Evolution of Breeding Systems in Cordia-Project Summary

This research explores the evolution of breeding systems and reproductive strategies in the flowering plant genus *Cordia* in the context of a rapidly changing environment. Breeding systems are a keystone feature of the life history strategies of a plant. They are known to be diverse and mutable. In flowering plants, many breeding strategies are also inextricably integrated with, and dependent upon, associations with animals as pollination vectors. Accordingly, the diverse array of plant breeding systems is thought to be differentially sensitive to environmental stresses that may impinge upon the associated fauna. Two breeding systems that are particularly noteworthy are distyly and dioecy. Distyly, with self incompatible (SIC) hermaphroditic individuals of two types has evolved multiple times in flowering plants. Mating of the two types of individuals, (those with long styles and short stamens (pin) and those with short styles and long stamens (thrum)), is generally restricted to crosses between types. Dioecious species, on the Other hand, have separate male and female (unisexual) individuals. There are many examples of closely related species (*Cordia* spp. is one) that possess these alternative breeding strategies. Indeed, it has been repeatedly suggested that dioecy has evolved from distyly. Yet neither genetic tests nor ecological studies have been made to confirm, or refute, the possibility of this evolutionary pathway. This research will simultaneously examine the likelihood and genetic basis of breeding system shifts and characterize the sensitivity of these breeding and associated pollination systems to habitat loss and degradation in dry tropical forests of Costa Rica.

The work is founded on three major objectives. The first is to characterize the evolutionary relationship of distyly and dioecy. The second is to test potential factors that may have driven breeding system changes. The third is to assess the sensitivity of these breeding systems and pollination mechanisms to major landscape changes that include massive deforestation and forest degradation. Molecular phylogenetic approaches are used to identify the frequency of breeding system shifts. DNA markers will be targeted to regions linked to sex determining genes in dioecious species and to flower morphology (pin and thrum) in distylous species. These markers will be utilized to characterize the genetic basis of each breeding system, the likelihood of a common origin and the specific steps that lead to changes. For objective two, field studies involving controlled crosses, estimates of outcrossing rates, quantification of reproductive success and documentation of pollinator abundance, diversity and behaviors will be used to test whether a breakdown of the SIC system or unidirectional pollen transfer may have contributed to the evolution of dioecy. Finally, the reproductive parameters quantified in the previous sections will be overlaid on the historical records of landscape changes and current population structures to assess the impact of forest degradation on the evolutionary dynamics of breeding systems and on different breeding systems and pollination mechanisms.

These studies combine molecular, ecological and landscape level approaches to make inferences about evolutionary pathways and species sensitivities. These data will impact both evolutionary thinking and conservation biology. The research will also impact human resource development because of the strong commitment of the PIs to provide educational opportunities to women and under-represented minorities. Several undergraduates will participate in these continuing projects, largely through other sources of funds including our summer Research Experience for Undergraduates (REU) programs, McNair fellowships and Undergraduate Mentoring in Environmental Biology (UMEB). In addition the project will involve graduate students and post doctoral associates.