

## Woods Proposal Summary

Plant-eating insects make up over one quarter of all macroscopic organisms, and the plants they eat another quarter. A primary challenge in understanding their interactions has been to identify factors influencing which insects occur on which plants and, secondarily, where insects occur within individual plants. A rich set of studies now suggests that di- and tri-trophic interactions are profoundly important. Remarkably, almost no work has examined the biophysical context in which these interactions occur. The proposed studies examine, in mechanistic detail, a set of questions about how leaf physical microenvironments structure insect-plant associations. In particular: (1) How strongly do host plants filter macroclimates into leaf microclimates? (2) To what extent do oviposition and larval feeding induce changes in plant physiology that subsequently alter leaf microclimates? (3) Do females choose oviposition sites with particularly suitable microclimates for eggs and larvae? Are female choices dependent on local ambient temperature and relative humidity? (4) How do leaf microclimates affect survival and development times of eggs and quality of hatchling larvae? (5) And does the effectiveness of two plant defenses, secondary compounds and trichomes, depend on leaf microclimate?

The application of environmental biophysics to the study of plant-insect interactions will illuminate several basic questions, such as how interaction strengths vary with latitude or biome, how seasonal weather patterns shape pressures on plants and herbivores, and the relative utility of different evolutionary solutions to interactions occurring in different places. This work will also serve as a platform for understanding effects of global climate change on insect herbivores. Climate change will include increasing air temperature and changes in local precipitation; how such macro-environmental changes will translate into insect-relevant microenvironments is far from obvious.

The work will be carried out in the context of a new, educational initiative at the University of Montana—the **Montana Program on Insects in the Environment**, or **M-PIE**, to be created and supported by funds from this proposal. Building on the University of Montana's strong commitment to undergraduate research (embodied in multiple current NSF-funded programs), M-PIE will initially focus on three areas. First, the PI will create and teach an upper-division undergraduate class on the environmental biophysics of plant-insect interactions, designed for  $\leq 10$  juniors. This yearly class will prepare students to be active collaborators in all project facets, including design and execution of field and laboratory experiments and design, testing, and deployment of sensor and data logging technology. Two students each year will be supported for a 2-month intensive research experience in the field. In addition, exceptional students will be invited to attend scientific meetings with the PI and participate in paper writing and publication. Second, M-PIE will establish formal ties to University of Montana's Project TRAIN (Training American Indians in Environmental Biology), which is currently supported by NSF. Project TRAIN seeks to increase the number of American Indians entering graduate school and careers in environmental biology by providing research experiences and mentoring. Ties are particularly strong between University of Montana and Salish Kootenai College (SKC), and one environmental sciences student from SKC will participate in M-PIE every year. Third, M-PIE will support local high schools (in Missoula) by training 2 teachers in Years 2 - 4 in the basics of environmental biophysics and plant-insect interactions. Teachers will visit field plots periodically and help with experiment execution, data collection, and analysis. In addition, I will visit high schools for mini-lectures on plant-insect interactions and will use those visits to recruit high-school students for summer research internships.