

A Genomics Platform for Detection Purposes and Better Protection of Our Forests

The risk of introducing exotic species, and the damage they cause, may increase in Canada because of the higher volume of trade, among other reasons. How do we protect our forests against these invasive species? Let us have a look at the genomics platform developed by Canadian Forest Service researchers, a next-generation detection centre.

Top 10 most unwanted species

Since it is impossible to detect every disease that may enter Canada, the researchers had to make up a list of 10 diseases to be monitored more closely. Their selection criteria were pathogen virulence, the number of hosts attacked, and distribution range. The chart shows the selected species.

Of course, several of these names mean nothing to you (and so much the better!) because most of these diseases are not present in Canada. Two of them are described in the inserts on the reverse side.



Photo: CFIA

Sudden Oak Death.
Dead oaks in California.

How does detection work?

The researchers use DNA to differentiate between the agents responsible for forest diseases. Based on the information contained in the genome (i.e., the entire genetic material), particularly in the part of the genome that is unique to each species, they managed to develop tools for detecting and identifying pathogens responsible for diseases. A minuscule amount of DNA is sufficient to detect diseases. This DNA can be extracted from various types of material: pure culture of the pathogen, herbarium specimen preserved for decades, infected plant tissue, air, water or soil samples, etc.

The genomic platform tools facilitate simple, quick and low-cost detection of targeted pathogens, while minimizing the risk of error. They are mainly used by the Canadian Food Inspection Agency. This research work is part of the Tree Aggressors Identification using Genomic Approaches (TAIGA) project set up in 2011 and funded primarily by Genome Canada and Genome British Columbia.

Latin Name	English Name
<i>Ceratocystis fagacearum</i>	Oak Wilt
<i>Ceratocystis laricicola</i>	Blue Stain Fungus (host: larch)
<i>Ceratocystis polonica</i>	Blue Stain Fungus (host: spruce)
<i>Fusarium circinatum</i>	Pine Pitch Canker
<i>Geosmithia morbida</i>	Thousand Canker Disease
<i>Gremmeniella abietina</i> (EU race)	Scleroderis Canker, European Strain
<i>Phytophthora kernoviae</i>	No common name
<i>Phytophthora ramorum</i>	Sudden Oak Death
<i>Rosellinia necatrix</i>	White Root Rot Fungus
<i>Sclerotinia pseudotuberosa</i>	Acorn Black Rot

Blue stain fungus

Identified for the first time in Poland, *Ceratocystis polonica* is a fungus that causes significant mortality in Norway spruce, its preferred host, in Europe. It shows a high level of pathogenicity against this tree species, regardless of the age or health status of the infected tree.

The tissues of infected conifers fill up with resin in an attempt to defend themselves by impeding the spread of the mycelium and of the toxins it releases. However, the fungus overcomes the natural defences of trees, even healthy ones, and rapidly invades the vessels in which sap flows. The size of the lesions that appear underneath the bark depends on the virulence of the attack. Not only does the fungus destroy large portions of the sapwood, the part of the wood that contains the living cells and nutrient reserves, it also invades the cambium, the living tissues that ensure the tree's diameter growth. *Ceratocystis polonica* is so highly virulent, it is one of the only fungi that can cause a reduction in diameter growth just a few weeks after it infects a tree. Trees can even die within only about 15 weeks of mass inoculation.

This blue stain fungus is often associated with the European spruce bark, its primary vector.

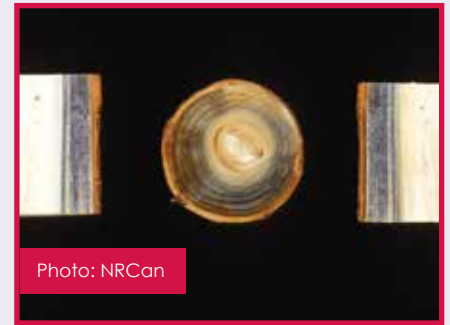


Photo: NRCan

Thousand canker disease

This disease, which originates from the United States, is caused by two pests acting together: a fungus (*Geosmithia morbida*) and a tiny insect (*Pityophthorus juglandis*). The insect excavates numerous galleries in the inner bark layer, more precisely inside the phloem, where phloem sap flows. This network of galleries blocks the flow of phloem sap, depriving the tree of nutrients that are essential to its growth.



Photo: Ned Tisserat, Colorado State University, Bugwood.org

As for the fungus, which is carried by the insect, its presence inside the galleries leads to the development of multiple cankers under the bark that accelerate the infected tree's decline. The wood around these galleries becomes discoloured. Trees may die quickly, often within a year after the first symptoms appear. The symptoms are similar to those associated with drought: leaves turn yellow and wilt, and subsequently turn brown. Damage first appears in the tree's upper crown and progresses down the tree. Given their small size, the insects are difficult to locate, and the entrance holes, which are just as minuscule, can only be seen with a magnifying glass.

Researchers and monitoring agencies are concerned about this disease for several reasons. First, the insect-fungus association can kill a large black walnut tree in less than a year. Also, affected trees are generally doomed, since the appearance of symptoms means that the tree is already heavily infested. Finally, black walnut is a high-value tree that is already in trouble in some regions of North America.

Useful links

taigaforesthealth.com

exoticpests.gc.ca

cfs.nrcan.gc.ca/publications/download-pdf/35303?lang=en_CA

For more information, please contact: Richard Hamelin

Natural Resources Canada
Canadian Forest Service
Laurentian Forestry Centre
1055 du P.E.P.S.

P.O. Box 10380, Stn. Sainte-Foy
Quebec City, Quebec G1V 4C7
418-648-3693

richard.hamelin@nrcan-rncan.gc.ca
nrcan.gc.ca/forests