RESEARCH HIGHLIGHT

The Pacific Forestry Centre

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GENETIC RESISTANCE EMPLOYED TO SAVE WESTERN WHITE PINE FROM A FUNGAL INVASION

White pine blister rust canker

Photo credit: Sandy McKellar

WESTERN WHITE PINE is an important conifer species that produces highly prized straight-grained, non-resinous wood used in lumber and value-added products. Once prevalent in BC's forests, this white pine species almost vanished when, in the early 20th century, an exotic pathogen called *Cronartium ribicola* was introduced into North America from Europe — killing up to ninety-five percent of Canada's wild stands of western white pine. "This situation may become worse because climate change makes the race between trees and pathogens even more unpredictable," said Dr. Jun-Jun Liu, a molecular forest pathologist working to save the threatened pines.

The disease caused by this fungal invader is commonly called white pine blister rust (WPBR), it attacks and kills white pines of all ages. The impact of the fungus has led the federal government to declare one native white or five-needle pines (whitebark pine) endangered in accordance with the Species at Risk Act. Without a way to curb the attack, the forest industry was forced to remove white pine from their planting lists while scientists searched for a solution.

The first step in controlling the outbreak and spread was understanding the complex life cycle of the fungus. White pine blister rust fungus alternates between two hosts; five-needle pines and Ribes species like currants and gooseberries. On pines, attack begins on the needles and over one or several years moves to the trunk and branches creating cankers and causing branches to break away. Spores produced on the tree are carried by wind to the alternate host from which the next infection is

Infected Ribes with urediniospores under the leaves

Photo credit: Jun-Jun Liu

Photo credit: Sandy McKellar

Ribes in the wild and in a research greenhouse

Photo credit: Jun-Jun Liu

initiated. Killing the spores and/or the alternate hosts is a challenging and cost intensive solution that has not produced successful results. The answer lies in genetic resistance.

Liu and his team at Natural Resources Canada's Pacific Forestry Centre in Victoria, British Columbia are engaged in long-term research to identify and enhance a genetic resistance road-map. They screen trees with disease resistance in order to develop genomics-based breeding tools. Phenotypic evaluation of resistance to blister rust is a complicated process, requiring a long growth period for seedlings, high cost, and well-trained staff; therefore, genomics-based tools are highly desirable to speed up the breeding process. But it doesn't happen overnight. Liu and his team are part of a long history of scientists in this field of research. "I'm the second, or the 3rd generation of scientists working on these tree species and their pathogens," Liu said. "Long term (30 - 50 years) support and continuous efforts with edge-cutting knowledge and technologies is a key factor leading to achieving current scientific innovations and solutions here at PFC".

Photo credit: Jun-Jun Liu

Seedlings awaiting inoculation

And, they don't work alone. The NRCan team works in collaboration with provincial governments (BC and Alberta), Parks Canada, USDA-FS, and universities. Collaborators have contributed in many ways. They have provided seeds and seedlings of white pines, and allowed PFC staff to collect samples of both trees and fungus from their seed orchards and field plantations. Background information and phenotypic data as related to WPBR disease resistance, collected in their field trials and Ribes garden or greenhouse inoculation trials have been crucial for the work at PFC. BC collaborators have provided white pine resistance screening at large scale and those local elite seed families were provided to CFS for tree genotyping and DNA marker development. Many of these collaborators are also the end-users of the research results.

"We know we've been successful when our clients (such as breeders and forest managers) get the information and tools they need for their practices or their decision-making", Liu explained. This knowledge and associated tools are driving programs to produce resistant seedlings used in planting regimes and ecosystem restoration.

Liu specializes in understanding the relationships and interactions between trees, microbes and the environment. "Our research objective is to mitigate the ecological damage caused by the pathogens and climate change," explained Liu, adding, "enhanced disease resistance can increase genetic gains for these trees in our forest sector". The development of populations of trees with durable genetic resistance—retaining genetic diversity and adaptability—is seen as a fundamental step in restoring white pine species. Looking forward, Liu's focus is on how to achieve durable tree resistance under changing climates and monitor real-time emergence and spread of new virulent pathogenic races.

Infected whitebark pine

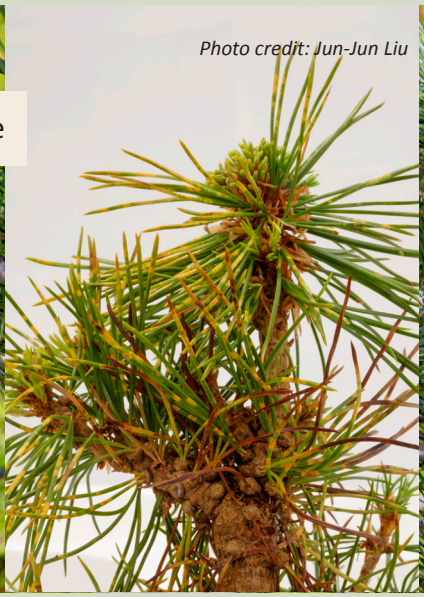

Photo credit: Jun-Jun Liu

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Resources:

- **Jun-Jun Liu** https://cfs.nrcan.gc.ca/employees/read/juliu
- **Publications** https://cfs.nrcan.gc.ca/authors/read/18563

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www.nrcan.gc.ca/science-data/research-centres-labs/forestry-research-centres/pacific-forestry-centre/13489