ECOPHYSIOLOGY OF SEEDLING ESTABLISHMENT IN CONTRASTING SPRUCE-FIR FORESTS OF SOUTHERN APPALACHIAN AND ROCKY MOUNTAIN ECOTONES, USA

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Fraser fir (*Abies fraseri* [Pursh] Poiret) and red spruce (*Picea rubens* Sarg.) occur as codominant trees in six relic, mountain-top populations that make up the high-elevation forests of the Southern Appalachian Mountains (SA). These two relic species of the former boreal forest have experienced a significant decline over the past century, most likely due to an introduced insect and/or air pollution. There also appears to be accumulating evidence that natural seedling regeneration appears to be inadequate for replacing these relic spruce-fir forests. Survival in young seedlings of *A. fraseri* and *P. rubens* was increased most (>90 percent) by a facilitated reduction in sky exposure, which was not negatively influenced by water competition with the surrounding plants that reduced sky exposure. Current year seedlings of *A. fraseri* had the least first-year seedling mortality under canopy gaps, compared to the relatively high values found in both closed-canopy and entirely open microsites. Similar trends in photosynthesis occurred and have also been reported for *Abies lasiocarpa* and *Picea engelmannii* in the more xeric spruce-fir forests of the western United States. Avoidance of sky exposure enables warmer needle temperatures at night due to less long-wave radiation exchange to the cold night sky, as well exposure to high levels of incident sunlight the following morning. This combination of stress factors that causes a substantial limitation to annual photosynthetic carbon gain associated with a high mortality (>90 percent), decreased root growth, and low ectomycorrhizal colonization, both of which appeared critical for preventing lethal water stress during the high-mortality in pre-established seedlings. Different modes of adaptation to this combination of stress factors included (i) avoidance mechanisms related to microsite facilitation and phenotypic adjustments in plant architecture, as well as (ii) differences in physiological tolerance that varied between the fir and spruce seedlings. Thus, survival of establishing seedlings in spruce-fir forests may be strongly dependent on microsite protection from sky exposure (e.g., surrounding plants and inanimate structures, plus canopy openness). This sky exposure may be greatest in ecotones between the forest and higher altitude communities such as grass balds in the southern Appalachians or the alpine zone in the Rocky Mountains. Moreover, these ecotonal boundaries could also serve as early indicators global change impacts such as warming temperatures and changing precipitation patterns.

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