Eco-evolutionary responses of *Schoenoplectus americanus* to global change

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- Plants exhibit non-additive responses to multiple, interacting global change factors
- Evolutionary trade-offs occur within plant populations during 100-year time period
- Rapid evolution of plant traits could alter marsh resiliency and carbon sequestration

Background:

- Coastal marshes are major global carbon stores. In these systems, dominant sedges like *Schoenoplectus americanus* can serve as ecosystem engineers, mediating carbon sequestration and the ability of marshes to build elevation in the face of sea-level rise.
- Ongoing research shows that *S. americanus* densities and carbon storage responds to global change factors such as sea-level rise ( ), increasing CO_2 ( ), and increasing salinity ( ), but little is known about the mediating role of genotypic variation and rapid evolution.
- Using "resurrected" genotypes of *S. americanus* in this experiment allowed us to ask how plant traits evolve on ecologically-relevant timescales.

Objective: Here, we sought to understand the scope and breadth of heritable and environmental variation of key traits of *S. americanus* in a mesocosm experiment and the capacity for these traits to rapidly evolve.

Methods:

Genotype acquisition

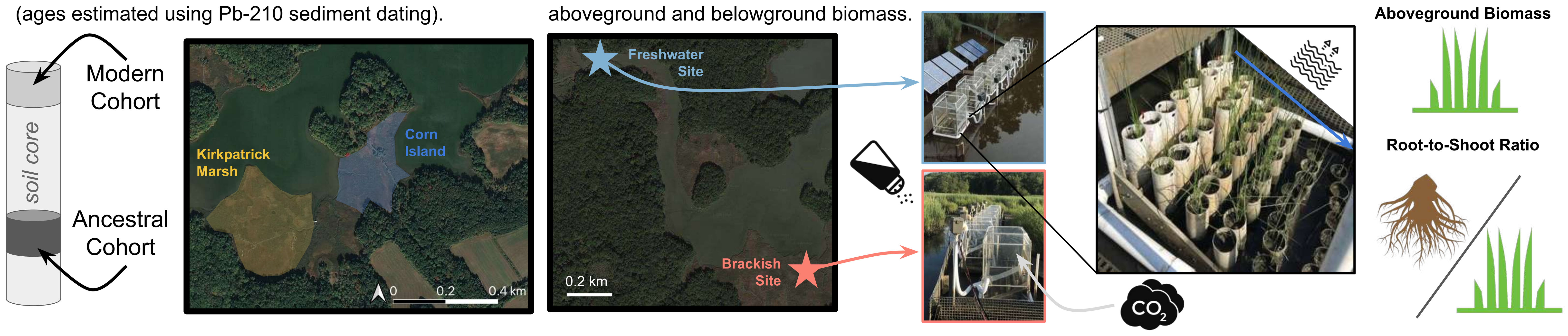
We resurrected *Schoenoplectus americanus* genotypes (n = 32) collected from two sites in the Chesapeake Bay, MD (Kirkpatrick Marsh and Corn Island) to create experimental clones. We grouped genotypes into four unique cohorts of plants (two sites x two age groups). Genotypes were defined as modern if they were approximated to be from 2000 to 2020, while ancestral cohorts were approximated to be from 1900 to 1960 (ages estimated using Pb-210 sediment dating).

Common garden experiment

Plants were grown in a mesocosm, at the Smithsonian Environmental Research Center (Edgewater, MD, UDA), that exposed them to a crossed environmental conditions of flooding (six levels), salinity (brackish marsh or freshwater creek), and atmospheric CO_2 (ambient or elevated to ~700 ppm). After exposure to tidal inundation for four months in mesocosms, the plants were destructively harvested for both aboveground and belowground biomass.

Statistical analysis

We fit linear mixed effects models to our trait data with environmental and cohort covariates as fixed effects, and genotype and genotype by environment interactions as random effects. We used backwards stepwise model selection to identify important fixed effects and genotype-by-environment interactions (*i.e.* random slopes).



Aboveground Biomass Results:

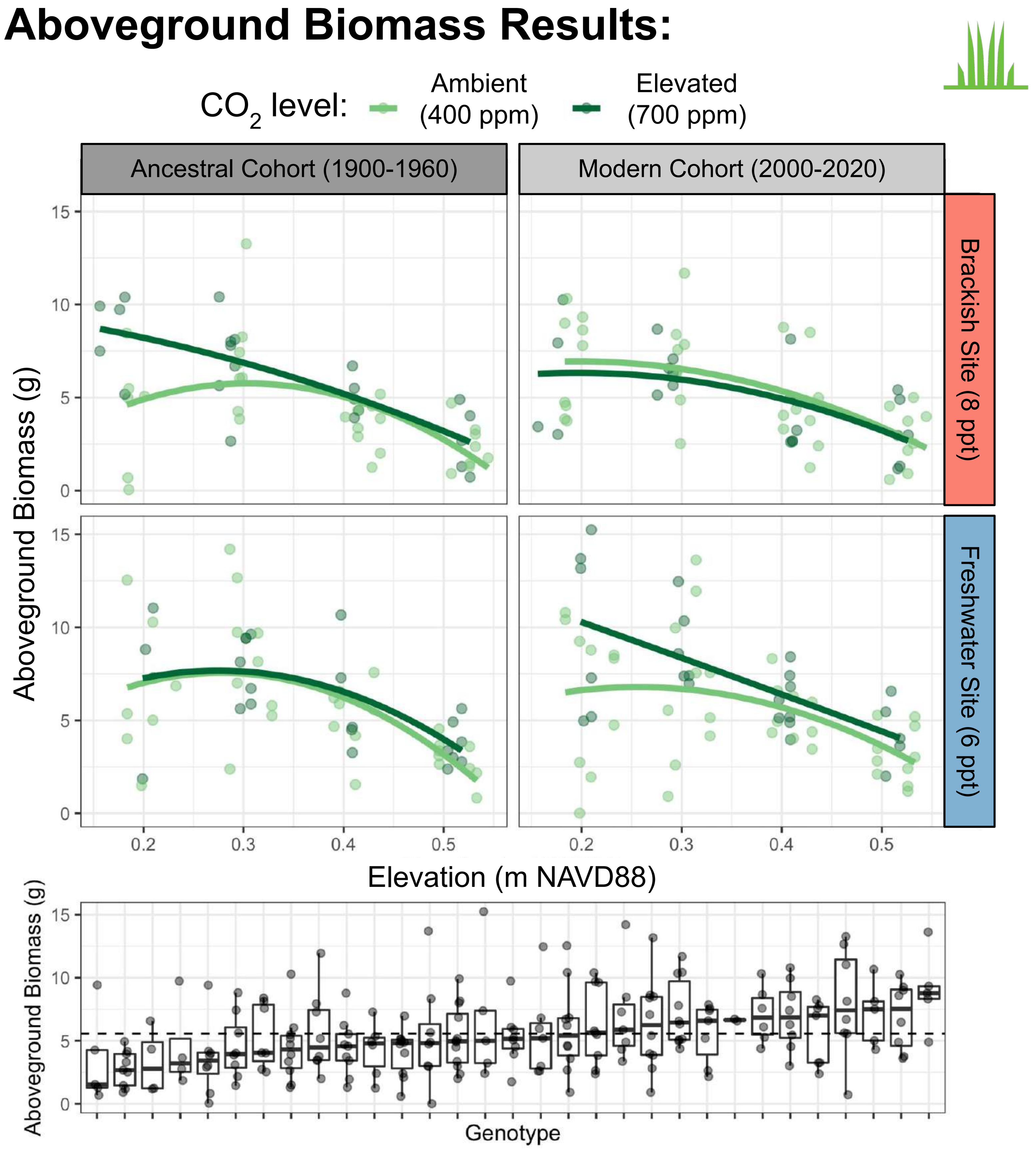


Figure 1. (A) Aboveground biomass (AGB) of *S. americanus* across elevation, where increasing elevation indicates less flooding, grouped by atmospheric CO_2 treatment (ambient = light green, elevated = dark green). The plots are faceted by age cohorts and salinity treatment. Elevated CO_2 stimulates AGB growth at low elevations in more saline conditions for ancestral genotypes (top left) and in freshwater conditions for modern genotypes (bottom right). (B) AGB for each of the 32 genotypes across all environmental treatments. Genotypes are ordered by median aboveground biomass.

Root-to-Shoot Ratio Results:

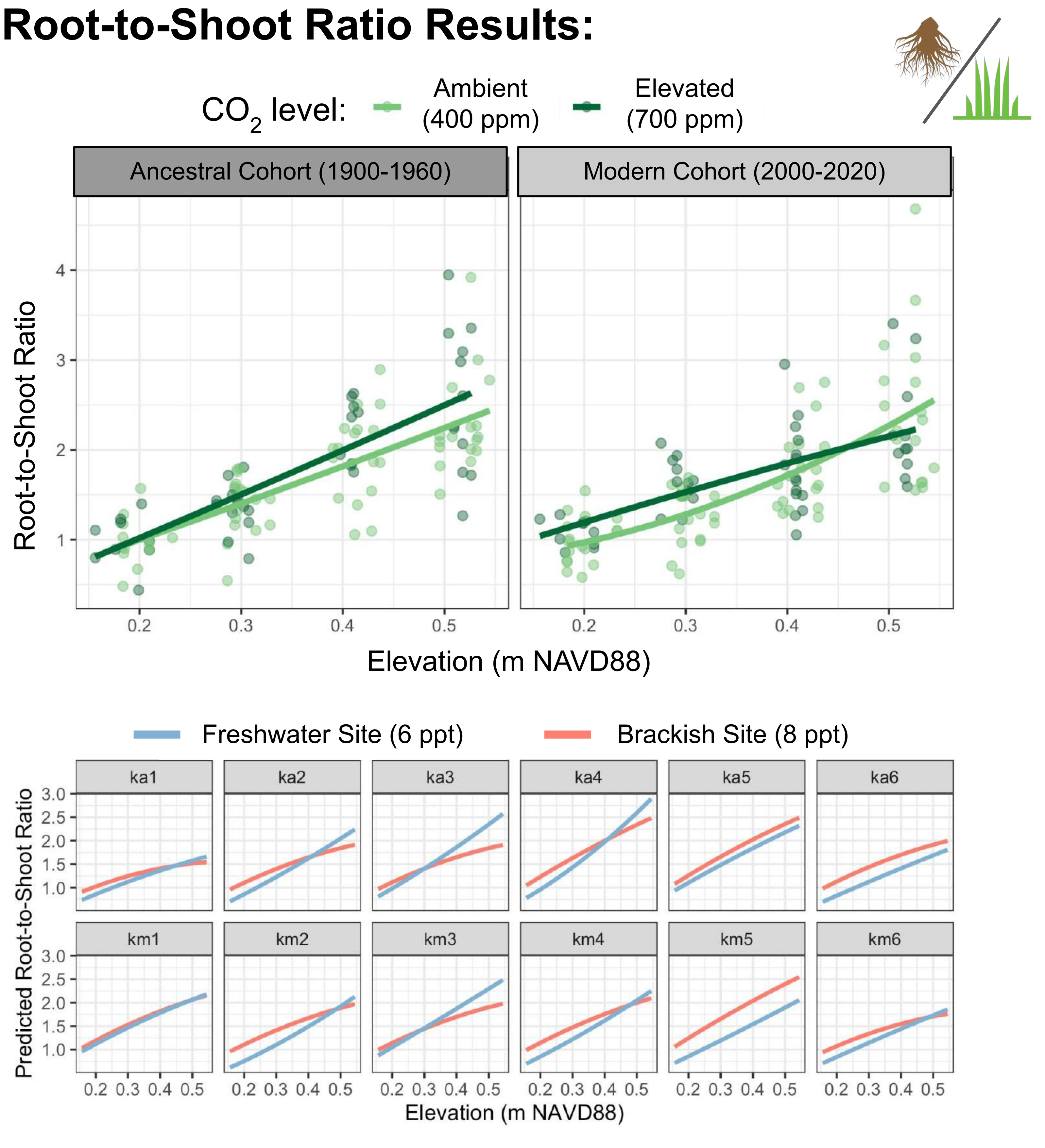


Figure 2. (A) Root-to-shoot ratio of *S. americanus* across elevation, grouped by atmospheric CO_2 treatment (ambient = light green, elevated = dark green) and faceted by age cohort. Elevated CO_2 stimulates root-to-shoot ratio at high elevations (low flooding) for ancestral genotypes and at low elevations (high flooding) for modern genotypes. (B) The root-to-shoot ratios for 10 individual genotypes of *S. americanus*, showing how genotype mediates the interaction between salinity and elevation on root-to-shoot ratio.

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