Branching out

from the Canadian Forest Service ▪ Laurentian Forestry Centre

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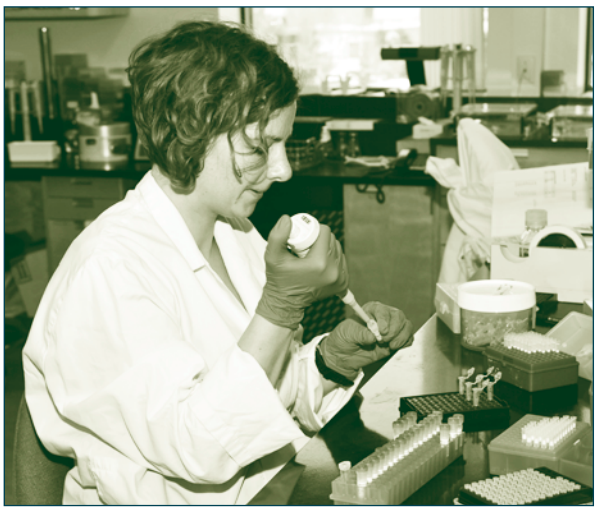
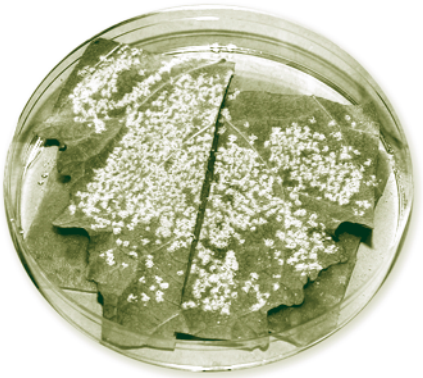
The DNA barcode: a unique identifier for pathogenic forest fungi

In the era of molecular biology, DNA barcoding is being used to fill gaps in taxonomy and confirm findings obtained through traditional approaches based on morphological differences between species. DNA barcodes can be used to correctly identify and classify any kind of living organism.

Forest pathology is the scientific study of forest tree diseases and of methods of controlling diseases that affect forest trees and stands. A forest tree species may become susceptible to disease when a living agent or an environmental stressor, such as drought, causes changes in its growth, morphology or physiology. Living organisms capable of causing disease can be divided into three main categories: fungi, bacteria and viruses. Fungi constitute the largest group of tree pathogens. In the past, the most damaging tree diseases were often caused by exotic fungi with the ability to circumvent the trees' normal defence mechanisms. Dutch elm disease and white pine blister rust are two well-known examples of such diseases.



Researcher at work in an LFC laboratory.
Photo: Gervais Pelletier (CFS)



Poplar leaf rust caused by Melampsora aecidioides-P. x canescens.
Photo: Gervais Pelletier (CFS)

Researchers at Natural Resources Canada's Canadian Forest Service are working with colleagues at Université Laval and the University of Guelph to increase their understanding of tree diseases and develop methods for preventing their spread. A proper diagnosis is the key to effective control and therefore to minimizing the negative impact of disease on all forest resources.

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One of the primary challenges that forest pathology researchers face relates to the accurate identification of pathogenic fungal species. Many of them have few morphological features that can be used for diagnostic purposes. A new molecular biology tool called DNA barcoding can be used to differentiate such species. A DNA barcode is a short segment of DNA from one or a few genes that contain sufficient variation to permit the rapid and effective identification of individual species. All individuals have an internal genetic label that identifies the species to which they belong, somewhat like UPC barcodes on consumer products.

DNA barcoding is a fast, easy and inexpensive method for identifying genetic differences resulting from the evolution of species. It also helps to overcome the shortcomings of traditional methods of identification based on sometimes indistinguishable morphological features.

DNA barcodes for pathogenic forest fungi may prove to be a powerful identification tool, enabling experts to distinguish between phytopathogenic fungi that have only benign effects on forest trees and those that can cause severe damage to forests in Canada.

In this collaborative research, DNA barcoding has been used to identify the fungal species that cause poplar leaf rust. To complete their life cycle, these microscopic fungi must infect other plant hosts, called "alternate hosts," such as larches, pines or even herbaceous plants. Some of the fungi are highly virulent to their alternate hosts. For example, the species *Melampsora pinitorqua* Rostr. causes pine twisting rust in Scots pine throughout Europe. Given the susceptibility of Canadian pines to this pathogen and the threats posed by the continued expansion of world trade, it is important to implement measures to prevent introduction of the fungus and its spread in North America. This highly destructive fungus (*M. pinitorqua* Rostr.) belongs to a complex of morphologically indistinguishable species found on poplars. It therefore cannot be identified by conventional microscopy.

Fortunately, DNA barcodes specific to the causal pathogens of poplar leaf rust provide a means of solving this problem. Using this method, the researchers were able to demonstrate that there is no evidence indicating that *M. pinitorqua* Rostr. is present in Canada. They have also created a tool that Canadian regulatory agencies can use to detect undesirable species.

C C C A A A G - G C A A C
Melampsora aecidioides (present in Canada)

T A C A A A G T C T G A C
Melampsora pinitorqua (not present in Canada and undesirable)

Two pathogenic fungi of poplar and their respective barcodes.

USEFUL LINKS:

International Barcode of Life Project
www.ibolproject.org

Forest Invasive Alien Species
www.ExoticPests.gc.ca

Insects and diseases of Canada's forests
http://imfc.cfl.scf.rncan.gc.ca

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