweed and baby's breath) where applicable.

Collections

We plan to use sweep-netting to capture insects in each invaded and uninvaded site approved by Research Coordinators. The insects will be removed from the site and identified at Rice University, where some specimens may be pinned and others destroyed and discarded. Even if the collected insects are already in a repository, additional collecting is necessary because we plan to survey for abundance. Specimens will be returned to NPS if requested.

Analysis

In order to evaluate the effects of invasive species on pollinator visitors to native flowers, pollinator observations will be analyzed with ANOVA models to determine if pollinator abundance, richness, and diversity is different for invaded and uninvaded sites. The same variables will be analyzed with ANOVA models for collected arthropods, and a separate analysis will be run for collected pollinators. Abundance is number of individuals, richness is number of species, and diversity will be measured with Hurlbert's PIE measure of diversity.

Schedule

The proposed schedule is June 10 to August 10, 2008, and the analysis and reporting will continue until approximately January 1, 2009.

Budget

We are not expecting any funds from Sleeping Bear or any other national parks.

Housing	\$570
Transportation to and within Michigan	\$1200
Insect collection and mounting supplies	\$200
Total	\$1970

Sources:	Mellon Mays Associate Fellowship	
	Summer Stipend	\$3000
	Garden Club of America Summer	
	Environmental Studies Scholarship	\$2000

PRODUCTS***Publications and reports***

We will write Investigator Annual Reports to provide information and accountability to the National Park Service. Experimental results and any publications in peer-reviewed journals will be provided to park staff in Sleeping Bear Dunes and similar parks.

Collections

Insects will be collected and taken to Rice University for identification. If requested, specimens will be given to the NPS upon completion of identification.

Data and other materials

If requested, we will give presentations, tours, or help park staff prepare brochures or exhibits related to the preservation of biodiversity.

LITERATURE CITED

- Brown BJ, Mitchell RJ. Competition for pollination: effects of pollen of an invasive plant on seed set of a native congener. *Oecologia* 2001;129(1):43-49.
- Brown BJ, Mitchell RJ, Graham SA. Competition for pollination between an invasive species (purple loosestrife) and a native congener. *Ecology* 2002;83(8):2328-2336.
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- Waser NM, Fugate ML. Pollen precedence and stigma closure- a mechanism of competition for pollination between *Delphinium nelsonii* and *Ipomopsis aggregata*. *Oecologia* 1986;70(4):573-577.

QUALIFICATIONS

CV for Carina Baskett:

CARINA ALEXIS BASKETT

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EMPLOYMENT

Field Assistant to Kerri Crawford

Sleeping Bear Dunes National Lakeshore, Empire, Michigan, July-August 2007

Lab Assistant to Michelle Afkhami

Rice University, Houston, Texas, January-June 2007

Copy Editor for *The Rice Thresher* (campus newspaper)

Rice University, Houston, Texas, January 2007-April 2008

EDUCATION

Rice University
Department of Ecology and Evolutionary Biology
Undergraduate Student
GPA after three semesters: 3.95/4.0
Degree Expected: May 2010

RESEARCH GRANTS, FELLOWSHIPS, & AWARDS

Barry M. Goldwater Scholar 2008-2010 (\$15,000)
Mellon Mays Associate Fellow 2008-2010 (\$10,000)
Garden Club of America Mary T. Carothers Summer Environmental Studies Scholarship 2008 (\$2,000)
Rice Undergraduate Research Symposium 2008 1st Prize Poster in Ecology and Evolutionary Biology
Rice University Trustee Distinguished Scholarship 2006-2010 (\$40,000)
National Merit Scholarship Program Finalist
Rice University President's Honor Roll 2006-2007

PUBLICATIONS

Toshinori, O. and Baskett, C.A. (*in prep*) Metabolic response to predator chemical cues in a wolf spider.

PRESENTATIONS

Baskett, C.B., K.M. Crawford, K.M., and J.A. Rudgers. (2008) POSTER: Are invasive species competing for pollinators with an endemic, threatened thistle? Rice Undergraduate Research Symposium. 21 April: Houston, TX.

RESEARCH EXPERIENCE

Rice University, Houston, TX

2007: Pollination competition between dune flowers

With the help of graduate student Kerri Crawford and Dr. Jennifer Rudgers, I studied the effects of baby's breath, spotted knapweed, and native horsemint on the richness and abundance of visitors to Pitcher's thistle.

2007: Restoring and preserving biodiversity at multiple levels.

As a research assistant, I helped graduate student Kerri Crawford set up her experiment in Sleeping Bear Dunes National Lakeshore. This study will examine the combined effects on dune restoration of species diversity and genetic diversity in the dominant grass.

2007: Endophyte transmission in prairie grass.

As a research assistant, I helped graduate student Michelle Afkhami examine the vertical and horizontal transmission of endophyte in prairie grass.

2007: Metabolic response to predator chemical cues in a wolf spider.

I collaborated with Dr. Toshinori Okuyama on an experiment that examined the changes in metabolism in wolf spiders exposed to chemical cues of predator spiders.

I am currently collaborating with Dr. Ken Whitney on an experiment that manipulates the amount of population-level genetic diversity in *Arabidopsis thaliana* to determine if increased genetic diversity improves colonization success in new habitats.

CURRICULUM VITAE
JENNIFER ANNE RUDGERS

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EMPLOYMENT

James H. Godwin Assistant Professor

Rice University, Houston, Texas. August 2005 - present

Research Associate

Indiana University, Bloomington, Indiana. August 2002 - 2005

Postdoctoral advisor: Keith Clay

National Science Foundation Postdoctoral Research Fellowship in Microbial Biology

EDUCATION

Ph.D. Population Biology University of California, Davis, CA. August 2002

Dissertation advisors: Sharon Strauss and Don Strong

Dissertation committee: Maureen Stanton and Jay Rosenheim

B.S. Environmental Science Denison University, Granville, OH. May 1996

Salutatorian, *Summa Cum Laude*, Honors Thesis

RESEARCH GRANTS AND FELLOWSHIPS - EXTERNAL

National Science Foundation Ecological Biology Cluster - *COLLABORATIVE RESEARCH: Consequences of Grass Endophytes on Soil Communities and Processes* (**pending**)

National Science Foundation Ecological Biology Cluster - *COLLABORATIVE RESEARCH: Predictors of abundance in an ecosystem engineer: the relative importance of genetics, environment, and symbionts* (**pending**)

National Science Foundation Microbial Interactions and Processes - *MIP: Linking microbial community composition to the ecological dominance of plants* (**pending**)

National Science Foundation BIO/DEB 2006-2011 - *Do symbioses determine plant species abundances? How endophytic fungi may control rarity, dominance, and invasiveness of grasses* (\$449,946)

National Science Foundation Postdoctoral Fellowship in Microbial Biology 2003-5 (\$100,000)

National Geographic Society *Yellow crazy ant invasion of the Samoan Archipelago: Do novel mutualisms amplify the ecological impacts?* (\$20,000)

Environmental Protection Agency Science to Achieve Results Fellowship 1998-2001 (\$66,000)

National Science Foundation Graduate Research Trainee 1997 (\$4,000)

National Science Foundation REU at Kansas State University and Konza Prairie 1995 (\$2,000)

RESEARCH GRANTS AND FELLOWSHIPS - INTERNAL

Rice University Energy and Environmental Systems Institute Award 2007 *Mechanisms of soil carbon sequestration: optimizing soil carbon interactions with minerals and fungi* (\$10,000)

Rice University Brown Teaching Grant: *Enhancing lecture quality and comprehension with technology* 2007 (\$4,977)

Rice University Brown Teaching Grant 2006 *Learning beyond the classroom walls: applying a student-teacher collaborative approach to biology* (\$4,957)

Rice University Institute of Biosciences and Bioengineering Hamill Innovation Award 2006 *Isolating AM fungi as keystone regulators of carbon sequestration in dune ecosystems* (\$20,000)

University of California-Davis Dissertation Year Fellowship 2001-2 (\$17,000)

University of California-Davis Competitive Intramural Research and Travel Awards (totaling \$21,000)

TEACHING EXPERIENCE

Instructor	Rice University	Insect Biology Spring 2007-
Instructor	Rice University	Environmental Sustainability: The design and practice of community agriculture every Spring and Fall since 2007
Instructor	Rice University	Undergraduate Honors Research in EEB 2006-
Instructor	Rice University	EEB Graduate core course Fall 2006
Instructor	Rice University	Topics in Ecology 2005-
Instructor	Rice University	Topics in Biodiversity 2006-
Instructor	Indiana University	Field and Laboratory Ecology, Fall 2002 and 2004
Instructor	University of California-Davis	Women and Biology Seminar, Spring 2002

PUBLICATIONS *Undergraduate advisee

Afkhami, M. E. and J. A. Rudgers (in press) Symbiosis lost: Imperfect vertical transmission of fungal endophytes in grasses. **American Naturalist**

Rudgers, J. A., and K. Clay (in press) An invasive plant-fungal mutualism reduces arthropod diversity **Ecology Letters**

Rudgers, J. A. and A. L. Swafford* (in press) Benefits of a fungal endophyte in *Elymus virginicus* decline under drought stress. **Basic and Applied Ecology**

Johnson, S. D.*, K. C. Horn*, A. M. Savage, S. Windhager, M. T. Simmons, and J. A. Rudgers (in press) Timing of prescribed burns affects abundance and composition of arthropods in the Texas Hill Country. **Southwestern Naturalist**

*Kannadan, S. and J. A. Rudgers (2008) Endophyte symbiosis benefits a rare grass under low water availability. **Functional Ecology** in press, *Online early*.

- *Mack, K. and J. A. Rudgers (2008) Balancing multiple mutualists: asymmetric interactions among plants, arbuscular mycorrhizal fungi, and fungal endophytes. **Oikos** 117: 310-320
- Rudgers, J. A., and K. Clay (2007) Endophyte symbiosis with tall fescue: How strong are the impacts on communities and ecosystems? **Fungal Biology Reviews** 21: 107-124.
- Rudgers, J. A., J. Holah, S. P. Orr, and K. Clay (2007) Forest succession suppressed by an introduced plant-fungal symbiosis **Ecology**. 88: 18-25
- Flory, S. L., J. A. Rudgers, and K. Clay (2007) Experimental light treatments affect invasion success and the impact of *Microstegium vimineum* on the resident community **Natural Areas Journal** 27: 124-132
- Rudgers, J. A. and K. D. Whitney (2006) Interactions between insect herbivores and a plant architectural dimorphism **Journal of Ecology** 94: 1249-1260
- Tintjer, T. and Rudgers, J. A. (2006) Grass-herbivore interactions altered by strains of a native endophyte **New Phytologist** 170: 513-521
- *Finkes, L. K., Cady, A. B., Mulroy, J. C., Clay, K., and Rudgers, J. A. (2006) Plant-fungus mutualism affects spider composition in successional fields **Ecology Letters** 9:347-356
- *Orr, S. P., J. A. Rudgers, and K. Clay (2005) Invasive plants can inhibit native tree seedlings: testing potential allelopathic mechanisms. **Plant Ecology** 181: 153-165
- Clay, K., J. Holah, and J. A. Rudgers (2005) Herbivores cause a rapid increase in hereditary symbiosis and alter plant community composition **Proceedings of the National Academy of Sciences** 102: 12465-12470
- *Lemons, A., K. Clay, and J. A. Rudgers (2005) Connecting plant microbial interactions above- and belowground: an endophytic fungus affects decomposition. **Oecologia** 145: 595-604
- Rudgers, J. A., W. B. Mattingly, and J. M. Koslow (2005) Mutualistic fungus promotes plant invasion into diverse communities. **Oecologia** 144: 463-471
- Rudgers, J. A. and S. Y. Strauss (2004) A selection mosaic in the facultative mutualism between ants and wild cotton. **Proceedings of the Royal Society of London: Biological Sciences** 271: 2481-2488
- Rudgers, J. A. (2004) Enemies of herbivores can shape plant traits: selection in a facultative ant-plant mutualism. Ecology 85: 192-205**
- Rudgers, J. A. and M. C. Gardener (2004) Extrafloral nectar as a resource mediating multi-species interactions in communities. Ecology 86: 1495-1502**
- Rudgers, J. A., J. M. Koslow, K. Clay (2004) Endophytic fungi alter relationships between diversity and ecosystem properties. Ecology Letters 7: 42-51**
- Rudgers, J. A., S. Y. Strauss, and J. F. Wendel (2004) Trade-offs among anti-herbivore resistance traits: insights from Gossypieae (Malvaceae). **American Journal of Botany** 91:871-880

Rudgers, J. A., and J. D. Hoeksema (2003) Inter-annual variation in above- and belowground herbivory on a native, annual legume. **Plant Ecology** 169: 105-120

Rudgers, J. A., J. G. Hodgen, and J. W. White (2003) Behavioral mechanisms underlie plant defense in an ant-plant mutualism. **Oecologia** 135: 51-59

Rudgers, J. A. and J. L. Maron (2003) Facilitation between coastal dune shrubs: a non-nitrogen-fixing shrub facilitates establishment of a nitrogen fixer. **Oikos** 102: 75-84

Strauss, S. Y., J. A. Rudgers, J. A. Lau and R. E. Irwin (2002) Direct and ecological costs of resistance to herbivory. **Trends in Ecology and Evolution** 17: 278-285

Agrawal, A. A., J. A. Rudgers, L. W. Botsford, D. Cutler, J. B. Gorin, C. J. Lundquist, B. W. Spitzer, A. L. Swann (2000) Benefits and constraints on plant defense against herbivores: Spines influence the legitimate and illegitimate flower visitors of yellow star thistle, *Centaurea solstitialis* L. (Asteraceae). **Southwestern Naturalist** 45: 1-5

PUBLICATIONS - IN REVIEW *Undergraduate advisee

Rudgers, J. A., M. E. Afkhami, M. A. Rua, A. J. Davitt, S. Hammer, and V. M. Huguet (in review) A fungus among us: Broad patterns of endophyte distribution in the grasses **Ecology**

BOOK CHAPTERS

Rudgers, J. A. and K. Clay (2007) Community and Ecosystem Consequences of Endophyte Symbiosis with Tall Fescue. In: Proceedings of the 6th International Symposium on Fungal Endophytes of Grasses (A.J. Popay and E.R. Thom, eds.). Grassland Research and Practice Series No. 13, New Zealand Grassland Association, Dunedin, New Zealand.

Clay, K., Reinhart, K., Rudgers, J., Tintjer, T., Koslow, J. and S. L. Flory. (2008) Red queen communities. In: V. Eviner, F. Keesing and R. Ostfeld, (eds.) Ecology of Infectious Diseases: Interactions between diseases and ecosystems. Princeton University Press, Princeton. pp. 145-178.

Rudgers, J. A and K. Clay (2005) Fungal endophytes in terrestrial communities and ecosystems. In: J. Dighton, J. F. White, Jr., and P. Oudemans (eds.) The Fungal Community : Its Organization and Role in the Ecosystem. Third Edition. CRC Press, Boca Raton, pp. 423-442

POST-DOCTORAL ASSOCIATES

Sarah Emery - National Parks Ecological Research Fellow, *Do microbial mutualists alter invasibility of sand dune communities?*, \$120,000

currently - Assistant Professor, University of Louisville

Valérie Huguet - *MIP: Linking microbial community composition to the ecological dominance of plants* NSF proposal pending

PROFESSIONAL SOCIETIES

Botanical Society of America

Ecological Society of America

Entomological Society of America

AWARDS

Distinguished Faculty Associate Award (Lovett College, Rice University)
 Allen G. Marr Prize for Best Dissertation, University of California at Davis
 Botanical Society of America, Young Botanist Award
 Phi Beta Kappa, Denison University
 Sigma Xi, Denison University
 Distinguished Leadership Award Denison University

INVITED TALKS

Dartmouth College, Department of Biology, 2004
 Cornell University, Ecology and Evolutionary Biology, 2004
 Haskell Indian Nations University, Department of Biology, 2005
 Illinois Natural History Survey, 2004
 Indiana University, Plant-Interactions Group, 2002
 Iowa State University, Dept. Ecology, Evolution and Organismal Biology, 2007
 Rice University, Ecology and Evolutionary Biology, 2004
 Sam Houston State University, Department of Biology, 2007
 Susquehanna University, Department of Biology, 2003
 Syracuse University, Department of Biology, 2006
 Texas A&M, Department of Plant Pathology and Microbiology, 2006
 Texas A&M, Department of Ecosystem Science and Management, 2006
 Texas A&M, Department of Entomology, 2008
 Trinity University, Department of Biology, 2005
 University of Akron, Department of Biology, 2004
 University of Georgia, Institute of Ecology, 2004
 University of Massachusetts-Amherst, Department of Entomology, 2004
 University of Miami, 2008
 University of Missouri-Columbia, Department of Biological Sciences, 2004
 University of Pittsburgh, Department of Biology, 2003
 University of Tennessee, Ecology and Evolutionary Biology, 2005
 University of Toronto, Department of Botany, 2003
 Wright State University, Department of Biology, 2004

PRESENTATIONS

Afkhami, M. E. and J. A. Rudgers (2007) Imperfect vertical transmission of fungal endophytes in native grass species. Ecological Society of America (5-10 August 2007) San Jose, CA
 Emery, S.M. J. A. Rudgers and D. Thompson. (2007) Do fungal mutualists alter dominance and invasibility of dune plant communities? Ecological Society of America (5-10 August 2007) San Jose, CA
 Rua, M.A., A. Savage, J. A. Rudgers. (2007) An ant-plant mutualism alters local arthropod community composition. Ecological Society of America (5-10 August 2007) San Jose, CA
 Rudgers, J. A. (2007) Small mutualists with big impacts: community and ecosystem-level consequences of pair-wise mutualisms between fungal endophytes and grasses. Symposium 18 – Yin and Yang: The combined influences of positive and negative interactions in ecological communities. Ecological Society of America (5-10 August 2007) San Jose, CA
 Rudgers, J. A. and K. Clay (2006) Fungal endophyte genotype affects plant and insect community structure. Ecological Society of America (6-11 August 2006) Memphis, TN.

PROFESSIONAL SERVICE

Manuscripts reviewed total = 100.

Acta Oecologia, American Journal of Botany, American Midland Naturalist, American Naturalist, Annals of Botany, Australian Journal of Botany, Behavioral Ecology, Biochemical Systematics and Ecology, Biological Conservation, Biological Invasions, Ecology, Ecology Letters, Ecoscience, Entomologia Experimentalis et Applicata, Evolution, Functional Ecology, Global Change Biology, Grass and Forage Science, Journal of Applied Entomology, Journal of Chemical Ecology, Journal of Ecology, Journal of Ethology, Journal of Tropical Ecology, Microbial Ecology, Naturwissenschaften, New Phytologist, Oecologia, Oikos, Plant and Soil, Plant Ecology, Proceedings of the Royal Society of London Series B, Restoration Ecology, Symbiosis, Trends in Ecology & Evolution

Nature Conservancy

Invasive Plant Species Assessment Working Group, Indiana. September 2004.

Panelist

National Science Foundation Doctoral Dissertation Improvement Grant Panelist, Ecological Biology Cluster (February 2006)

National Science Foundation Population and Evolutionary Processes Grant Panelist, Division of Environmental Biology (April 2008)

External Grant Reviewer

DOE National Institute for Climatic Change Research (NICCR)
(2006 – one review, 2007 – one review)

National Science Foundation, Ecological Biology Cluster External Reviewer
(2006 – two reviews, 2007 – one review)

National Science Foundation, Plant Genome Research External Reviewer
(2007 – one review)

National Science Foundation, Microbial Interactions and Processes External Reviewer
(2007 – two reviews)

National Science Foundation, CREST External Reviewer
(2007 – one review)

National Science Foundation HBCU-RISE External Reviewer
(2007 – one review)

University of Massachusetts HATCH Grant (2006 – one review)

Book Reviews

Oxford University Press

COMMUNITY OUTREACH AND SERVICE

Lovett College Associate at Rice University

Hermann Park Conservancy, Houston, Texas

Urban Harvest, Houston, Texas

Science Day for the Academy of Classical Education

Rice University Community Garden

International Baccalaureate High School Biology Teachers Workshop (annual workshop leader)

Advanced Placement High School Biology Teachers Workshop (annual workshop leader)

GRADUATE STUDENT ADVISEES

Amy Savage (PhD – co-advised with Dr. Kenneth Whitney 2005 -)

Kerri Crawford (PhD - 2006 -)

Michelle Afkhami (MS - completed August 2007: Symbiosis Lost: Imperfect vertical transmission of fungal endophytes in grasses) *currently* - PhD student, University of California-Davis
Andrew J. Davitt (PhD - 2007 -)

AWARDS RECEIVED BY MY STUDENTS:

Howard Hughes Medical Institute Capstone Undergraduate Research Award (Indiana University)

Alisha Lemons (2004)

Sam Orr (2003)

Rice University Presidential Fellowship

Kerri Crawford (2006-2011)

Houston Rodeo Scholarship

Michelle Afkhami (2006-2007)

National Science Foundation Graduate Research Fellowship

Kerri Crawford (2006 – honorable mention)

Kerri Crawford (2007-2010)

Michelle Afkhami (2007-2010)

Garden Club of America Fellowship in Ecological Restoration

Kerri Crawford (2007, \$8,000)

Redwood Creek Preservation Award

Kerri Crawford (2007, \$3,000)

Sigma-Xi Grants-in-Aid of Research

Amy Savage (2007, \$400)

KERRI MARGARET CRAWFORD

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EDUCATION

Rice University
Department of Ecology and Evolutionary Biology
Ph.D. Student
Degree Expected: May 2011

University of Tennessee – Knoxville
University Honors Student, *Summa cum Laude*
B.S. in Ecology and Evolutionary Biology, Honors
Graduated: May 2006 Cumulative GPA: 3.99

RESEARCH GRANTS, FELLOWSHIPS, & AWARDS

National Science Foundation Graduate Research Fellowship 2007-2010 (\$91,000)
Redwood Creek Preservation Award 2007-2008 (\$3,000)
Garden Club of America Fellowship in Ecological Restoration 2007-2008 (\$8,000)
Rice University Presidential Fellowship 2006 – 2010 (\$20,000)
Travel Grants, Rice University 2007 (\$700)
Travel Grant, EEB Rice University 2007 (\$100)
Travel Grant, Gordon Research Conference in Plant-Herbivore Interactions 2007 (\$500)
National Science Foundation Graduate Research Fellowship 2006 (Honorable Mention)
Higher Education Research Experience at Oak Ridge National Laboratory 2005-2006 (\$7,000)
Elected Phi Beta Kappa 2004

PUBLICATIONS

Crawford, K.M., G.M. Crutsinger and N.J. Sanders. (2007) Host-plant genotypic diversity mediates the distribution of an ecosystem engineer. **Ecology** 88(8): 2114-2120.

Rudgers, J.A., K.M. Crawford, S.C. Wooley. (*in prep*) Microbial mediation of terrestrial food webs.

PRESENTATIONS

Crawford, K.M. (2008) Understanding the combined importance of species diversity and genetic diversity for the restoration of sand dune ecosystems. **Western Great Lakes Research Conference**. 1-2 April: Marquette, MI.

Crawford, K.M., P. Thompson, and K.D. Whitney. (2007) POSTER: Genetic diversity and invasion success: Testing hypotheses with a model system. ESA. 7 August: San Jose, CA.

Castro-Gonzalez, H.F., E.E. Austin, K.M. Crawford, A.T. Classen, R.J. Norby, and C.W. Schadt. (2007) Toward approaches for disentangling root from microbial contributions to total soil respiration measurements using molecular genetic approaches. ESA. 10 August: San Jose, CA.

Castro, H.F., E.E. Austin, K.M. Crawford, A.T. Classen, R.J. Norby, and C.W. Schadt. (2007) POSTER: Interpreting changes in microbial communities in a multifactor world: Interactive effects of atmospheric carbon dioxide and surface temperature. ASM. 22 May: Toronto, ON.

Crawford, K.M., G.M. Crutsinger, and N.J. Sanders. (2007) POSTER: Host-plant genotypic diversity alters community composition by mediating the distribution of an ecosystem engineer. Gordon Conference on Plant-Herbivore Interactions. 18 February: Ventura, CA.

Crawford, K.M., G.M. Crutsinger and N.J. Sanders. (2005) The causes and consequences of galling by the goldenrod bunch gall midge, *Rhopalomyia solidaginis*. Southern Appalachian Conference on Arthropod Biology. 24 September: Asheville, NC.

Crutsinger G.M., Crawford K.M., Sanders N.J. (2005) The effects of intraspecific genetic diversity in plants on associated insect communities. Southern Appalachian Arthropod Biology Conference. 24 September: Asheville, NC.

RESEARCH EXPERIENCE

Rice University, Houston, TX

2007: *Herbivore responses to N-fixing bacteria.*

In collaboration with Michelle Afkhami, I am setting up an experiment that manipulates the presence of a symbiotic bacteria with the native Texan Bluebonnet to determine how this mutualism influences above-ground herbivory.

2006: *The influence of genetic diversity on invasion success.*

I am currently collaborating with Dr. Ken Whitney on an experiment that manipulates the amount of population-level genetic diversity in *Arabidopsis thaliana* to determine if increased genetic diversity improves colonization success in new habitats.

Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN

2006: *Disentangling contributions to soil respiration.*

As a research intern under Drs. Chris Schadt and Hector Castro-Gonzalez at Oak Ridge National Laboratory (ORNL), I assisted with a tool-building ecosystem genomics project that sought to disentangle the relative contribution of plants, fungi, and bacteria to soil respiration using transcribed DNA collected from soil samples.

2005: *Ecosystem responses to climate change.*

As a research intern, I helped address the ecosystem-level effects of climate change at ORNL with Drs. Aimee Classen and Richard Norby. Specifically, I assisted with a project that monitored the interactive effects of climate change on above- and below-ground processes in an old field ecosystem.

The University of Tennessee, Knoxville, TN

2006: *Latitudinal gradient of herbivory and gall-formation on *Solidago altissima*.*

I collaborated with Greg Crutsinger to develop and implement a study that examined variation in herbivory and gall-formation on *Solidago altissima* along a latitudinal gradient from Florida to Maine.

2005: *Genetic diversity mediates the distribution of an ecosystem engineer.*

For my senior honors thesis, I developed a project that used both observation and experimental techniques to answer two interrelated questions: (i) Is the goldenrod bunch gall midge (*Rhopalomyia solidaginis*) and ecosystem engineer? (ii) What factors influence the distribution of galls produced by the midge?

2005: *Effects of genetic diversity on community diversity and productivity.*

As a research assistant, I worked with Dr. Nathan Sanders and Greg Crutsinger. This project studied how the genetic identity and population-level genetic diversity of tall goldenrod (*Solidago altissima*) influenced primary productivity and the species diversity of associated arthropod communities.

2002: *Indirect genetic effects.*

As a research assistant with Dr. Jason Wolf, I assisted with a project which explored how indirect genetic effects between genotypes of *Brassica* are phenotypically displayed.

MENTORING & TEACHING EXPERIENCE

2008: Teaching Assistant – Plant Diversity, Rice University

Currently, I assist a class of approximately 25 students. I help prepare lecture and laboratory materials and lead group discussions.

2007: Teaching Assistant – Insect Biology, Rice University

I served as a teaching assistant for a class of approximately 15 students that surveys insect diversity and ecology. I helped prepare lecture and laboratory materials, led group discussions and review sessions, and assisted the students in preparing and maintaining insect collections.

2007 - 2008: Undergraduate Independent Study, Rice University

Currently, I have mentored six students (three past, three current) participating in independent research. I am assisting them with experimental design, data analysis, and helping them design posters for an annual undergraduate research exhibition at the university. I will also help them prepare manuscripts for submission to peer-reviewed journals.

2006: SECME Program at ORNL

SECME is a pre-college program that prepares and motivates students, especially underrepresented students, to enter and complete post-secondary studies in science, mathematics, engineering and technology. I helped one student develop her own project and present her results at an annual meeting.

2004-2006: University Honors Program Peer Mentor, University of Tennessee

Peer mentors assist first-year students in the University Honors Program in their transition to college by advising them on classes, extracurricular activities, and introducing them to the Knoxville community. I mentored four students over two academic years.

PROFESSIONAL SOCIETIES

Ecological Society of America

SUPPORTING DOCUMENTATION AND SPECIAL CONCERNS

Safety

No plans involve hazardous activities.

Access to study sites

Field sites will be accessed by car and hiking and will be visited frequently during the fieldwork period to conduct surveys and observations. No vegetation will be disturbed or trampled.

Use of mechanized and other equipment

No mechanized equipment will be used.

Chemical use

No chemicals will be used.

Ground disturbance

The ground will not be disturbed.

Animal welfare

No vertebrates will be used.

NPS assistance

Assistance will be required to determine appropriate sites for collection and observation.

Wilderness “minimum requirement” protocols

Collections may be conducted in wilderness areas. This will be discussed with park Research Coordinators and protocols will be determined at that time if research will be conducted in wilderness areas.