**THE DISTRIBUTION OF THE PARASITOID *MICROCTONUS*
AETHIOPOIDES LOAN (HYMENOPTERA: BRACONIDAE)
IN SOUTHERN SOUTH ISLAND *SITONA DISCOIDEUS*
GYLLENHAL (COLEOPTERA: CURCULIONIDAE)
POPULATIONS**

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SUMMARY

The parasitoid, *Microctonus aethiopoides* was released in New Zealand in the early to mid 1980s including two sites in Otago, to control *Sitona discoideus*. In order to determine its establishment and spread in *S. discoideus* and associated non-target weevil populations, 88 lucerne stands throughout Otago and Southland were sampled during summer 1993-4. Parasitised *S. discoideus* were recorded at 58 sites with parasitism levels of up to 100%, indicating successful establishment and spread in the target host since its introduction. Of the native and other non-target weevil hosts, about 12% were parasitised, including the introduced biological control agent, nodding thistle receptacle weevil, *Rhinocyllus conicus*.

Keywords: *Sitona discoideus*, *Microctonus aethiopoides*, biological control, survey, non-target hosts

INTRODUCTION

Sitona discoideus Gyllenhal (Coleoptera: Curculionidae), a univoltine aestivatory pest of lucerne, was first discovered in New Zealand in 1974 and is now found throughout the country where ever lucerne (*Medicago sativa* L.) is grown. Crop damage occurs from adult weevil feeding on the foliage but, more importantly, as a result of larvae feeding on root nodules, depriving the plants of nitrogen and thereby reducing crop vigour and quality (Goldson 1993).

S. discoideus adult emergence occurs in late December, followed by a period of intensive feeding, development of flight muscles and then flight to aestivation sites, often remote from lucerne. The weevils return to lucerne stands in autumn often dispersing quite widely. After re-establishment, the weevils feed and become reproductively mature and remain so for the rest of their life span (Goldson *et al.* 1984). Eggs are laid throughout winter but most of those which give rise to the damaging larval populations are thought to be those laid in September (Frampton 1984). While good results can be obtained using insecticides to control pre-reproductive adults, this requires farmers to anticipate in May the problems which result from larval damage in November-December.

In 1982, the parasitoid *Microctonus aethiopoides* Loan (Hymenoptera: Braconidae) was introduced from Australia (Stufkens *et al.* 1987) where it had been introduced as a biological control agent originally from the Mediterranean region. *M. aethiopoides* lays a single egg within the weevil's body cavity causing sterilisation within a few days and, after full parasitoid larval development, eventual death of the weevil. The potential of this wasp as a biological control agent against *S. discoideus* was recognised by Aeshlimann (1980) in the Mediterranean region, where levels of parasitism of up to 31% had been recorded. *M. aethiopoides* has since been shown, in New Zealand, to be a highly effective parasitoid reaching 60% parasitism (Goldson *et al.*, 1990). A single wasp has been shown to infect up to 64 weevils in its 2 week life span (Proffitt and Goldson 1987).

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After limited host range testing, *M.aethiopoides* was released at 17 sites around Marlborough, Canterbury and Central Otago (Stufkens *et al.* 1987). Follow up monitoring of the introductions in 1985-86 (Stufkens *et al.* 1987) showed that *M.aethiopoides* had established at 90 of 110 South Island sites surveyed. Goldson *et al.* (1993) have since demonstrated the success of this wasp using population simulation models, and conservatively estimated the value of its introduction at between \$5.6 and \$6.8 million p.a. The releases made in Central Otago were at Earnscleugh (near Alexandra) in 1983, 1984 and 1985, and near Middlemarch in 1985. Monitoring the establishment and spread of *M.aethiopoides* by Stufkens *et al.* (1987) in Central Otago was very limited but *M.aethiopoides* was located at two of seven sites sampled, both very close to the release site at Earnscleugh. Its establishment at Middlemarch and its spread from both sites have not been measured.

The aim of this investigation was to determine the extent of establishment of *Microctonus aethiopoides* in the southern South Island since its introduction to Central Otago and the Strath Taieri, and to determine the levels of parasitism of *S. discoideus*. Parasitism in native and other non-target weevil species collected from lucerne, other than *S. discoideus* was also investigated.

METHODS

Between November 1993 and February 1994, 88 lucerne paddocks (Table 1; Fig. 1), approximately 10 km apart along major roads, were sampled throughout the southern South Island, by sweep netting to collect weevils from the aerial portions of the plants, or by using a 'Homelite Blower-Vac' to suck the weevils from the plants and litter. On some occasions both methods were combined. Samples were collected from throughout the paddocks and combined for each paddock. The samples were stored at 4°C and processed by extracting weevils by hand. Adult weevils were dissected under a binocular microscope after embedding the ventral surface of the weevil in wax. The elytra, wings and dorsal integument were removed and the thoracic and abdominal cavities searched for parasitoid eggs or larvae. Weevil species other than *S. discoideus* which were collected in the field samples were identified and dissected in the same way.

Figure 1: Lucerne paddocks surveyed and the distribution of *M.aethiopoides* in the southern South Island.

RESULTS AND DISCUSSION

Of the 88 lucerne paddocks sampled during summer 1993–4, *S. discoideus* adults were collected from 75, and *M. aethiopoides* was found to be parasitising weevils from 58 of these (Table 1; Fig. 1). The number of weevils dissected per site ranged from 1 – 131. *S. discoideus* was least abundant in samples taken during the first 2 weeks of December, before the emergence of the new generation. While a generation overlap was apparent the majority of the weevils collected between mid December and mid February were teneral.

Parasitism levels were particularly low at the Waitaki and North Otago sites sampled in January 1994 (Table 1), possibly because of the relative phenologies of the weevils and the parasitoid. The same may have applied to the Southland lucerne stands where parasitism was low, but numbers of *S. discoideus* collected from these sites were probably too low to give a reliable estimate. Evidence of encapsulation, a response of the host to parasitism, of a small proportion of the parasitoid larvae was observed.

TABLE 1: *Microctonus aethiopoides* in the southern South Island of New Zealand.

Location	No. sites sampled	No. sites sampled <i>M. aethiopoides</i>	n ²	% parasitism ¹		
				range	mean	SEM
Waitaki/North Otago	27	18	704	2-90	19	4.9
Strath Taieri/Maniototo	17	14	327	17-100	53	5.5
Central Otago	29	19	316	8-100	50	6.7
Wakatipu	9	5	181	2-100	67	16
Southland	6	2	54	6-27	16	10

¹ For sites where *M. aethiopoides* was found.

² Number of *S. discoideus* dissected.

In addition to *S. discoideus*, native and other introduced weevil species were present in the lucerne samples (Table 2). Native weevils were present at 25 sites, represented by 15 species in the genera *Irenimus*, *Nicaeana*, *Brachyolus*, and *Catoptes* (Subfamily: Brachycerinae). Of these, seven individuals comprising four species of *Irenimus* were parasitised (Table 2). Three introduced weevils species were present at a total of 11 sites, comprising *Rhinocyllus conicus* Frolich (Subfamily Curculioninae), *Listronotus bonariensis* (Kuschel) and *Otiorynchus ovatus* L. (Subfamily Brachycerinae) (Table 2). Of these introduced species, two of the *L. bonariensis* specimens and one specimen of *R. conicus* were found to be parasitised (Table 2).

TABLE 2: Other weevil species collected from lucerne paddocks.

	No. sites	No. weevils dissected	No. parasitised weevils
Native			
<i>Irenimus</i> spp	21	49	7
<i>Nicaeana</i> spp	6	11	0
<i>Catoptes</i> spp	1	2	0
<i>Brachyolus</i> spp	3	7	0
Introduced			
<i>Listronotus bonariensis</i>	6	11	2
<i>Rhinocyllus conicus</i>	3	3	1
<i>Otiorynchus ovatus</i>	2	2	0

While the identity of the parasitoid larvae dissected from native and introduced weevil species have not been positively confirmed, most were first instar larvae with head capsule and mandibular structure consistent with the characters of *M. aethiopoides*, including the parasitoid larva in the *R. conicus* specimen (examined by C.B. Phillips, AgResearch, Lincoln, pers. comm.). The capacity of this parasitoid species to parasitise *R. conicus* has been demonstrated in the laboratory (G.M. Barker, AgResearch, Ruakura pers. comm.).

The lack of an adequate environmental impact assessment study prior to the release of *M. aethiopoides* is of concern. The fact that four species of native weevils, and even the beneficial weevil *R. conicus*, itself introduced as a biological control agent for nodding thistle (*Carduus nutans*), were found to be parasitised by *M. aethiopoides* during this study, attest to the need for more stringent host range testing procedures to be developed. *M. aethiopoides* parasitism of *L. bonariensis* at levels of up to 2% in Canterbury (Goldson and Proffitt 1991), and levels of up to 5% in Otago (Barratt unpublished data) have been recorded. It has also been reared from the native brachycerine weevil *Irenimus aequalis* Broun in Canterbury (McNeill *et al.* 1993) and the Waikato (Barker unpublished data).

In addition to the presence of insect parasitoids, two *S. discoideus* adults collected from Gimmerburn (Maniototo) contained an unidentified and previously unrecorded protozoan species (T. Jackson, AgResearch, Lincoln pers comm.). The significance of this find merits further investigation.

The most common method by which *M. aethiopoides* has become distributed throughout the country is likely to have been via *S. discoideus* dispersal flights. The phenology of both parasite and host are closely integrated, such that when *S. discoideus* leaves the lucerne to aestivate, parasite development beyond the first larval instar is inhibited until recommencement of host activity. However, Goldson *et al.* (1990) observed that 3% of the Canterbury population did not enter sympatric aestivation with their hosts, but rather continued to develop in pre-aestivatory weevils. Such atypical parasitoid development prevents infected weevils from flying out of the lucerne to aestivate, leaving a pool of parasitised weevils in the lucerne stands. This, and the associated ability of the parasitoid to suppress a large proportion of the *S. discoideus* population prior to egg laying in autumn and winter (Goldson *et al.* 1993) has probably contributed to the build up of parasitism to levels up to ten times greater than those observed in Australia (Goldson and Proffitt 1986).

Goldson *et al.* (1984) expressed concern over the survival of the parasite in the period between the old generation of weevils disappearing and the new generation weevils emerging. However the generation overlap found in Otago populations by Goldson *et al.* (1984) was again apparent in this investigation thereby allowing *M. aethiopoides* to successfully transfer from the old to the new generation of weevils. The presence of native weevil species in mixed populations with *S. discoideus* in lucerne may have also assisted the parasitoid to survive between generations of the target host.

CONCLUSION

The results from this investigation indicate that *M. aethiopoides* is well established within the southern South Island. Although not found at all sites sampled it is reasonable to assume, because of its distribution, that *M. aethiopoides* is ubiquitous in the region.

It has spread throughout the major lucerne growing areas and also to locations where lucerne is a minor crop. In the context of these conclusions the introduction of *M. aethiopoides* into the region and New Zealand must be seen as successful. However the results also attest to the need for more stringent host range testing procedures to be developed.

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