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Sexual selection in a changing world: How human-induced environmental change affects sexual selection and consequently the health of populations

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I. Project Description: Sexual selection in a changing world: How human-induced environmental change affects sexual selection and consequently the health of populations

Project Background

Sexual selection, i.e. differential mating success due differences among individuals in traits that are used for mating, is a powerful evolutionary force that is responsible for some of the most striking traits that we see in nature (Andersson 1994). This form of selection can occur by way of three mechanisms. Mate competition, typically male-male competition, is responsible for much of the weaponry we see in nature (e.g., antlers and horns, large jaws, spurs in fowl). Mate choice, typically it is the females that are doing the choosing, is responsible for many of the ornamental traits in nature (e.g., elaborate calls of frogs and birds, showy plumage in birds, elaborate courtship dances). Besides these two “standard” mechanisms of sexual selection, a third mechanism, sexual conflict, has received much attention in the recent literature. Here, males that are successful at mating are better at deceiving females or overcoming female resistance to mating (Arnqvist & Rowe 2005).

The field of sexual selection is one of the most theory-rich subjects in evolutionary ecology and many of the predictions from models have been tested in a variety of organisms (Kokko et al. 2006). However, the population-level consequences of sexual selection is one area that has not received much empirical attention. Theory predicts that whether sexual selection is good or bad for a population will depend on the mechanism of sexual selection operating in a population (Kokko & Rankin 2006; Kokko and Jennions 2014; Fricke et al. 2009). For example, female choice could potentially increase the health of a population by weeding out poor-quality males that would otherwise decrease the productivity of females. On the other hand, sexual conflict is predicted to decrease the health of populations, because females incur costs from interacting with manipulative males. In fact, some models of sexual conflict predict that this evolutionary process can cause populations to go extinct (Kokko & Rankin 2006).

We will explore the population-level consequences of sexual selection in amphipods in the genus *Hyalella* (small crustaceans) that live in natural lakes in NW Pennsylvania. The first step in tackling this overarching research aim is to assess patterns of sexual selection in the field. Using laboratory studies, we have identified a number of mating traits that will be the focus of our research (Cothran 2008; Cothran et al. 2010). Interestingly, the mating traits we have identified are also extremely sensitive to changes in nutrient availability, which suggest human-induced changes in nutrient loading to aquatic systems may affect sexual selection (Cothran & Jeyasingh 2010; Cothran et al. 2012; Cothran et al. 2014). The

work completed as part of this proposal will be used to develop a Career Grant that will be submitted to the NSF. If funded, this grant would launch further work by the PI and his students at PLE.

Project Methods and Predicted Results

We will assess patterns of sexual selection by collecting mating pairs and single individuals and using regression-based techniques to quantify which traits are important in determining male mating success. The work will be done at 9 natural lakes in NW Pennsylvania. PLE provides a perfect research base for investigating the ecology of these lakes that are found in Crawford and surrounding counties. These lakes all contain populations of *Hyalella* amphipods and have spring total P values that range from 13 ug/L to 48 ug/L, which includes P concentrations indicative of relatively pristine and highly eutrophic lakes (Butkas & Ostrofsky 2006; Wetzl 2001). We will also collect samples of lake water and attached algae (i.e. amphipod food) to assess whether differences in the nutritional quality of the algae the amphipods are eating.

We predict that males will have larger sexual traits and there will be less variation among males in these traits in lakes with higher spring total P availability. Sexual selection will be weaker in these amphipod populations because there is less variation among males for selection to act on. This work will provide valuable information on how cultural eutrophication affects the evolutionary ecology of natural populations.

Results from our field study will be used to develop a proposal for external funding from NSF to explore how changing nutrient availability affects sexual selection from an elemental perspective. Our plan is to assess both the environmental supply of biologically important elements and the demand for these elements in different traits. We predict that sexually selected traits will be composed primarily of elements that are in short supply in the environment making their acquisition and assimilation indicators of the quality of individuals. This research proposal will fill gaps in our knowledge about how human-induced changes in the environment affect traits that are extremely sensitive to changes in the environment and the evolutionary implications of these changes for natural populations.

Literature Cited

- Andersson, M. B. (1994). *Sexual Selection*. Princeton University Press.
- Arnqvist, G., & Rowe, L. (2005). *Sexual Conflict: (Monographs in Behavior and Ecology)*. Princeton University Press.
- Butkas K, Ostrofsky M (2006) The status of unionid and dreissenid mussels (Bivalvia) in northwestern Pennsylvania inland lakes. *Nautilus-Sanibel* 120:106–111.
- Cothran, R. D. (2008). The mechanistic basis of a large male mating advantage in two freshwater amphipod species. *Ethology*, 114(12), 1145–1153.

- Cothran, R. D., & Jeyasingh, P. D. (2010). Condition dependence of a sexually selected trait in a crustacean species complex: importance of the ecological context. *Evolution*, 64(9), 2535–2546.
- Cothran, R. D., Kuzmic, A., Wellborn, G. A., & Relyea, R. A. (2010). Phenotypic manipulation provides insights into the function of a sexually selected trait in a freshwater crustacean species complex. *Animal Behaviour*, 80(3), 543–549.
- Cothran, R. D., Stiff, A. R., Jeyasingh, P. D., & Relyea, R. A. (2012). Eutrophication and predation risk interact to affect sexual trait expression and mating success. *Evolution*, 66(3), 708–719.
- Cothran, R. D., Stoler, A. B., & Relyea, R. A. (2014). Leaves and litterbugs: how litter quality affects amphipod life-history and sexually selected traits. *Freshwater Science*, 33(3), 812–819.
- Fricke C, Perry J, Chapman T, Rowe L (2009) The conditional economics of sexual conflict. *Biology Lett* 5:671–674. doi: 10.1098/rsbl.2009.0433
- Kokko, H., & Rankin, D. J. (2006). Lonely hearts or sex in the city? Density-dependent effects in mating systems. *Philosophical Transactions of the Royal Society B-Biological Sciences*, 361(1466), 319–334.
- Kokko, H., Jennions, M., & Brooks, R. (2006). Unifying and testing models of sexual selection. *Annual Review of Ecology Evolution and Systematics*, 37, 43–66.
- Kokko H, Jennions MD (2014) The relationship between sexual selection and sexual conflict. *Cold Spring Harbor Perspectives in Biology* 6:a017517. doi: 10.1101/cshperspect.a017517
- Wetzel, R. G. (2001) *Limnology: lake and river ecosystems*. Academic Press, San Diego, CA.

II. Timeline of Research

We will arrive at PLE around June 15 and depart around July 31. While at the field station, it would be nice to have access to some lab space to process samples and do short-term behavioral and life history experiments with the amphipods that we are studying. The Farm Lab would provide perfect accommodations for this research.

III. Budget

Item	Description	Cost
Student wages		
Wages	2 students @ \$10/hr for 6 weeks	\$4800
Fringe	7.7% of student wages	\$369
Student lodging	2 students for 42 days @ \$9/day	\$756
Travel		
Car rental	car for field work 1.5 months	\$2000
Mileage	3000 miles at \$0.54/mile	\$1620
Supplies for field work	jars, ethanol, pipettes, nets, etc..	\$455
	Total	\$10000

- I. Student wages: I will pay two students \$10 an hour for 40 hours for six weeks. Fringe benefits are applied at 7.7% of wages.
- II. Lodging for students: I will have two students assisting me with the research. If possible, I would like for them to stay in the Bald Eagle Dorm.
- III. Travel: We will rent a car to do field work for 1.5 months at an estimated cost of \$2000. I have also budgeted \$1620 for mileage (\$0.54 per mile for 3000 miles).
- IV. Supplies for field work: We will need jars, ethanol, disposable pipettes, trays, nets, tape for labelling jars, microcentrifuge tubes for pairs collected, 50-ml tubes for water and algae samples, rite-in-rain paper for labels, and field notebooks.

Rickey D. Cothran
Updated 27 January 2016

Current Position

Assistant Professor
Department of Biological Sciences
Southwestern Oklahoma State University
<http://rdcothran.wix.com/hyalella>

Academic Positions

2014 to present: Assistant Professor, Southwestern Oklahoma State University, Department of Biological Sciences

2012 to 2014: Research Associate, University of Pittsburgh, Department of Biological Sciences.

2008 to 2012: Postdoctoral Fellow, University of Pittsburgh, Department of Biological Sciences.

Education

Ph.D. Zoology: December 2007, University of Oklahoma

Thesis: Ecological context and the evolution of mating biases in a freshwater amphipod species complex. Major Advisor: Dr. Gary A. Wellborn.

M.S. Zoology: May 2002, University of Oklahoma

Thesis: Precopulatory mate guarding affects predation risk in two freshwater amphipod species: Implications for the operation of sexual selection and intersexual conflict. Major Advisor: Dr. Gary A. Wellborn.

B.S. Zoology: May 1999, University of Oklahoma

Publications

* *Undergraduate or high school teacher*

33. Goos J.M., **R. D. Cothran**, P. D. Jeyasingh. In press. Sex-specific nutrient use and preferential allocation of resources to a sexually selected trait in *Hyalella* amphipods. **Journal of Experimental Biology**.
32. Bradley, P. W., S. S. Gervasi, J. Hua, **R. D. Cothran**, R. A. Relyea, D. O. Olson, A. R. Blaustein. 2015. Differences in sensitivity to the fungal pathogen *Batrachochytrium dendrobatidis* among amphibian populations. **Conservation Biology** 29, 1347-1356.
31. Hua, J., D. K. Jones, B. M. Mattes, **R. D. Cothran**, R. A. Relyea J. T. Hoverman. 2015. Evolved pesticide tolerance in amphibians: Predicting mechanisms based on pesticide novelty and mode of action. **Environmental Pollution** 206, 56-63.
30. Hua, J., D. K. Jones, B. M. Mattes, **R. D. Cothran**, R. A. Relyea, J. T. Hoverman. 2015. The contribution of phenotypic plasticity to the evolution of insecticide tolerance in amphibian populations. In press at **Evolutionary Applications** 8, 586-596.
29. Snell-Rood, E., **R. D. Cothran**, A. Espeset, S. Hobbie, P. D. Jeyasingh, N. I. Morehouse. 2015. Life history evolution in the anthropocene: effects of increasing nutrients on traits and tradeoffs. **Evolutionary Applications** 8, 635-649.

28. Cothran, R. D., B. J. French*, and R. A. Relyea. 2015. An assessment of putative sexually antagonistic traits in a freshwater amphipod species. **Ethology** 121, 740-748.
27. Cothran, R. D. 2015. The importance of reproductive interference in ecology and evolution: from organisms to communities. **Population Ecology** 57, 339-341.
26. Cothran, R. D., P. Noyes*, R. A. Relyea. 2015. An empirical test of stable coexistence in an amphipod species complex. **Oecologia** 178, 819-831.
25. Cothran RD, S. S. Gervasi, C. Murray*, B. J. French*, P. W. Bradley, J. Urbina, A. R. Blaustein, R. A. Relyea 2015. Carotenoids and amphibians: effects on life history and susceptibility to the infectious pathogen, *Batrachochytrium dendrobatidis*. **Conservation Physiology** 3: doi:10.1093/conphys/cov005.
24. Cothran, R. D. A. B. Stoler, R. A. Relyea. 2014. Leaves and litterbugs: How litter quality affects amphipod life history and sexually selected traits. **Freshwater Science** 33, 812-819.
23. Wellborn, G. A., J. D. S. Witt, R. D. Cothran. 2014. Chapter 31. Class Malacostraca, Superorders Peracarida and Syncarida. In J. Thorp, C. Rogers, and K. Tockner, editors. Thorp and Covich's Freshwater Invertebrates, Volume 1: Ecology and General Biology. To be published by Elsevier.
22. Hoverman, J. T., R. D. Cothran, R. A. Relyea. 2014. Generalist versus specialist strategies of plasticity: snail responses to predators that have different foraging modes. **Freshwater Biology** 59, 1101-1112.
21. Goos, J. M., R. D. Cothran, P. D. Jeyasingh. 2014. Subtle variation in phosphorus availability influences mating biology in *Hyalella* (Amphipoda: Hyalellidae) amphipods. **Biological Journal of the Linnean Society** 111, 878-888.
20. Jeyasingh, P. D., R. D. Cothran, M. Tobler. 2014. Testing the ecological consequences of evolutionary change using elements. **Ecology and Evolution** 4, 528-538.
19. Goos, J. M., B. J. French*, R. A. Relyea, R. D. Cothran, and P. D. Jeyasingh. 2014. Sex-specific variation in somatic phosphorus content of two freshwater amphipod species. **Hydrobiologia** 722, 93-102.
18. Cothran, R. D., A. R. Stiff*, K. Chapman*, G. A. Wellborn and R. A. Relyea. 2013. Reproductive interference via interspecific pairing in an amphipod species complex. **Behavioral Ecology and Sociobiology** 67, 1357-1367.
17. Cothran, R. D., K. A. Henderson*, D. Schmidenberg*, and R. A. Relyea. 2013. Phenotypically similar but ecologically distinct: Differences in competitive ability and predation risk among amphipods. **Oikos** 122, 1429-1440.
16. Cothran, R. D., J. M. Brown*, and R. A. Relyea. 2013. Proximity to agriculture is correlated with pesticide tolerance: evidence for the evolution of amphibian resistance to modern pesticides **Evolutionary Applications** 6, 832-841.
15. Hua, J., R. D. Cothran, A. B. Stoler, R. A. Relyea. 2013. Cross resistance in amphibians: Wood frog (*Lithobates sylvatica*) mortality when exposed to three insecticides with a common mode of action. **Environmental Toxicology and Chemistry** 32, 932-936.
14. Cothran, R. D., K. Chapman*, A. R. Stiff*, and R. A. Relyea. 2012. "Cryptic" direct benefits of mate choice: choosy females experience reduced predation risk. **Behavioral Ecology and Sociobiology** 66, 905-913.
13. Cothran, R. D., A. R. Stiff*, P. D. Jeyasingh, and R. A. Relyea. 2012. Eutrophication and predation risk affect sexual trait expression and mating success. **Evolution** 66, 708-719.

12. **Cothran, R. D.**, F. Radarian*, and R. A. Relyea. 2011. Altering aquatic food webs with a global insecticide: arthropod-amphibian links in aquatic communities. **Journal of the North American Benthological Society** 30, 893-912.
11. **Cothran, R. D.**, P. D. Jeyasingh. 2010. Condition dependence of a sexually selected trait in a crustacean species complex: importance of the ecological context. **Evolution** 64, 2523-2546.
10. **Cothran, R. D.**, A. Kuzmic*, G. A. Wellborn, and R. A. Relyea. 2010. Phenotypic manipulation provides insights into the evolution a sexually selected trait in a crustacean species complex. **Animal Behaviour** 80, 543-549.
9. **Cothran, R. D.**, R. Greco*, R. A. Relyea. 2010. No evidence that a common pesticide affects female mate choice in a freshwater crustacean. **Environmental Toxicology** 25: 310-314.
8. **Cothran, R. D.** 2008. Direct and indirect fitness consequences of mate choice in a crustacean. **Evolution** 62, 1666-1675.
7. **Cothran, R. D.** 2008. Phenotypic manipulation reveals sexual conflict over precopula duration. **Behavioral Ecology and Sociobiology** 62 1409-1416.
6. **Cothran, R. D.** 2008. The mechanistic basis of a large male mating advantage in two freshwater amphipod species. **Ethology** 114 1145-1153.
5. Wellborn, G. A., **R. D. Cothran**. 2007. Evolution and ecology of mating behavior in freshwater amphipods. In E. Duffy and M. Thiel, editors. *Evolutionary ecology of social and sexual systems: crustaceans as model organisms*. Cambridge University Press.
4. Wellborn, G. A., **R. D. Cothran**. 2007. Niche diversity in crustacean cryptic species: complementarity in spatial distribution and predation risk. **Oecologia**, 154, 175-183.
3. Wellborn, G. A., **R. Cothran**, S. Bartholf. 2005. Life history and diversification in regional ecomorphs of the *Hyalella azteca* species complex. **Biological Journal of the Linnean Society** 84, 161-175.
2. **Cothran, R. D.** 2004. Precopulatory mate guarding increases predation risk for two freshwater amphipod species. **Animal Behaviour** 68, 1133-1138.
1. Wellborn G. A., **R. D. Cothran**. 2004. Analysis of phenotypic similarity and differentiation among sympatric cryptic species in an amphipod species complex: implications for coexistence and evolution of phenotypic similarity. **Freshwater Biology** 49, 1-13.

In review/revision

- Goos, J. M., **R. D. Cothran**, P. D. Jeyasingh. The material basis of sexual dimorphism: age- and sex-dependent nutrient use strategies in response to phosphorus availability. In review at *Journal of Experimental Biology*.

Grants

Received

- 2015 Southwestern Oklahoma State University, College of Arts & Science Research Grant, "Population-level consequences of sexual selection," \$2,000
- Proposal Development Award— Southwestern Oklahoma State University, "Putting sexual conflict in an ecological context: How phosphorus availability affects sexual conflict in a freshwater amphipod," \$6,000

- 2014 Southwestern Oklahoma State University, College of Arts & Science Research Grant, "Population-level consequences of sexual selection," \$2,000
- 2009 McKinley Grant, Pymatuning Laboratory of Ecology, "Reproductive interference in a freshwater amphipod species complex," \$2,660
- 2006 Crustacean Society Student Research Grant, \$1,000; Research Grant, University of Oklahoma, Graduate Student Senate, \$250
- 2005 University of Oklahoma, Graduate College, Robberson Research Grant, "Ecological context and the evolution of mating biases in two freshwater amphipod species," \$ 1000
- 2004 Theodore Roosevelt Memorial Grant, American Museum of Natural History, "Ecological context and variation in mating biases in a freshwater amphipod species complex," \$ 1200
- 2002 Creativity and Research Grant, University of Oklahoma Graduate Student Senate, \$ 250; Conference and Creative Exhibition Grant, University of Oklahoma, Graduate Student Senate, \$172.55
- 2001 Conference and Creative Exhibition Grant, University of Oklahoma Graduate Student Senate, \$150; Creativity and Research Grant, University of Oklahoma, Graduate Student Senate, \$300

Presentations

Invited seminars

- 2015 *Sexual selection in an ecological context: Insights from amphipods.* Oklahoma State University, Stillwater, Oklahoma
- 2014 *Sexual selection in an ecological context: Insights from amphipods.* Florida Atlantic University, Boca Raton, Florida.
Sexual selection in an ecological context: Insights from amphipods. Southwestern Oklahoma State University, Weatherford, Oklahoma.
- 2013 *Can they all get along? An assessment of the ability of cryptic amphipod species to coexist.* University of Pittsburgh, Pittsburgh, Pennsylvania.
Sexual conflict and sexual selection in an ecological context: Insights from amphipods. Eastern Kentucky University, Richmond, Kentucky.
- 2012 *Sexual conflict and sexual selection in an ecological context: Insights from amphipods.* Oakland University, Rochester, Michigan.
- 2009 *Using amphipods to fill empirical gaps in our understanding of mating biases.* University of Pittsburgh, Pittsburgh, Pennsylvania.
- 2008 *Sexual conflict or harmonious confluence: the evolution of mating traits in a crustacean species complex.* Trent University, Peterborough, Ontario Canada.

Sexual conflict or harmonious confluence: the evolution of mating traits in a crustacean species complex. Slippery Rock University, Slippery Rock, Pennsylvania.

Mechanisms driving variation in mating biases in a freshwater amphipod species complex. University of Pittsburgh, Pymatuning Laboratory of Ecology, Linesville, Pennsylvania.

2007 *Understanding mating biases in a freshwater amphipod species complex.* Sam Houston State University, Huntsville, Texas.

Understanding mating biases in a freshwater amphipod species complex. Department of Zoology Seminar Series, University of Oklahoma, Norman, Oklahoma.

2002 *Interspecific variation in the costliness of precopulatory mate guarding in two freshwater amphipod species.* Department of Zoology Seminar Series, University of Oklahoma, Norman, Oklahoma.

Conference presentations

2016 *The cost of courtship: Effects of male-male competition on harm experienced by females in Hyalella amphipods.* Society of Comparative and Integrative Biology Meeting, Portland, Oregon, presented by Ashna Dhoonmoon (undergraduate researcher).

2015 *The economy of sexual conflict.* Oklahoma Research Day, Tahlequah, Oklahoma.

The cost of courtship: Effects of male-male competition on harm experienced by females in Hyalella amphipods. SWOSU Scholarly Research Fair, Weatherford, OK. Presented by Ashna Dhoonmoon (undergraduate researcher).

Nutrients and nuisances: Environmental diet and its effect on female defense mechanisms. SWOSU Scholarly Research Fair, Weatherford, OK. Presented by Shanna Simmons (undergraduate researcher).

2014 *Turns out males are picky: no evidence for reproductive interference in an amphipod species complex.* Society for Integrative and Comparative Biology Meeting, Austin, Texas.

Integrating genetics, physiology, and ecology to understand the evolution of condition dependent sexual traits: an elemental approach. Society for Integrative and Comparative Biology Meeting, Austin, Texas, presented by Jarred Goos (graduate student at Oklahoma State University).

2011 *Cryptic direct benefits of mate choice: choosy females experience less harassment and reduced predation, but receive no indirect benefits.* Evolution Meeting, Norman, Oklahoma.

2010 *Making the best of a bad situation: the effect of agriculture on the life history traits of amphibian populations.* Ecological Society of America Meeting, Pittsburgh, Pennsylvania, Presented by Jenise Brown (REU student).

Size does matter: the direct benefits of female mate choice in a freshwater crustaceans species complex Ecological Society of America Meeting, Pittsburgh, Pennsylvania, Presented by Kristopher Chapman (RET).

Show me the phosphorus: environmental stressors and tradeoffs between sexual and nonsexual trait development. Ecological Society of America Meeting, Pittsburgh, Pennsylvania, Presented by Andy Stiff (REU student).

- 2009 *Phenotypic manipulation reveals insights into the evolution of a sexually selected trait in a crustacean species complex.* Evolution Meeting, Moscow, Idaho.
- 2008 *Condition dependence of a sexually selected trait in a crustacean.* International Society for Behavioral Ecology Meeting, Ithaca, New York.
- 2007 *Fitness consequences of mate choice in a crustacean.* Animal Behavior Society Meeting, Burlington, Vermont [Distinguished Dissertation Series (Allee Competition)].
- 2006 *Condition dependent expression of a sexually selected trait: what do we mean by resource pool?* Midwest Ecology and Evolution Conference, St. Louis, Missouri.
- Male-male competition does not explain the large male pairing advantage in a freshwater amphipod species.* Behavioral Ecology Conference, University of Oklahoma Biological Station.
- 2003 *Lack of evidence for an energetic cost to mating for a freshwater amphipod species.* Meeting of the Animal Behavior Society, Boise, Idaho.
- 2002 *Diel patterns of precopulatory mate guarding behavior for two amphipod species that experience different types of predators.* Joint meeting the Oklahoma- Texas Aquatic Research Group and Great Plains Limnology Society, University of Oklahoma Biological Station.
- Energetic costs of precopulatory mate guarding in two freshwater amphipod species: evidence from the field.* Annual Meeting of the North American Benthological Society, Pittsburgh, Pennsylvania.
- 2001 *Pre-copulatory mate guarding behavior affects predation risk in two freshwater amphipod species.* Annual Meeting of the North American Benthological Society, La Crosse, Wisconsin.
- 2000 *Mating costs and the evolution of mating behavior in a freshwater amphipod *Hyalella azteca*.* Behavioral Ecology Conference, University of Oklahoma Biological Station.

Honors and Awards

- 2006 1) Blanche and Francis Adams Memorial Scholarship, University of Oklahoma, Department of Zoology; 2) Cornine Price Memorial Scholarship, University of Oklahoma, College of Arts and Sciences
- 2005 1) Blanche and Francis Adams Memorial Scholarship, University of Oklahoma, Department of Zoology
- 2004 1) Graduate Student Senate Graduate Teaching Assistant Award; 2) Cornine Price Memorial Scholarship, University of Oklahoma, College of Arts and Sciences
- 2003 1) University of Oklahoma Office of the Provost Graduate Teaching Award; 2) James Thompson Award for Teaching Excellence, University of Oklahoma, Department of Zoology
- 2002 1) Blanche and Francis Adams Memorial Scholarship, University of Oklahoma, Department of Zoology

Teaching

-
- 2014-present Biological Concepts Lecture and Lab, Principles of Biology I Lab, Invertebrate Biology and Lab, Principles of Biology II Lecture and Lab, Current Issues in Biology.
- 2008-2014 Guest Lecturer, University of Pittsburgh, Department of Biological Sciences, *Animal Behavior*
- 2006-2007 Instructor, University of Oklahoma, Department of Zoology: *Evolution, Animal Behavior*
- 2000-2007 Graduate Teaching Assistant, University of Oklahoma, Department of Zoology: *Invertebrate Zoology Laboratory, Concepts in Biology Laboratory, Introduction to Zoology Laboratory, Field Methods in Ecology, Animal Behavior Laboratory, Human Anatomy Laboratory*

Mentoring Experience

- 2014-present **Sinthia Youmba** (SWOSU) Sinthia is interested in community ecology and is in the beginning phases of developing her project.
- Lindsey Hendricks** (SWOSU) Lindsey is interested in how exposure to multiple contaminants affects species interactions.
- Ashna Dhoonmoon** (SWOSU) Ashna is exploring how different demographic variable affect sexual conflict.
- Shanna Simmons** (SWOSU) Shanna is exploring how diet quality affects female resistance and the outcome of sexual conflict.
- 2014 **Erika Yates** (REU Relyea Lab) explored the interactions between vertebrate and invertebrate detritivores in vernal ponds.
- Jen Antonio** (RET Relyea Lab) investigated how pesticides affect the quality of food consumed by vernal pond animals.
- 2013 **Pat Monahan** (REU Relyea Lab) investigated the effects of condition on infodisruption in a predator-prey relationship.
- 2012 **Beverly French** (REU Relyea Lab) discovered that a male's claws are used to resolve sexual conflict over guarding duration in amphipods.
- Cindy Murray** (RET Relyea Lab) investigated how carotenoid content of amphibian diets mediates their susceptibility to infectious diseases.
- 2011 **Patrick Noyes** (REU Relyea Lab) discovered that cryptic amphipod species are unlikely to stably coexist.
- 2010 **Kristopher Chapman** (RET Relyea Lab) investigated the effects of pesticide breakdown products on aquatic communities.
- Kate Henderson** (REU Relyea Lab) discovered that a combination of predators and competition fosters coexistence in an amphipod species complex.

- Dave Schmidenberg** (REU Relyea Lab) discovered that density plays an important role in determining the intensity of sexual selection and sexual conflict in an amphipod species complex.
- 2009 **Jenise Brown** (REU Relyea Lab) discovered that amphibians exposed to agriculture have higher pesticide tolerance, but pay a cost in terms reduced fitness in pesticide-free environments.
- Kristopher Chapman** (RET Relyea Lab) discovered that direct benefits females gain from choice can be cryptic and play an important role in the evolution of mate choice.
- Andy Stiff** (REU Relyea Lab) discovered that allocation patterns to sexually selected traits are often plastic, which has implications for understanding the evolution of sexually selected traits and unlocking the lek paradox.
- 2008 **Raymond Greco** (RET Relyea Lab) discovered that freshwater amphipods are very sensitive to the most commonly applied pesticide in the US, but that sublethal levels have no effect on female choice.
- Forrest Radarian** (REU Relyea Lab) discovered that sensitivity of invertebrates to pesticides can have far-reaching effects in aquatic communities.

Outreach & Professional Development

- 2015 **BioBlitz 2015.** Led a group of students from SWOSU in surveying the aquatic invertebrates for BioBlitz. This year's BioBlitz was held at Osage Hills State Park near Pawhuska, OK.
- Deer Creek Conservations District Outdoor Classroom.** Assisted with a water quality workshop for elementary school students.
- Tech Trek.** Led a workshop on water quality for middle school girls.
- Gulf Coast Summer Institute.** Five-day workshop to learn techniques to transform undergraduate science education. The workshop is part of the National Academy's Summer Institutes and is funded by the Howard Hughes Medical Institute.
- 2014 **BioBlitz 2014.** Led a group of students from SWOSU in surveying the aquatic invertebrates for BioBlitz. This year's BioBlitz was held in natural areas near the Washita National Battlefield located near Cheyenne, OK.
- 2013 **Instructor, High School Teachers Workshop in Ecotoxicology.** This workshop uses lectures and experiments that can be used in high school classrooms to introduce teachers to cutting-edge research in the field of ecotoxicology. Supported by the HHMI.
- 2011 **Co-instructor, High School Teachers Workshop in Ecotoxicology.** This workshop uses lectures and experiments that can be used in high school classrooms to introduce teachers to cutting-edge research in the field of ecotoxicology. Supported by the HHMI.

- 2010 **Co-instructor, High School Teachers Workshop in Evolution.** This workshop uses lectures and experiments that can be used in high school classrooms to teach evolutionary concepts. Supported by the HHMI.
- Project designer, Science in the Classroom.** This is a joint effort by people in our lab and the University of Pittsburgh's outreach office experiment testing how nutrient availability mediates the costs of phenotypic plasticity. This project is being done in five high school biology classrooms in NW Pennsylvania.
- 2009 **Co-instructor, High School Teachers Workshop in Evolution.** This workshop uses lectures and experiments that can be used in high school classrooms to teach evolutionary concepts. Supported by the HHMI.
- 2008 **Co-instructor, High School Teachers Workshop in Evolution.** This workshop uses lectures and experiments that can be used in high school classrooms to teach evolutionary concepts. Supported by the HHMI.
- 2007 **Research Scientist for the Teacher Workshop Program.** Project title: "Why do males with big guns get all the females? The use of a sexually dimorphic appendage in male-male combat in two freshwater amphipod species. Sponsored by the University of Oklahoma's Sam Nobel Museum of Natural History.
- Project designer for Infusing Inquiry into Elementary School Science (I²ES²).** Project title: Exploring eco-evolutionary questions using *Hyaella* amphipods as model organisms. Sponsored by the University of Oklahoma's Sam Nobel Museum of Natural History.

Professional Service

Service of at Southwestern Oklahoma State University

- 2014- Faculty Advisor for the Biology Club; Faculty Advisor for the Research Excellence Club, STEM Editor for the SWOSU Journal of Undergraduate Research, SWOSU Saturday; Parent's Weekend at SWOSU; Faculty Senate Substitute, Member of the Academic Appeals Committee, Member of the University Research and Scholarly Activity Committee, Supervised SWIM Interscholastic Meet, Promoted SWOSU at the Oklahoma State Fair, Project Blue Thumb, Faculty Organizer for BioBlitz

Service at the University of Oklahoma

- 2000-2004 Faculty Meeting Graduate Student Representative, President of the Zoological Association of Graduate Students, General Seminar Committee, Graduate Student Representative; Steering Committee, Zoological Association of Graduate Students

Membership in Scientific Societies

American Association for the Advancement of Science, Animal Behavior Society, Society for the Study of Evolution, Society of Integrative and Comparative Biology, Tri Beta

Referee for the following journals and agencies

Animal Behaviour, Evolution, Ecology, Ecology Letters, Oecologia, OIKOS, Behavioral Ecology and Sociobiology, Biological Journal of the Linnean Society, Ethology, Journal of Ethology, Acta Ethologica, Ecological Entomology, Hydrobiologia, Diversity, Naturwissenschaften, Environmental Science and Pollution Research, Journal of Zoology, Journal of Herpetology, Journal of Crustacean Biology, PLOS ONE, Journal of Animal Ecology, Limnology and Oceanography, Evolutionary Applications, Herpetologica, NSF IOS (ad hoc), NSF DEB (panel member)