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Branching Out
from the Canadian Forest Service - Laurentian Forestry Centre

Auto-inoculation: Making Insects Agents of Their Own Destruction

If a pair of flies was able to reproduce unimpeded for five years, the Earth's surface would be covered with a 1.5 m thick layer of buzzing insects. Fortunately, this could never happen because natural control mechanisms keep insect populations in check. Entomopathogenic fungi, which cause disease in insects, constitute an important control factor. These naturally occurring fungi, which target specific insects, are being used increasingly to control insect pests, and they may prove to be invaluable allies against the emerald ash borer.

Two birds, one stone

A Lindgren funnel trap[1] is baited with a particular attractant to capture specific forest insect pests; the insect penetrates into the trap and cannot escape. This technique can be used to kill insects one by one, but it only works with insects that actually enter the traps. Could these traps be used to kill insects without capturing them, perhaps even without needing them to go into the trap?

Researchers at the Canadian Forest Service (CFS) involved with the ECOBIOM group (see box) modified a Lindgren trap by adding a special chamber containing spores from a pathogenic fungus. When an insect (male or female) is attracted to the lure and enters the trap, it walks on the spores and becomes contaminated (auto-inoculation). From this point on, its days are numbered, but it will not die in the trap. Indeed, the trap is designed to allow the insect to escape right away and fly off to breed with its partners, thereby transmitting the lethal spores. This kills two birds with one stone: the insect inoculates itself when it enters the trap and it then disseminates the fungal spores to other insects. Under laboratory conditions, 80% of insects die within the first four days following contamination.

Field testing of a prototype for the pine shoot beetle.
Photo: R. Lavallée (CFS)

Laboratory follow-up.
Photo: R. Lavallée (CFS)

Initially designed for use in pine shoot beetle and spruce beetle control, this type of trap is currently being tested in the field by CFS research teams against the emerald ash borer in Ontario and against the brown spruce longhorn beetle in Nova Scotia.

The specific case of the emerald ash borer

The emerald ash borer, an exotic beetle from Asia, was first detected in the United States and Canada in 2002, specifically in the twin cities of Detroit and Windsor. The pest was then detected in the Montérégie region in 2008 and in Montreal in the summer of 2011. Although 10% of gravid (egg-bearing) females can fly distances of up to 20 km per day (based on laboratory modelling), human activities, particularly the movement of infested firewood, seem to be the most likely explanation for the insect's long-distance dispersal.

Use of the trap for the emerald ash borer.
Photo: R. Lavallée (CFS)

1. Lindgren traps, which consist of a series of superimposed funnels, are commonly used to trap insects that bore galleries in trees.

Canada

The emerald ash borer has already killed millions of ash trees in southwestern Ontario, in Michigan, and in neighbouring states. Although it is too late to think about eradicating the pest in Canada, this auto-inoculation and dissemination research provides a new strategy for halting its spread.

Canadian Forest Service researchers still have several questions to address. How far do insects disperse after they become contaminated in the trap? Are males and females equally effective at transmitting the fungal spores to their partners and to eggs? How long do the insects remain contaminated? Are there other fungal species that would be more effective? What is the optimal fungal dose for killing an insect that enters a trap? Research partnerships will definitely play an important role in advancing knowledge and implementing these innovations.

Useful links

Protecting ash trees
from the emerald ash borer:
http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/31746.pdf

Forest Invasive
Alien Species of Canada:
http://www.exoticpests.gc.ca/

Invasive Species
in Canada:
http://www.inspection.gc.ca/english/plaveg/invenv/invenve.shtml

ECOBIOM

The ECOBIOM (Extended COllaboration on Biological control of forest Insects Or pathogenic Micro-organisms) research group is working to advance knowledge about the biology and the use of fungi as control agents for forest insect pests and diseases. Since 2007, two members of this group—Robert Lavallée (CFS) and Claude Guertin (Institut national de la recherche scientifique, INRS)—have been investigating the potential for using entomopathogenic fungi as biological control agents. Their initial biocontrol studies using entomopathogenic fungi focused on bark beetles, which are very difficult to control, and led to the idea of self-inoculation.

The national ECOBIOM group: Robert Lavallée, Johny Shajahan, Barry Lyons, Claude Guertin, Kees van Frankenhuyzen, Gene Jones and George Kyei-Poku. Missing from photo: Jon Sweeney and Martine Blais. Photo: S. Hooey (CFS)

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Adult emerald ash borer.
Photo: D. Cappaert (Michigan State University)

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