Title: Mustering the Measure of a Moss: The Importance of Moss Ecophysiology in the Southern Appalachian Mountains

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Funding from the Tom and Bruce Shinn Fund allowed me to construct an active warming system using infra-red heat lamps as part of my thesis research investigating the effects of climate change on several common moss species of the Southern Appalachian Mountains (SAM) in North Carolina. I studied four native SAM mosses and placed them in mesocosms under ambient conditions and also beneath the heaters. This heating experiment began in November of 2022 and is currently underway (Figure 1). Two species (*Ceratodon purpureus* and *Polytrichum juniperinum*) were collected from open habitats and two from forested habitats (*Hypnum imponens* and *Thuidium delicatulum*). The system maintains an elevated temperature above ambient of between 3-4°C to simulate future warming in this region[3,5].

Almost 400 taxa of mosses[1] call the SAM home. Although small in stature, mosses play critical ecological roles in this region. For example, they can prevent runoff and erosion, act as carbon sinks and nutrient reservoirs, create unique microclimates favorable to a wide range of organisms, and encourage germination for some vascular plant species[6].

Figure 1. Warming system and moss samples

Mosses quickly desiccate and remain metabolically active only when sufficiently hydrated, therefore, their growth could be adversely affected by climate change, with potentially significant impacts on SAM ecosystems. Since responses to altered rainfall patterns and higher temperatures may be species-dependent, it is important to understand the basic principles underlying the ecophysiology of SAM mosses.

I hypothesized that mosses subjected to the warming treatments would have higher rates of desiccation, less time available for photosynthesis, and less growth relative to samples under ambient conditions. I am predicting that open-grown moss species (see Figure 2) will be more tolerant of warming compared to forest understory species because their habitat and dense canopy architecture predisposes them to tolerate greater stress[2] than understory species. In contrast, pleurocarpous mosses (Figure 3) may be more susceptible to rapid desiccation upon warming and more adversely affected by elevated temperatures.

Figure 2. ***Polytrichum juniperinum*** **on a rocky slope in Boone, NC**

Figure 4. ***Thuidium delicatulum*** **in an understory site in Boone, NC**

To understand the physiology of mosses to changing climactic variables, I am also measuring a variety of ecophysiological responses on my mosses. I am conducting gas exchange measurements using an LI-6800 gas exchange system equipped with a custom moss cuvette with an LED light source (Figure 4). I am assessing their responses to light and moisture, which allows me to observe their photosynthetic activity in response to changing environmental conditions. Light response curves show that open habitat species reach higher photosynthetic rates and higher light saturation points than forest species. I also studied how photosynthesis responded as the mosses dried. These moisture release curves showed that mosses desiccate nonlinearly, drying rapidly at first but then it slowing down over time. Photosynthetic rates peak at intermediate water contents (65-80%), because at full saturation, CO_2 diffusion into leaves is inhibited by water films.

Figure 3. ***Hypnum imponens*** **in the custom cuvette attached to the LI-6800**

At the end of this summer, I plan to analyze the results of my warming experiment. I will measure chlorophyll contents and fluorescence of mosses in the heated and ambient treatments to determine if warming stresses the mosses via photoinhibition. I will also conduct additional gas exchange measurements to determine if warming reduces their photosynthetic potentials. Finally, I will measure growth and survival to see if warming has had any effects over the past year.

Climate change could greatly alter moss community structure and composition by reducing photosynthetic activity and lowering survival in the SAM region, which has implications for ecosystem functioning. Physiological differences in response to drought and warmer temperatures may shift species dominance in moss systems[7]. This work should increase our understanding of how climate change in the SAM of North Carolina may affect these native moss species in the future.

References:

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