

## **Ecological niche differentiation of the *Adiantum pedatum* complex in the Green Mountains**

*Mehrhoff Botanical Research Fund ~Updated Research Report*

Morgan Southgate

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### **Research Summary:**

Supported by the Mehrhoff Botanical Research Fund for the summer of 2017, I conducted a second season of field research on the ecology and biogeography of the *Adiantum pedatum* complex in the Green Mountains of Vermont. The *Adiantum pedatum* complex, a clade of maidenhair ferns, comprises three species in northeastern North America that exhibit disparate distributions largely shaped by the geology of the region. *Adiantum pedatum* L., the northern maidenhair fern, is widely distributed in rich northern hardwood forests, while *A. aleuticum*, the aleutian maidenhair fern, and *A. viridimontanum*, the green mountain maidenhair fern, are restricted to serpentine substrates in northern VT and southern Quebec. *Adiantum viridimontanum* is an allotetraploid hybrid derived from a sterile cross between the diploid taxa *A. aleuticum* and *A. pedatum*.

### **Ecological Data Collection & Analysis**

The objective of my field research was to collect a wide range of ecological data in order to characterize the niches of the three maidenhair fern species. This provided the means to test the hypothesis that the ecological niches of the two serpentine species are differentiated from one another, due to the inclusion of two genomes adapted to disparate ecological niches in the allotetraploid hybrid *Adiantum viridimontanum*. In the summer of 2017, I added 22 survey patches to my pre-existing data-set of 30 survey patches, resulting in a total sample size of 52 survey patches across 13 sites. Using each survey patch as a sample, results from a principal components analysis (PCA) of ecological niche data for the three species revealed a pattern of hybrid ecological intermediacy, in which the niche space of *Adiantum viridimontanum* appears intermediate between its progenitors, but overlaps more closely with that of *A. aleuticum* (Figure 1). Additionally, the niche space of the green mountain maidenhair fern in relation is wider than that of the aleutian maidenhair fern, as quantified by the PCA results. The ecological intermediacy and wider ecological tolerance observed for the hybrid maidenhair fern in relation to its progenitors provide evidence to support the hypothesis that niche differentiation exists between the two species of serpentine maidenhair ferns.

The first principal component of the PCA explains 26.47% of the total variance present in the data-set, and the clusters of the three maidenhair fern species separate primarily along this first axis (Figure 1). The ecological variables that contribute most to the first principal component are all edaphic; the magnesium concentration (ppm), magnesium base saturation, and effective cation exchange capacity (ECEC) all have a negative loading, while the depth of the A soil layer and calcium base saturation have a positive loading. Because the niche space of *Adiantum pedatum* clusters in the right portion of the plot, the edaphic niche of the northern maidenhair fern can be characterized as having a deep A soil layer, high calcium base saturation, low magnesium concentration, low magnesium base saturation, and low ECEC. Inversely, as the niche space of *A. aleuticum* clusters in the left portion of the plot, the edaphic niche of the

aleutian maidenhair fern can be characterized as having a shallow A soil layer, low calcium base saturation, high magnesium concentration, high magnesium base saturation, and high ECEC. The niche space of the hybrid *Adiantum viridimontanum* can be characterized as intermediate between the two progenitors in terms of the above variables, but shifted more closely to the edaphic regime inhabited by *A. aleuticum*.

The quantitative niche characterizations provided by the PCA results are consistent with qualitative observations made over the course of my field research. *Adiantum pedatum* is most often found in rich northern hardwood forests, where the calcium concentration is high due either to bedrock chemistry or alluvial processes, and the soil is deep. In contrast, the other diploid maidenhair fern *Adiantum aleuticum* tends to occupy cracks in serpentine outcrops and the thin soil of steep serpentine slopes, where the soil layers are shallow and the soil chemistry is influenced heavily by the high magnesium content of the serpentine bedrock from which it is derived. *Adiantum viridimontanum* is often distributed in the forests below serpentine outcrops where serpentine-influenced water washes down from above, and thrives in asbestos and talc mine-waste habitats. The observed ecology for the hybrid maidenhair fern is consistent with the offset ecological intermediacy quantified by the PCA results, as *Adiantum viridimontanum* inhabits a wider range of serpentine habitat than does its serpentine progenitor *A. aleuticum*.

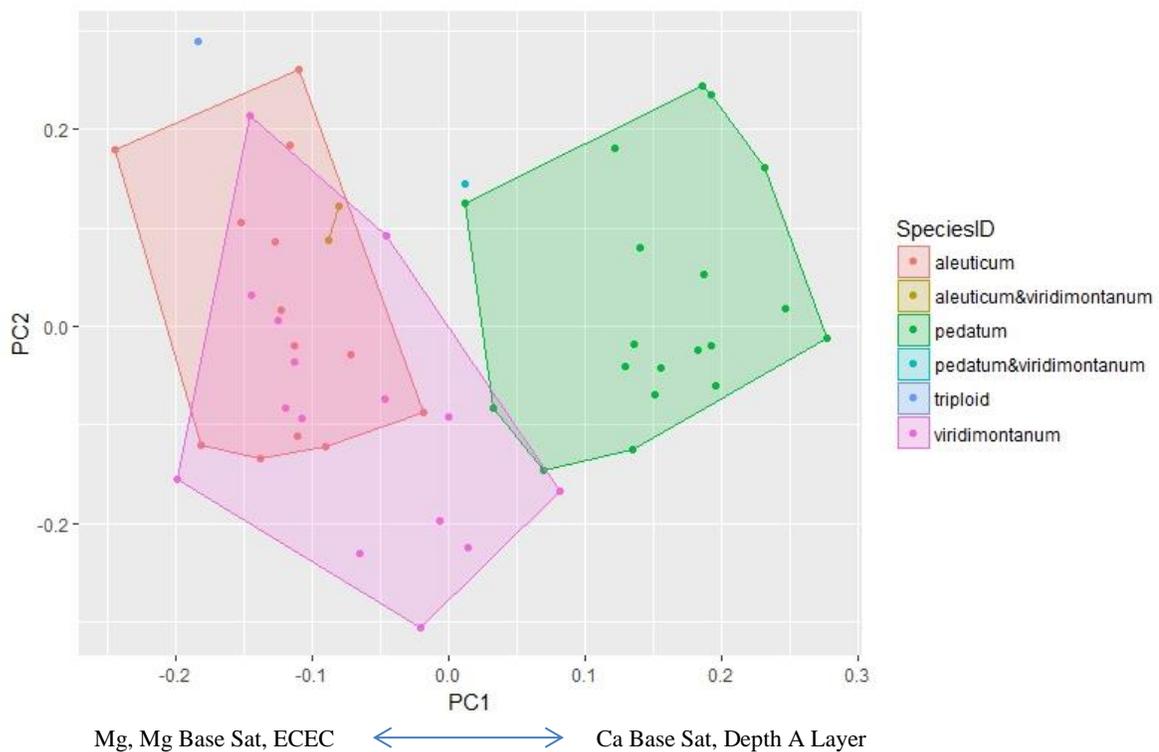


Figure 1: Plot of the first two principal components of the PCA analysis of the ecological data gathered for the three species of maidenhair fern. Each dot on the plot represents one survey patch. Species ID for each survey patch is shown in the legend to the right. The top five most important loadings are shown for PC1, with an arrow denoting their direction of contribution to the principal component. Mg = magnesium soil concentration (ppm), Mg Base Sat = soil magnesium base saturation, ECEC = effective cation exchange capacity, Ca Base Sat = calcium base saturation, Depth A Layer = depth of the A soil layer.