BIOLOGICAL CRUISE MISSILE

BEETLE VERSUS BEETLE IN FOREST PROTECTION

KEYWORDS

· Exotic pests
· Monitoring
· Biological control

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EXHIBIT 2

Figure 1 Adult *Dendroctonus micans*.

BACKGROUND – MANAGING EXOTIC PESTS

One of the most serious threats to forestry and agriculture is the introduction of 'exotic' pests from other regions. As an island, Britain is much less exposed to pests spreading by natural mechanisms than continental countries. But pests that can cause economic or environmental damage can be hidden in the vast volumes of goods imported into the country each year. Inspection and, where necessary, treatment of imported goods at ports of entry keeps many pests as well as pathogens at bay but occasionally some avoid detection and are transported inland where they become established locally. These exotic pests have usually given their natural enemies the slip and, free from natural controls, they can quickly reach outbreak levels. For many of these pests, eradication is not a practicable possibility so limiting further spread and reducing their populations are the key strategies for minimising their impact in the new environment.

In forestry, exotic bark beetles are a particular threat because they can be concealed in imported timber. The most damaging species tunnel to form galleries within the bark of living trees where their larvae feed and develop, ultimately killing the tree. In western Britain, the spruce bark beetle, *Dendroctonus micans,* is a well-established pest that was accidentally introduced from continental Europe (Figure 1). Spruce is our most important commercial tree species and managing this pest is a high priority. Our approach to management has been twofold: first, to restrict spread by annual surveys around the edge of a quarantined area followed by destruction of infested trees and, secondly, to breed and release a host-specific predatory beetle, *Rhizophagus grandis*, found within the pest's natural range, in a strategy known as 'classical' biological control.

The biological programme has been highly successful because of the extraordinary ability of the predator to locate its prey even when there may be only a few infested trees in the forest. Our research has been focused on identifying the chemical cues that the predator uses to locate its prey – ie on the guidance system of a biological cruise missile!

ABOUT THE RESEARCH

The larvae of the bark beetle *Dendroctonus micans* aggregate together in a large gallery in spruce trees, eating the resinous bark and producing large amounts of faeces or 'frass' (Figure 2, overleaf). In behavioural experiments with the predator *Rhizophagus grandis*, using wind tunnels we were able to show that this frass is highly attractive to the predator, much more so than the resin that flows from the gallery entrance formed by adult bark beetles or indeed the bark itself. In collaboration with researchers at the University of Cardiff, we made different solvent extracts of frass and tested them individually and in combination for their ability to attract flying predators. The most attractive solvent fraction contained several resinous compounds called monoterpenes which are detected by sense organs located on the antennae (Figure 3, overleaf). However, these same

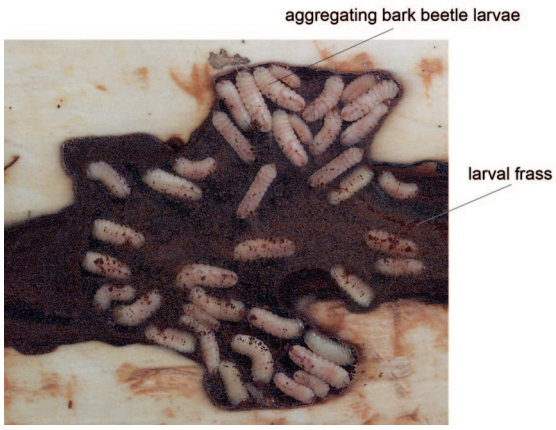

Figure 2 A gallery in bark formed by larvae of the bark beetle, *Dendroctonus micans*.

Figure 3 The predator *Rhizophagus grandis*. Sense organs that detect chemical signals from the prey are located on the antennae, one of which has been magnified (inset).

monoterpenes also occur in bark as well as in the 'resin tubes' at the entrance to the gallery, so why is frass in particular so attractive? The secret of specificity lies in the blend – the distinctive 'bouquet' from the particular ratio of monoterpenes present in the frass. Some monoterpenes such as β-pinene are especially attractive at low concentrations but the blend of monoterpenes always elicits a greater response in the wind tunnel. By mixing together synthetic monoterpenes in appropriate ratios, we have obtained an artificial lure that has proved to be highly attractive not only in laboratory experiments but also when deployed as a bait in traps within the forest.

The laboratory-based studies have given us a real insight into how prey location may occur in the complex forest environment. They suggest why this particular bark beetle predator, unlike many others, attacks only a single species and why therefore it is such an ideal agent of biocontrol. Our research shows that the chain of events in prey location goes something like this: the predator initially responds to some of the individual monoterpenes that are highly attractive at low concentrations and which therefore function as long range attractants. Closer to *D. micans* infested trees within the forest, the distinctive 'bouquet' of the monoterpene mixture in frass initiates orientation to the tree followed by landing as a visual response to the trunk silhouette. Once on the tree, predators walk to the source of frass odour and enter the bark beetle gallery. Within the gallery, final identification of the prey may occur through a response to specific chemicals associated with the bark beetle larvae such as those that influence larval aggregation or perhaps by chemicals that stimulate egg laying.

WHAT'S NEXT?

The specificity of the association between predator and bark beetle and the development of an artificial lure offers the exciting possibility of using the predator to detect the bark beetle at the edge of its expanding range. This could provide a much more cost-effective method of monitoring and detection than the current labour-intensive visual survey methods. For example predators could be released in vulnerable forests and traps baited with the artificial lure deployed in the following year. Only predators that find and breed in bark beetle galleries will still be present after a year, so finding the predator means that bark beetle infested trees are certain to be nearby. Forest managers can readily locate and destroy these trees. Not only does the predator find the target, it may help *us* find it too.

FURTHER INFORMATION

Forest Research. **www.forestresearch.gov.uk** for further information about research on forest pests.

Forestry Commission. **www.forestry.gov.uk/plant health** for information on threats to UK forests from exotic pests and pathogens.

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