Leanna M. Birge
New Mexico State University
Las Cruces, NM

Creating and maintaining biodiversity: Understanding the dynamics of reproductive isolation

2004 EPA STAR Graduate Fellowship Conference *Next Generation Scientists—Next Opportunities*

Environmental Issue

•The decline of biodiversity is occurring at an alarming rate.

The extinction today is largely due to: human alteration or destruction of habitats, the introduction of alien species, overexploitation of species and natural resources (hunting, fishing, pet trade), human overpopulation, the spread of agriculture,and pollution. Extinction is accelerating. The decline in numbers and sizes of populations is reducing genetic variation and mate selection.

•"Death is one thing, an end to birth is something else." –Michael Soule

Biodiversity is the result of two processes: extinction and speciation. While understanding extinction is of critical importance in preserving biodiversity, it is only half of the story. In order to manage biodiversity, it is critical that we not only slow extinction rates but also understand the processes that produce biodiversity.

•Every effort should be made to understand traits that result in reproductive isolation between populations

Questions regarding physiological or behavioral characters that may result in reproductive isolation between populations are of particular interest. Interest in traits that reproductively isolate is concordant with the biological species concept. It is not only important to know what the isolating characters are, but what forces drive divergence of these isolating characters, and how many and what kinds of genes control variation in these characters early in divergence.

Photograph of male, Lake County, Tennessee, by T. J. Walker, University of Florida.

Scientific Approach

•Hypothesis:

What role, if any, does sperm precedence have on reproductive isolation at the intraspecific level between geographically isolated populations of the stripe ground cricket, *Allonemobius*?

•Research Plan:

System

-*Allonemobius fasciatus* (Orthoptera: Gryllidae) and *A. socius* are sister taxa that exhibit genetic divergence. Reproductive isolation is present between these two species, but it is not complete. Over the last 13 years, the Howard lab has demonstrated that this isolation is due to conspecific sperm precedence[1]. Since *A. socius* and *A. fasciatus* are isolated by only one identifiable character, CSP; they make ideal study organisms for examining the relationship between geographic distance, genetic divergence, and sperm precedence within a species.

Genetic Divergence and Geographic Distance

-*Allonemobius* populations of varying geographic distance will be mated to each other and patterns of sperm precedence will be measured. This will allow me to assess the relationship between genetic divergence and hetero-population advantage or con-population advantage. Analysis of paternity will utilize microsatellites.

-I will undertake a phylogeographic analysis of the populations for each species using 12S, 16S, and COII.

-Develop genetic markers: development of microsatellites as well as 12S, 16S and COII. These markers will quantify that geographic distance is a sufficient proxy for genetic distance. Thirty microsatellite loci and primer sequences for 12S, 16S, and COII have been identified.

Sperm Precedence

-Five allopatric populations of nymphs will be collected for *Allonemobus fasciatus and A. socius.*

Literature Cited:
[1] Howard, D. J. 1999. Conspecific sperm and pollen precedence and speciation. Annual Review of Ecology and Systematics 30:109-132; Gregory, P. G. and D. J. Howard. 1994. A post-insemination barrier to fertilization isolates two closely related ground crickets. Evolution 48(3):705-710.
[2] Caro, T. 1998. Behavioral Ecology and Conservation Biology. Oxford Univ. Press, NY; Wedekind, C. 2002. Sexual selection and life-history decisions: implications for supportive breeding and the management of captive populations. Conservation Biology 16(5):1204-1211.

-Each trial will consist of one virgin female mated to two virgin males as follows: (A) female mated to two con-population males, (B) female mated with a con-population male then a hetero-population male, (C) female mated with a hetero-population male then a con-population male, and (D) female mated to two hetero-population males..

Impact

•Biodiversity is a balance between extinction and speciation rates

It has become apparent that elements of sexual selection may maintain and even create species boundaries. This helps to maintain speciation rates. One of the best-studied examples of this is the Hawaiian *Drosophila*.

•Effective population size

Sperm competition, one mechanism that drives sexual selection, impacts extinction rates by influencing effective population size and captive breeding programs. Intense mate competition will skew the operational sex ratio and change effective population sizes. Females may mate multiply causing sperm competition as a mechanism to ensure fertilization with well-provisioned sperm or to obtain extra resources such as parental care or nourishment. Knowledge of these processes needs to be taken into account when planning a management strategy for endangered species[2]. Current theory also suggests that sexual conflict will be stronger in larger populations than in smaller populations

•Captive breeding and Reintroduction

Sperm competition also has implications for conservation topics such as captive breeding and reintroduction. If endangered species are bred without consideration for forces such as sperm competition, these elements of their behavior may be lost. If lost upon reintroduction to the wild, the species may be introgressed to extinction reducing biodiversity.

This fellow is sponsored by EPA's STAR or Greater Research Opportunities (GRO) Program.