except that females become sterile and unable to produce eggs once they are parasitised. When the parasite is fully developed it leaves the weevil, killing its host, and forms a pupa from which a new wasp emerges.

The first step in our research was to identify native species that could potentially be at risk from these introduced insects. These were considered most likely to be taxonomically related native weevils, and particularly those that live in environments similar to those of the intended hosts, and would therefore be recognised by the parasitic wasps as possible targets. Both target pests – sitona weevil and Argentine stem weevil – are members of the large broad-nosed weevil subfamily, Brachycerinae, a group that includes many native species in New Zealand.

Many of these native weevils are found in modified pastures as well as their natural tussock grassland and alpine environments. Their distribution therefore overlaps with the pest species, especially in pastures and semi-modified grassland areas, but both sitona weevil and the Argentine stem weevil can also be found occasionally in native grasslands, extending up to the alpine zone.

From a list of related native species collected during surveys of grassland, a number were selected for laboratory tests, in which they were held in cages and exposed to the parasitic wasps. The results of these tests indicated that one of the introduced wasp species, *M. aethiopoides*, was very much more successful in attacking and developing in native weevils, than the other – both in terms of the number of species in which the wasps laid eggs, and the number of individual weevils in each test that were parasitised (see table above). Most of the native species parasitised by *M. aethiopoides* are in the genera *Irenimus* and *Nicaeana*, but one was the subalpine to alpine species *Zenagraphus metallescens*, a weevil that is two to three times the size of the intended sitona host.

Parasitism of native weevils

Although it was reassuring to find the laboratory tests matching results in the field, it was worrying to discover what was thought to be a reasonably host-specific biological control agent attacking a number of native weevil species.

	Wasps introduced as biological control agents	
	Microctonus aethiopoides	*Microctonus hyperodae*
Laboratory tests		
No. native species parasitised/no. tested	7/7	5/7
Average parasitism	58%	13%
Field monitoring		
Number native species parasitised	13	1
Maximum parasitism recorded	71%	3%
Number of sites where parasitism was found in native species	10	1

To see how well laboratory tests could "predict" what might happen in the field, surveys of native weevils have been carried out to ascertain whether they are being parasitised "naturally" in the environment. From these studies, we found that again, *M. aethiopoides* is far more successful in exploiting native weevils as hosts, than is *M. hyperodae*, with up to 70 percent of one native weevil population in pasture being attacked by the former.

While the result was encouraging in indicating that laboratory testing can give a useful indication of likely impact in the environment, it was also worrying that such a non-specific parasitic organism has been released. The studies will continue with regular monitoring of some of the native weevil species that are being parasitised, so that we can gain an understanding of longer-term effects of *M. aethiopoides* on the species concerned.

BARBARA BARRATT

Tussock grassland on the East Otago Plateau at about 900 metres. This is typical broad-nosed weevil habitat where population densities can reach 30 per square metre.

BIOLOGICAL CONTROL agents are usually released to combat an agricultural pest problem, but obviously once they are released, they spread by their own means into any suitable environment including conservation areas. The research at Invermay has shown that introduced biological control agents can pose a risk to native species, although more work is required to work out the extent to which native weevil populations are threatened, and whether other introduced biological control agents are having a similar impact.

The environmental implications of non-target effects of biological control agents are clearly complex, ranging from direct effects upon the survival of non-target hosts, to ecological ramifications which follow in food webs when there is a substantial change to the status of any species in an ecosystem. Depending upon the role of the "at risk" species in the ecosystem, and the balance and complexity of the system itself, changes may be almost insignificant, or conversely they may impact severely upon a number of other species. This makes prediction of effects extremely difficult.

It is important to realise also that effects might not be noticed for many years. The chances of an introduced biological agent affecting non-target organisms increases over time as the introduced agent spreads and comes into contact with more native species.

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