A Morphometrics Study of Prostrate Leaves of Wintergreen Fern *Dryopteris intermedia*

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Introduction

Wintergreen fern *Dryopteris intermedia* (Intermediate Wood Fern) is a common understory herbaceous fern that inhabits much of the Eastern United States and Canada (Nielsen 2017). In early winter leaves become prostrate, forming a hinge in the proximal region of the petiole that allows them to lay flat. In the temperate regions of upstate New York, being wintergreen has several advantages. Wintergreen ferns have a prolonged photosynthetic period, while also retaining valuable nutrients, allowing them to thrive in nutrient poor environments (Aerts 1995). Many studies have been published on the effects of prostration on wintergreen ferns, showing that without, processes such as photosynthesis and respiration would not be as efficient during the winter months (Forget et al. 2018). Prostration gives these leaves an advantage, allowing them to reach conditions optimal for photosynthesis and facilitating respiration in the airspace below (when under snow cover) (Forget et al. 2018). Although this species of fern is well known, there has not been previous studies regarding the morphometrics of the hinge formation on the petiole.

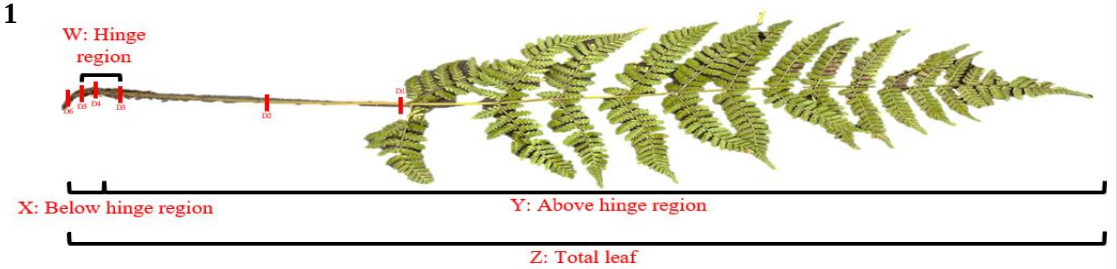
Material and Methods

Prostrated leaves from six different clones of similar size located on Blue Trail at Rice Creek Field Station were collected in early winter. From each clone, three leaves in each size group were collected (small-, medium-, and large-sized leaves; *see table below*). The weight of different regions of the fresh leaves were measured within two hours of collection. These measurements included, the length and fresh leaf weight of the region of the petiole above the hinge, the length and fresh weight of the region of the petiole below the hinge, the entire length of the leaf, length of the hinge region and the diameter of six points along the entire petiole of the leaf. These measurements are illustrated in Figure 1.

	Leaf Length Ranges (cm)
Small	16.8-40.6
Medium	41.5-59.5
Large	60.1-78.3

Results

1



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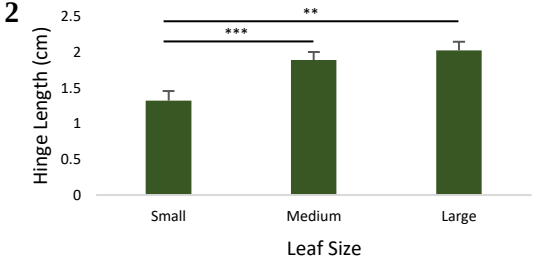

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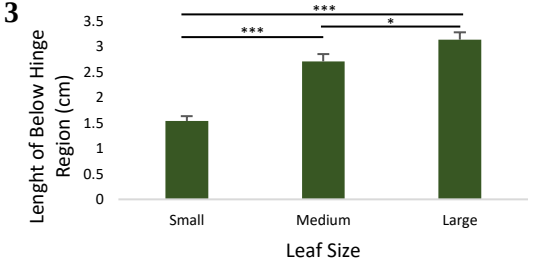

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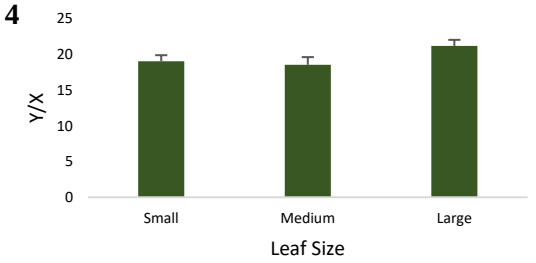

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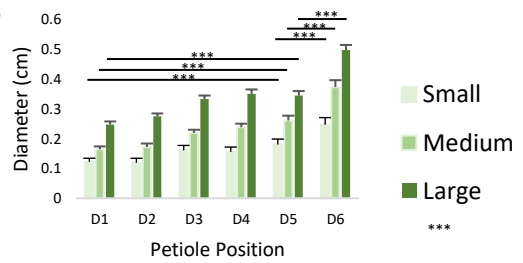

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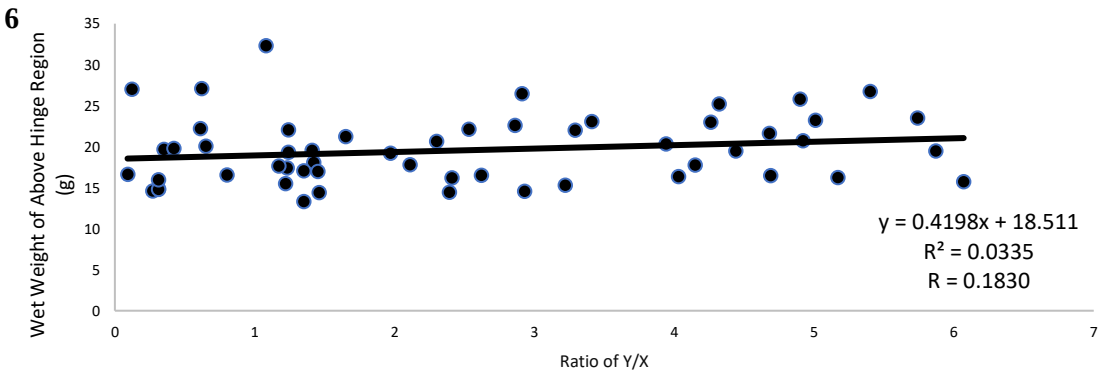

Objectives

We hypothesize that weight may contribute to **where the hinge forms.**

- What is the average hinge length for each of the three sizes?
- What is the average distance of the hinge from the bottom of the petiole for all three size groups?
- Is there a significant difference between the position of the hinge for all three size groups?
- What is the diameter at different points on the petiole, and do the diameters suggest stronger mechanical support in some regions of the leaf?
- Dose the position of the hinge correlate to the weight of the above hinge region?

Results: Figures 1-6

Figure 1: This figure represents the several points of measurement on the leaf.
Figure 2: Average hinge length for the small-, medium-, and large-sized leaves.
Figure 3: Average length of the below hinge region for small-, medium-, and large-sized leaves
Figure 4: Average ratio of the above hinge region over the below hinge region for small-, medium-, and large-sized leaves.
Figure 5: Diameter measurements at six points along the petiole, for small-, medium, and large-sized leaves.
Figure 6: Linear regression of fresh weight of the above-hinge zone versus the relative position of the hinge (Y/X).
For figures: Triple asterisk indicates significance level of P < .001. Double asterisks indicates significance level of p < .005. Single asterisks indicates significance level of P < .05.

Discussion

Previous research indicated that the length of the zone where the hinge forms is 1-2 cm for *Polystichum acrostichoides* (Nooden and Wagner, 1997). Our research indicates the hinge zone is much more variable: 1-6 cm. Weight might be a potential cause for the relative location of the hinge, but more experimental studies are needed to conclude that weight plays a role in the relative location of the hinge.
In conclusion, weight might be the deciding factor of the relative location of the hinge zone on the petiole, and this location might be the balance point between the weight of the leaf and the gradually increasing level of mechanical support towards the base of the petiole.