REPORT: Les Mehrhoff Botanical Research Fund
Microhabitat characterization and differentiation in two sympatric rare Aspleniums in northeastern North America

Susan Fawcett susan.fawcett@gmail.com - 2016 Recipient

Introduction:

Thirteen species of *Asplenium* (Aspleniaceae) occur in the northeastern United States, all but two primarily on rock outcrops, with eight of the thirteen considered endangered in at least one state. Two rare species, *Asplenium rhizophyllum* and *A. viride*, are sympatric in Michigan, Ontario, New York and Vermont. However, their global ranges contrast sharply: *A. rhizophyllum* is restricted to temperate eastern North America, whereas *A. viride* is circumboreal. In the western portion of this range (e.g., the Niagara escarpment in Michigan and Ontario) these two species regularly occur in the same habitat: calcareous, mossy, low, shaded rock outcrops and large boulders in the understory of deciduous or mixed forests; they may be considered syntopic, occasionally growing within centimeters of each other. In contrast, within the eastern portion of their range of overlap (e.g., Vermont), they tend to be segregated along elevational gradients, with *A. rhizophyllum* occurring in the valleys (~100 m) and *A. viride* growing at higher elevations (lowest recorded ~430 m). Given the tremendous long-range dispersal ability of ferns, their ranges are probably in climatic equilibrium, despite the short time since deglaciation. Both species are evergreen, so the plants may be affected by and integrate environmental variables spanning all seasons. For example, evergreen species are suggested to be more susceptible than deciduous species to harsh winters (de Groot et al. 2012), although populations of *Asplenium scolopendrium* have been shown to decrease in response to drought (Keuhn & Leopold 1992).

Sampling sites where both species co-occur enables us to identify variables associated with microhabitat preference, while the inclusion of sites where the two species are segregated by elevation will enable us to further characterize niche differentiation within the sympatric range. Accurate niche characterization will allow improved predictions about these species' responses to climate change, which we expect to be different. As they are in climate equilibrium, observed climate parameters for the two species are unlikely to be distorted by absence from appropriate niches. The study provides baseline data that will allow us to determine whether these species exhibit similar or differential responses to winter versus summer conditions in the same habitat.

The recent development of miniaturized and relatively inexpensive durable long-term temperature and humidity data loggers (iButtons) opens new horizons for gathering highly specific microclimate data in quantity. The iButtons are small enough (ca. 16 mm in diameter and 6 mm thick) to be placed into and measure specific zones of interest for even small plants, that is, directly measuring in the leaf zone of even tiny plants like *Asplenium* spp. (see: Mittra, van Etten, & Franco 2013). The estimated maximum lifespan of the stainless-steel-encased iButtons is up to 10 years, but some premature failure has been noted in Arctic applications.

As these species occur in forests that are subject, on both private and public lands, to logging and other forms of management and manipulation, results will be broadly useful in providing management considerations and also for future deliberations about the status of the species. This project also builds on the work of Evans (1997) and Cuthrell et al. (2012) regarding niche characterization of these species. The results may be generalizable to other rock ferns, especially those with somewhat similar habit and habitats.

Methods:

As of fall, 2016, 37 iButton data loggers have been placed on *Asplenium viride* and *A. rhizophyllum* sites in Wisconsin, Michigan, Ontario, New York and Vermont, spanning the northernmost range limits of *A. rhizophyllum* in Michigan's upper peninsula, and the southernmost limit for *Asplenium viride* in eastern North America, in Ontario (Fig. 1). Specimens were collected where previously undocumented populations occurred, resulting in new county records, and a northern range limit extension for *Asplenium rhizophyllum*, with vouchers at MICH and VT. iButtons were placed in the fall of 2015 on three populations of *Asplenium viride* in Vermont, at elevations of 1360 ft in Windsor co., and 2080 ft and 3430 ft in Lamoille co., spanning the known elevation of the species in the state, and will soon be collected with one year of temperature and humidity data, and the iButtons will be replaced to continue recording until spring of 2017 to coincide with the 34 other iButtons recording in Wisconsin, Michigan, Ontario, and New York.

First-year data collection began in April, 2016 and was completed in August, 2016. A total of 138 0.5 M plots were established at 37 localities. In most cases, five plots were established at each site, but in some instances, fewer plots were placed at localities with smaller populations. All individual ferns were counted, binning them into size-class categories including fertile adult, sterile adult, and juvenile (Bucharová et al. 2010, Keuhn & Leopold 1992, 1993, Hunter 1922). Vegetative reproduction from proliferous buds on frond apices of *Asplenium rhizophyllum* results in 'individuals' that are represented by multiple rosettes. Because these clonal individuals may become independent upon losing connection to the parent plant, the unit of population size estimates was the rooted rosette, regardless of connection to a parent plant. In addition to detailed population counts made within the plots, a coarser estimate was made for the population size in the immediate area, delineated by discrete geologic features. Descriptive habitat data included height of boulder or outcrop, maximum and minimum heights of colony, canopy composition and cover (using a densiometer), Braun-Blanquet cover-abundance estimates of associated herbaceous species composition, (in case of inhibition or facilitation by associated species (Testo & Watkins 2013)), aspect and slope of boulder and underlying topography, chemistry of substrate (measured with a pH meter in situ) and presence and abundance of moss. Photo monitoring of all plots was established, with a scale, and general habitat photos taken in a standard way, both to aid in relocation of the iButtons and for baseline population monitoring. Finally, data loggers were placed in close proximity to the fern foliage near the base of the plant and are recording temperature and humidity every four hours for one year, most programmed to start on either May 15th or June 15th, with two additional sites added later in the summer that began recording on August 15th. The Vermont *Asplenium viride* iButtons will be recovered, reprogrammed and replaced to continue recording. Though not directly able to measure snow cover, the temperature variation pattern will change dramatically after snow cover is achieved and when it disappears, giving a clear snow cover signal. The data loggers will be recovered in spring and summer of 2017.

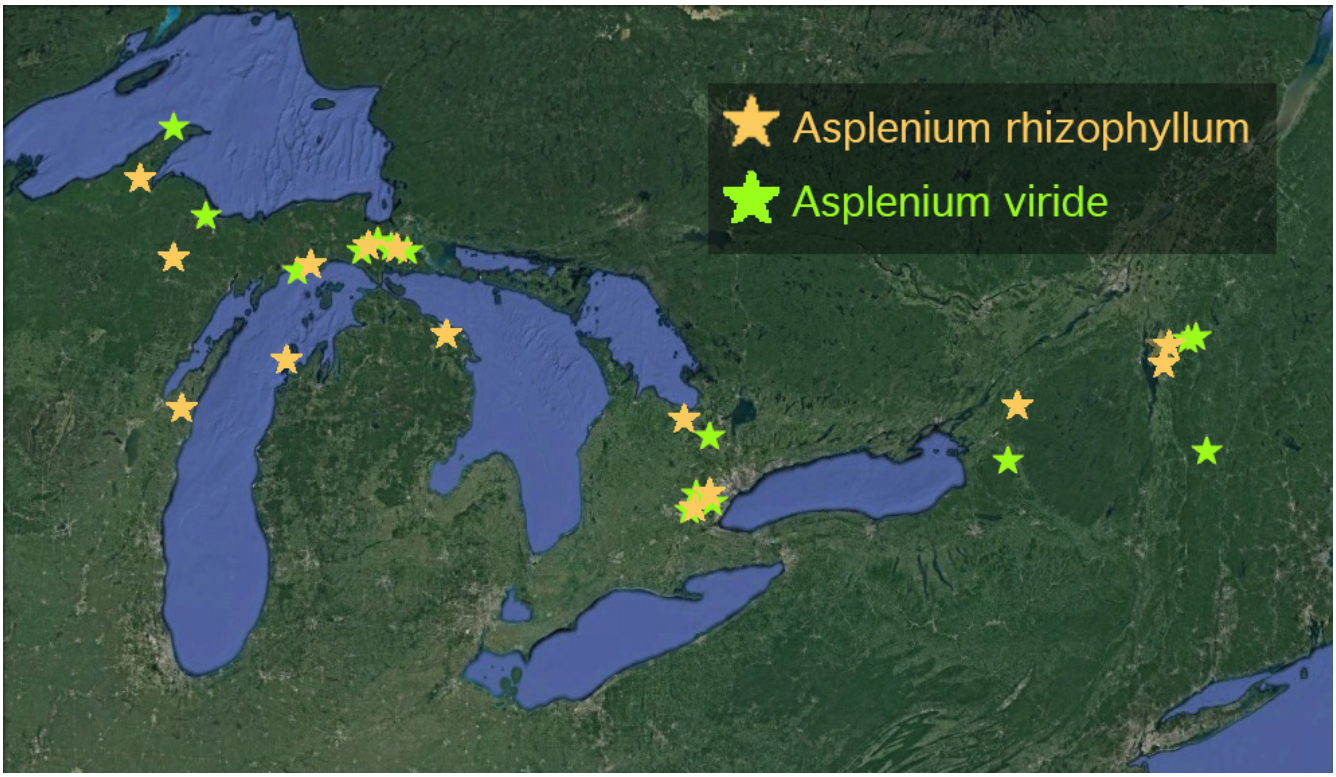

Figure 1. Approximate locations of 37 iButton data recorders and placed in spring / summer 2016.

Data Analysis:

The focus in the first season is niche characterization and differentiation; the results from the first year of observations will be submitted to a peer-reviewed journal. I will use discriminant function analysis to determine the degree of niche overlap between the two species. Ecological niche models generated from fine-scale microclimate data will be compared to models generated using coarser-scale (1 km grid) data (www.worldclim.org/) in a future publication. While this will be essentially baseline data, the methods we propose will allow future demographic studies using transition matrices (Bucharová et al. 2010, de Groot et al. 2012).

Timeline:

Summer 2016. iButtons were placed on populations in Wisconsin, Michigan, Ontario, New York and Vermont, and set to record temperature simultaneously for one year.
November 2016. iButtons currently placed on *A. viride* populations in Vermont will be recovered, reprogrammed and replaced.
June 2017. iButtons will be recovered from all locations.
Fall 2017. Data will be analyzed and the manuscript will be prepared for submission.

Project Advisors:

Dr. David Barrington, Director of the Pringle Herbarium, Professor of Plant Biology, Chair of the Plant Biology Department, University of Vermont
Dr. Anton A. Reznicek, Assistant Director of University of Michigan Herbarium, Research Scientist, Curator of Vascular Plants, University of Michigan

Acknowledgments:

This research was supported by the Les Mehrhoff Botanical Research Fund from the New England Botanical Club, support from the Michigan Botanical Foundation, the Hanes Fund Grant #2016-2, and the University of Vermont, Department of Plant Biology. I would like to acknowledge the assistance of the Michigan Department of Natural Resources, the Hiawatha National Forest, the Michigan Natural Features Inventory, the Michigan Nature Association, and the New York State Department of Parks, Recreation and Historic Preservation.

Literature Cited:

Bucharová, A., Z. Münzbergová, & P. Tájek. 2010. Population biology of two rare fern species: long life and long-lasting stability. American Journal of Botany 97: 1260-1271.

Cuthrell, D.L., M.R. Penskar, & J.L. Gehring. 2012. Surveys and Monitoring for the Hiawatha National Forest: FY 2012 Progress Report. Michigan Natural Features Inventory Report No. 2012-13, Lansing, MI. 8 pp. + appendices.

de Groot, G.A., P.A. Zuidema, H. de Groot, & H.J. During. 2012. Variation in ploidy level and phenology can result in large and unexpected differences in demography and climatic sensitivity between closely related ferns. American Journal of Botany 99: 1375-1387.

Evans, D.J. 1997. Habitat characteristics and Distribution Patterns of Three Rare Aspleniums in Northern Mackinac County, Michigan. MSc. thesis. Michigan Technological University, Houghton, MI. 112 pp.

Hunter, M.R. 1922. The present status of *Scolopendrium* in New York State. American Journal of Botany 9: 28-36.

Kuehn, D.M.C., & D.J. Leopold. 1992. Long-term demography of *Phyllitis scolopendrium* (L.) Newm. var. *americana* Fern. in central New York. Bulletin of the Torrey Botanical Club 119: 65-76.

Kuehn, D.M.C., & D.J. Leopold. 1993. Habitat characteristics associated with *Phyllitis scolopendrium* (L.) Newm. var. *americana* Fern. (Aspleniaceae) in central New York. Bulletin of the Torrey Botanical Club 120: 310-318.

Mittra, S., J. van Etten, & T. Franco. 2013. Collecting Weather Data in the Field with High Spatial and Temporal Resolution Using iButtons. CGIAR, CCAFS. 30 pp.

Testo, W.L., & J.E. Watkins. 2013. Understanding mechanisms of rarity in pteridophytes: Competition and climate change threaten the rare fern *Asplenium scolopendrium* var. *americanum* (Aspleniaceae). American Journal of Botany 100: 2261-2270.