THE SEASONAL BEHAVIOUR OF THE PARASITE *MICROCTONUS AETHIOPOIDES* AND ITS EFFECTS ON SITONA WEEVIL

S.L. GOLDSON and J.R. PROFFITT

Canterbury Agriculture and Science Centre, MAF, P.O. Box 24, Lincoln

SUMMARY

Field and insectary studies demonstrated that the braconid parasite *Microctonus aethiopoides* went through between three and four generations in 1985. Incidence of parasitism in *Sitona discoideus* was 20-30% which significantly reduced autumn weevil densities. Parasitism may also have reduced the duration of the egg laying period in spring by 2-3 weeks. However the net effect of this may be negligible because of density-dependent mortality in Sitona weevil larval stage. Early in the 1986 reproductive season infection levels were between 40 and 55%. This variation in incidence of parasitism between seasons may result in a corresponding variation in efficacy of *M. aethiopoides* as a control agent.

INTRODUCTION

As a pest of lucerne, the effects of *Sitona discoideus* on production are now reasonably well understood (e.g. Goldson *et al* 1985; Goldson and Proffitt 1985).

In view of the weevil's univoltine aestivatory life cycle, (Goldson *et al* 1984), it is generally recommended that a single insecticide application should be made in late May, prior to the onset of egg-laying. This effectively precludes the spring establishment of the larval stages which are difficult to control (Barratt 1985). Frampton (1984) has shown that applications up to mid-August may continue to be useful. While good results have been obtained from this insecticide use, it imposes an additional cost and there have been extension difficulties in getting growers to anticipate in May problems which may occur in November-December. In an attempt to offset these limitations, DSIR has been releasing the braconid parasite *Microctonus aethiopoides* at various South Island sites since 1982 (Stufkens pers.comm.).

Aeschlimann (1978, 1980) has observed the potential value of this wasp in the Mediterranean region as a biological control agent against *S. discoideus.* He confirmed that once the parasite egg is laid within the weevil's body cavity sterilisation ensues within days and after full parasite larval development, the host weevil inevitably dies (Aeschlimann 1983). In the Mediterranean region he found five generations a year with parasitism levels of up to 31% (Aeschlimann 1978). *M. aethiopoides* imports into Southern Australia commenced in 1976 (Cullen and Hopkins 1982) where Sitona weevil had been present since 1958 (Chadwick 1960). The wasp was found to establish satisfactorily in Australia with dispersal rates of about 10 km a year (Aeschlimann 1983). Initially control was felt to be promising (Hopkins 1982) but recent observations in South Australia have suggested otherwise (Hopkins pers comm). Hopkins (1985) has observed that post-aestivatory *S. discoideus* egg-laying in the autumn is the most important period for larval establishment in annual medicks (*Medicago* spp.) but this allows little time for a useful post-aestivatory build-up of parasites before damaging numbers of *S. discoideus* eggs are laid. In New Zealand, however, Frampton (1984) has found that the spring (September-November) egg-laying period contributes most to subsequent larval densities in lucerne. This later period of significant egg-laying may therefore present the parasite with a longer period over which to usefully act.

This paper describes the bionomics of the parasite as observed in 1985 and discusses its probable effects on the weevil population from year to year.

METHODS

The research site for this study was at Tinwald near Ashburton at a site where DSIR first released *M. aethiopoides* in 1982 (Stufkens pers comm).

Weevil population densities and levels of parasitism

From 8.2.85 to 10.4.85 and 13.2.85 to 11.11.85 weevils were randomly collected at weekly intervals from aestivation sites and a lucerne stand respectively. These were taken to the laboratory and assessed for levels of parasitism by dissection. Sample sizes ranged from 30-50 weevils depending on their availability. To test for variability in infection levels from season to season, samples were again taken from the same lucerne stand on 10.4.86, 28.5.86 and 7.6.86.

At the time of collection, field population densities of the weevil were measured by taking 20-30, 0.2 m^2, litter samples using a modified high-powered vacuum cleaner. The samples were sorted in the laboratory and the weevils counted.

Insectary assessment of number of parasite generations

Once the post-aestivatory return of weevils to the lucerne crop had commenced in early April, an insectary experiment was established to determine the number of parasite generations that were likely to occur during the course of the *S. discoideus* reproductive season.

The cages used in this experiment were based on those developed by Aeschlimann (1978). They consisted of 190 mm x 120 mm x 100 mm plastic boxes fitted with 0.9 mm nylon gauze floors through which the prepupal parasite larvae could pass. Earlier stages of the parasite develop within the haemocoel of the weevil. The cages were initially stocked on 15/4/85 with 100 field-collected weevils from the parasite release site at Tinwald. The weevils were provided with fresh lucerne throughout the experiment. The dates of emergence of parasite prepupae were noted as were the times required for their development into adults.

Once adult parasites had been procured as above, non-parasitised populations of c. 200 weevils were collected from Darfield and 'inoculated' with the adult parasites in similar cages, again in the insectary. Duration of each generation was determined by noting the elapsed time required before the next generation of adults emerged. This procedure was continued until late November by which time the *S. discoideus* populations in the field had become depleted through ageing.

RESULTS AND DISCUSSION

The field incidence of *M. aethiopoides* parasitism of *S. discoideus,* and the associated weevil densities and generation times (as measured in the insectary) in 1985 are presented in Fig. 1. The much higher levels of infection, measured at Tinwald in 1986 are also indicated. For comparison, Fig. 1 shows the behaviour of a larger, unparasitised *S. discoideus* population observed at Darfield in 1982.

From the figure, it can be seen that the level of infection of the aestivating weevils in February 1985 was c. 15%. This level was considerably higher than those observed by Cullen and Hopkins (1982) in South Australia who noted aestivating populations with parasitism levels of 0.04% and 6.5%. In spite of this promising start at Tinwald, infection levels apparently declined during the weevils' post-aestivatory flights back to lucerne, as the initial field infection was found to be only c. 3%. However by mid-May this had risen to 20-30% (Fig. 1). Infection of this order persisted throughout 1985 and is comparable to those levels found by Cullen and Hopkins (1982); in 1986 initial infection levels were far higher (Fig. 1).

The levels of parasitism observed at Tinwald in 1985 appeared to have an effect on adult densities. Fig. 1 shows that in May there was a significant drop from c. 35 weevils/m^2 to 25/m^2. Such a decline does not usually occur in an unparasitised population such as that monitored at Darfield in 1982 (Fig. 1). Generally, ground populations of the weevil have been found to remain stable until September-October when mortality through ageing commenced (Goldson *et al* 1984). From June to August the lack of obvious parasitic activity at Tinwald (Fig. 1) probably reflects the high development temperature threshold requirements of the parasite larvae which Hopkins (pers. comm) has calculated to be about 11°C. However examination of Fig. 1 suggests

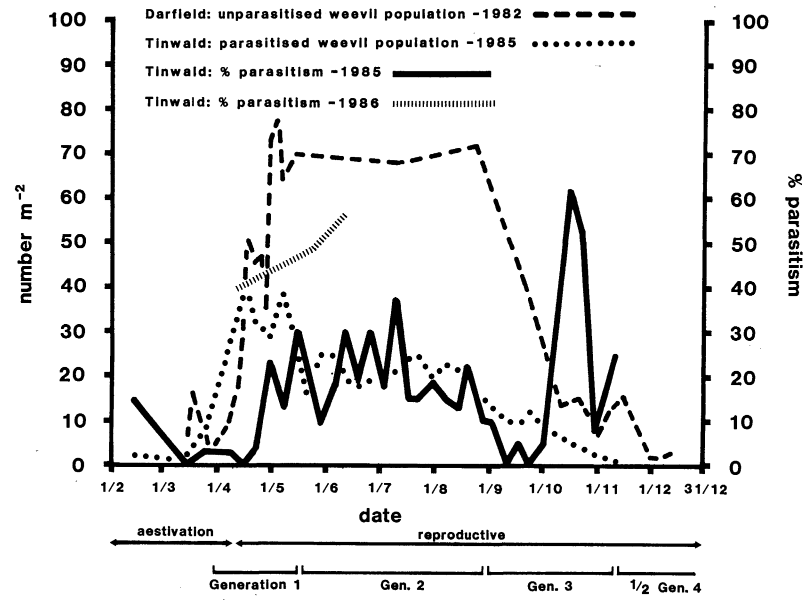

Fig. 1: The relationship between the percent incidence of the parasite *Microctonus aethiopoides* and the ground densities of its host *Sitona discoideus* at Tinwald in 1985. Parasite generation time-spans are indicated along the x-axis. Densities of unparasitised *Sitona discoideus* as measured at Darfield in 1982 are presented for comparative purposes.

that the rate of decline in the parasitised weevil population from mid-August until mid-November was greater than that observed in the unparasitised population, at Darfield. Moreover, the Tinwald population appeared to 'run out' some 2-3 weeks earlier than expected. While these differences in the spring are relatively modest, they could be important as Frampton (1984) has shown September-November to be the most significant period of egg-laying in terms of subsequent larval establishment.

The ability of *M. aethiopoides* to reduce field populations of *S. discoideus* in 1985 was not great. Whether there was likely to have been any reduction in larval densities remains a moot point as recent analysis (Goldson *et al* unpublished) of population data has shown that strongly density-dependent mortality occurs at the egg/larval establishment phase. Consequently a parasite-induced reduction in egg recruitment may often simply result in a corresponding reduction in larval competition mortality and therefore have a negligible effect on larval densities. However, the much higher levels of infection recorded at the Tinwald site in 1986 and elsewhere in Canterbury (Goldson unpublished), indicates that the efficacy of the parasite may vary widely from season to season, perhaps relating to the degree of spring overlap between one generation and the next (Goldson *et al* 1984). This being so, there may be a case for introducing a complementary egg-parasite, such as *Anaphes diana* (Aeschlimann pers. comm.) which may help to stabilise parasite-induced suppression of *S. discoideus* populations.

In general, thorough life-table analyses of *S. discoideus* populations with and without parasitic effects will be necessary before deciding whether or not to continue the current insecticidal recommendations. At present such recommendations work against the survival and dispersal of the biological control agents.

ACKNOWLEDGEMENTS

We gratefully acknowledge the technical advice and co-operation of Mr M.A.W. Stufkens of the DSIR Entomology Division, Christchurch.

REFERENCES

Aeschlimann, J.P., 1978. Heavy infestations of *Sitona humeralis* Stephens (Col., Curc.) on lucerne in Southern Morocco. *Ann. Zool. Ecol. Anim. 10:* 221-225.

Aeschlimann, J.P., 1980. The *Sitona* [*Col.: Curculionidae*] species occurring on *Medicago* and their natural enemies in the Mediterranean region. *Entomophaga 25:* 139-153.

Aeschlimann, J.P., 1983. Sources of importation, establishment and spread in Australia, of *Microctonus aethiopoides* Loan (Hymenoptera: Braconidae), a parasitoid of *Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae). *J. Aust. Ent. Soc. 22:* 325-331.

Barratt, B.I.P., 1985. An attempt to control *Sitona discoideus* larvae with systemic insecticides. *Proc. 38th N.Z. Weed and Pest Control Conf.:* 35-37.

Chadwick, C.E., 1960. *Sitona humeralis* Steph. (Coleptera: Curculionidae) recorded from New South Wales. *Aust. J. Sci. 22:* 453-454.

Cullen, J.M. and Hopkins, D.C., 1982. Rearing, release and recovery of *Microctonus aethiopoides* Loan (Hymenoptera: Braconidae) imported for the control of *Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae) in South Eastern Australia. *J. Aust. Ent. Soc. 21:* 279-284.

Frampton, E.R., 1984. The seasonal pattern of *Sitona discoideus* larval establishment in Canterbury lucerne and its implications for control. *N.Z. J. Exp. Agric. 12:* 319-322.

Goldson, S.L., Frampton, E.R., Barratt, B.I.P. and Ferguson, C.M., 1984. The seasonal biology of *Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae), an introduced pest of New Zealand lucerne. *Bulletin Ent. Res. 74:* 249-259.

Goldson, S.L., Dyson, C.B., Proffitt, J.R., Frampton, E.R., and Logan, J.A., 1985. The effect of *Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae) on lucerne yield in New Zealand. *Bulletin Ent. Res. 75:* 429-442.

Goldson, S.L. and Proffitt, J.R., 1985. Measurement of the impact of different larval densities of *Sitona discoideus* Gyllenhal (Coleoptera: Curculionidae) on Canterbury lucerne. *Proc. 14th Australasian Conf. Grassland Invert. Ecol.:* 26-34.

Hopkins, D.C., 1982. Establishment and spread of the sitona weevil parasite *Microctonus aethiopoides* in South Australia *Proc. 3rd Australasian Conf. Grassland Invert. Ecol.:* 177-182.

Hopkins, D.C., 1985. Controlling sitona weevil, *Sitona discoideus* with insecticides. *Proc. 4th Australasian Conf. Grassland Invert. Ecol.:* 94-98.

Wightman, J.A. and Stufkens, M.A.W., 1986. The establishment of *Microctonus aethiopoides* (Hym. Braconidae), parasite of *Sitona discoideus* (Col: Curculionidae), in New Zealand, *Entomophaga* (in press).