

Patterns of Resistance to *Cronartium ribicola* in *Pinus aristata*, Rocky Mountain Bristlecone Pine

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Abstract

The core distribution of Rocky Mountain bristlecone pine, *Pinus aristata* Engelm., extends from central Colorado into northern New Mexico, with a disjunct population on the San Francisco Peaks in northern Arizona. Populations are primarily at high elevations and often define the alpine treeline; however, the species can also be found in open mixed conifer stands with ponderosa (*Pinus ponderosa* Lawson & C. Lawson) and/or pinyon (*Pinus edulis* Engelm.) pines in some locations. On dry, exposed sites the stands are open and sparse and Rocky Mountain bristlecone (hereafter referred to as bristlecone) is commonly the only species present. The combination of the pine's adaptive traits with infrequent disturbance has enabled trees on these sites to attain ages of over 2,500 years. These same traits and conditions, which contribute to a long generation time, will inevitably hinder the ability of bristlecone pine to adapt to novel anthropogenic stresses such as climate change and infection by the non-native pathogen (*Cronartium ribicola*) that causes the lethal disease white pine blister rust (WPBR). Infection of bristlecone pine by *C. ribicola* was first documented in the field in 2003 in south-central Colorado. Rapid climate warming and the associated increase in mountain pine beetle activity are also affecting these high elevation ecosystems. These threats and the species' unique aesthetic and ecological roles make bristlecone pine a species of conservation interest. Blister rust invasion is relatively recent compared to the generation time of bristlecone pine, thus we still have a window of opportunity to gain and utilize new knowledge of this species and their ecosystems under natural conditions and develop proactive conservation strategies.

Genetic resistance to WPBR is a key factor that will affect the trajectory of bristlecone pine populations in the future. Preliminary results of studies to identify and quantify rust resistance in bristlecone pine families are reported here. Seeds collected in 2001 from 184 individual trees across 11 sites along the full latitudinal gradient in Colorado were sown in 2002. The 3-year-old seedlings were inoculated with *C. ribicola* at Dorena Genetic Resource Center in 2005. Seeds for an additional smaller test, also conducted at Dorena Genetic Resources Center, were sown in April 2009 and seedlings inoculated with *C. ribicola* in September 2009. Needle infection lesions (spots) were easily identified on needles of the seedlings inoculated at a young age (2009 trial), but were less obvious on needles of the seedlings inoculated at an older age (2005 trial). However, WPBR stem symptoms did develop on many of the older seedlings in the 2005 trial for which infection spots were not observed, suggesting that needle lesions are not a good early measure of infection in older bristlecone pine seedlings. Multiple WPBR resistant phenotypes are expressed by bristlecone pine including canker-free seedlings, seedlings with partial bark reactions, and seedlings developing stem infections later or showing longer survival with stem infections. Survivorship of seedlings in the large study, 5 years post-inoculation, range from 0 percent to 92 percent among families, and 17 percent to 60 percent among geographic areas.

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