**BACKGROUND**

- Mosses are pioneers in ecological succession, prevent erosion, retain soil moisture, store and filter nutrients, and serve as refugia for fauna.
- Mosses are poikilohydric and embolomorph; they quickly desiccate and remain metabolically active only when sufficiently hydrated.
- They tolerate a wide range of light levels, from shady understory habitats to open-field habitats.
- Mosses reach peak photosynthesis ($A$) at intermediate water contents, before $A$ declines as tissues further desiccate.
- There are no studies on moss ecophysiology in the Southern Appalachian Mountains (SAM); understanding responses to changes in moisture content and light will be crucial for predicting climate change impacts.

**OBJECTIVES**

To compare open-habitat to forest understory moss species to understand how they differ physiologically in response to varying light and moisture levels.

**HYPOTHESES**

1. Open-habitat acrocarpous species, growing in clump formations, will maintain higher water use efficiency and higher PAR after 1 hr exposure.
2. Open-habitat moss species will undergo less stress from prolonged exposure to high light and moisture levels.
3. Open-habitat mosses will undergo less stress from prolonged exposure to high light and moisture levels.

**METHODS**

- **Moss Species**
  - Open-Habitat: Ceratodon purpureus, CP, Polytrichum juniperinum, PJ
  - Forest Habitat: Thuidium delicatulum, TD, Hylocomium impenum, HI

**Physiological Measurements**

- Determined chlorophyll contents in winter and summer using DMF extraction.
- Measured light responses of photosynthesis ($A$) using Li-6800 and LED light source with custom-built cuvette, allowing better control of RH (Fig. 1).
- RWC calculated as: (Fresh Wt – Dry Wt) / (Turgid Wt – Dry Wt).
- Measured diurnal changes in RWC in the field for a 3-day period following a rain event. Mosses were saturated at the start of the measurements.
- Built drying curves to determine relationship between $A$ and RWC.
- Calculated Water Use Efficiency when $A \geq 90\%$ of $A_{\max}$ as: Ratio of water lost to total carbon assimilation over this time interval.
- Measured dark-adapted chlorophyll fluorescence after 1 hr exposures at varying levels of PAR (15, 500, 1000, 2000 µmol m$^{-2}$ s$^{-1}$).

**RESULTS**

**Figure 2. Left Column: RWC vs Time (n = 5); Right Column: Photosynthesis ($A$) vs RWC (n = 5).**

- **Take Home Messages:**
  - Mosses dry in exponential decay fashion with time.
  - CP, a cushion moss, dries the slowest of all four mosses.
  - Mosses reach peak photosynthesis ($A$) at intermediate water contents, before $A$ declines as tissues further desiccate.
  - Moisture, store and filter nutrients, and serve as refugia for fauna.

**Figure 3. Top: Light Response Curves.** Parameters derived from light response curves marked by stars and linked to graphs on the right: Differences significant at $p \leq 0.05$ (n = 10).

- **Take Home Messages:**
  - Open-grown mosses (CP and PJ) have higher Rd rates than forest mosses. $A_{\max}$ and AQE trend higher in open-grown mosses.
  - CP has highest LCP and LSP than other mosses.
  - PJ has significantly higher AQE and $A_{\max}$ than other mosses.

**Figure 4. WUE of Mosses (n = 10).**

- **Take Home Messages:**
  - CP and PJ have higher water use efficiency and HI and TD lowest.
  - WUE higher for acrocarpous mosses compared to pleurocarpous mosses.
  - Mosses lose ~2X to 7X as much water per CO$_2$ absorbed compared to a typical leaf from a C3 plant.

**Figure 5. Field RWC vs Time (n = 10).**

- **Take Home Messages:**
  - Mosses dried at moderate rates over two days and had RWC that would support positive $A$ over this interval.
  - Increases in RWC on Day 3 due to hydration from fog and/or dew.

**Figure 7. Total chlorophyll contents and chl a:b ratios of mosses from January to June 2023 (n = 10).**

- **Take Home Messages:**
  - Total Chl similar in Jan and Jun.
  - When grown in high-light habitats, total chlorophyll amounts are lower (lower right panel, bars marked as sun).
  - Chl a:b ratios lowest in PJ and do not change substantially from Jan to Jun.

**CONCLUSIONS**

- Photophysiological rates peak at intermediate water contents before declining as the moss dries. Positive $A$ maintained to 20% RWC except in PJ, where it is 40%.
- $A$ may be a proxy for determining when SAM mosses are photosynthetically active, although prolonged exposure to high PAR may further reduce $A$.
- Habitat origin has a substantial impact on sensitivity to light stress: mosses grown in high light are less sensitive to light stress than those from low light habitats, irrespective of their primary habitat of origin (i.e., forest vs open-field).
- Open-habitat moss species may be more tolerant of warming and precipitation alterations due to climate change, because they are subject greater light and moisture stress than understory habitat moss species.
- With additional modeling, it should be possible to predict daily and annual carbon uptake by SAM mosses and predict impacts of future climate change on their productivity.

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