Different tree species use the same genes to adapt to climate change

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Lodgepole pine (far left) and interior spruce trees are widespread in western parts of the United States and Canada, and share the same suite of genes to adapt to climate. Credit: Jack Woods

An international research team from six universities, including Virginia Tech, works to better understand how trees – one of Earth's most vital renewable resources – adapt to changing climates.

Recently the team discovered that two distantly related tree species use the same genes to adapt to the range of temperatures in their geographical region. Their results were published Thursday in the journal *Science*.

Jason Holliday, an associate professor of forest resources and environmental conservation in the College of Natural Resources and Environment and a Fralin Life Science Institute affiliate, as well as Haktan Suren, a Ph.D. candidate from the same department in the Genetics, Bioinformatics and Computational Biology program, are part of the team investigating how trees adapt to different climatic conditions.

"A central question in biology is: how repeatable is the evolutionary process? One way to address this question is to study different species adapting to similar environments, and ask whether the same genetic solutions enable that adaptation," said Holliday, who is also one of the study's co-authors, along with Suren.

After five years and with the help of more than thirty people, the team studied two different conifer tree species, lodgepole pine and interior spruce, which are widespread in western parts of the United States and Canada. They collected seed from over 250 locations in western Canada, before sequencing more than 23,000 genes in each tree.

Their large-scale analysis revealed that both pine and spruce use the same suite of 47 genes to adapt to geographic variation in temperature, and to appropriately time acquisition of cold hardiness – a trait that allows plants to tolerate the adverse conditions of winter.

This discovery was surprising due to the evolutionary distance between the two species – they began evolving independently over 140 million years, when they shared a common ancestor. Similar species often evolve similar traits, but the extent to which similarities at the genomic level amount to similar observable traits in different species had not been tested until now.

"Since we're seeing the same genes across different species, there's a greater likelihood that these adaptations are due to natural selection rather than just by chance," said Sam Yeaman, an assistant professor of ecology and evolutionary biology at the University of Calgary in Alberta, Canada, and first author of the paper.

One implication of this work is that environmental adaptations may be genetically constrained. While variation in observable traits such as cold hardiness likely involves hundreds of genes, Holliday explained, a subset are required for adaptation to occur, even when comparing species that diverged long ago. This result has implications for ongoing adaptation of tree populations to climate change.

"We have to understand climate adaptation in other conifers so we can address trees that are becoming mismatched with local conditions due to climate change," said Sally Aitken, a professor of forest and conservation science at the University of British Columbia in Vancouver, Canada, and corresponding author on the study. "This will also help us offer better recommendations for forest management strategies in changing climates, and plant trees that are more likely to thrive and adapt more quickly to climate change."

More information: "Convergent local adaptation to climate in distantly related conifers," *Science*, science.sciencemag.org/cgi/doi … 1126/science.aaf7812

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