OVERWINTERING BIOLOGY AND SURVIVAL OF THE SITONA WEEVIL PARASITOID *Microctonus aethioides*

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SUMMARY

From insectary studies it was estimated that the New Zealand biotype of the sitona weevil parasite *Microctonus aethioides* required 111 and 88 day-degrees for egg/larval and pupal development respectively. Field-logged temperature data indicated 4 possible generations at Lincoln. At the same site, densities of parasitoids were low in September/early October possibly because wet soil conditions during the winter adversely affected the parasitoid's survival. The inter-generational transition of *S. discoideus* in December represented no impediment to the success of *M. aethioides*; about 3.3 parasitoids/m² apparently infected about 210 emergent pre-aestivatory weevils/m² within 2 weeks.

INTRODUCTION

In 1982, the braconid parasitoid *Microctonus aethioides* was introduced into New Zealand from Australia in an effort to suppress the univoltine aestivatory lucerne pest *Sitona discoideus* (Stufkens *et al* 1987). Little is known of the parasitoid's population behaviour or its impact on the weevil in New Zealand.

M. aethioides was first introduced from its primitive Mediterranean habitat into Southern Australia in 1976, where it established well (Cullen and Hopkins 1982). However, recent indications are that it has had little effect on damaging *S. discoideus* larval populations that establish in medick (*Medicago* spp.) pasture in the autumn (Hopkins 1985) before the winter-acting parasitoid has a chance to act. Conversely, studies on *S. discoideus* larval establishment in Canterbury lucerne have shown that the majority of larvae arise from spring egg-laying (Goldson *et al* 1984; Frampton 1984) so that the autumn and winter months may allow sufficient time for *M. aethioides* to usefully suppress the reproductive weevil populations.

In their insectary study of the overwintering behaviour of *M. aethioides*, Goldson and Proffitt (1986) reported that it undergoes 3-4 generations during the weevil's reproductive span. These results have provided the basis for this study in which the day-degree (D°) requirement for the development of *M. aethioides* was calculated and then related to field temperature data. Such an approach using thermal summation has been widely used elsewhere to forecast insect development (e.g. Worner and Penman 1983).

Goldson *et al* (1984) expressed concern that the weevil's inter-generational period, with no adults present, could be too protracted to permit a successful bridging by the adult parasitoid stage. Loan and Holdaway (1961) have indicated that the adult wasp survives for about 2 weeks only. The present study permitted an assessment of the extent of this problem and the possible effects of weather on *M. aethioides* infection levels.

METHODS

During the insectary study conducted to ascertain the number of generations that *M. aethioides* underwent (Goldson and Proffitt 1986), duration of the development of all larval stages combined and pupal stages were recorded, along with continuous temperatures. From these results the thermal requirement (day-degrees) for the development of the parasitoid under naturally varying temperature conditions could be estimated. Day-degrees were calculated as follows:

(ambient temperature - threshold temperature) X developmental time

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The threshold temperature is defined as that below which no development occurs. In *M. aethiopoulos* this has been found by Morales and Hower (1981) to be 8.4°C.

In order to relate the insectary data to field conditions, an SIDD field data logger was installed in a 4-year-old lucerne (cv. AS13R) stand, at Ashley Dene c. 15 km from Lincoln. This measured and recorded soil surface temperatures at hourly intervals which were subsequently used to calculate elapsed day-degrees above 8.4°C. The crop was also monitored every 3-4 weeks for *S. discoideus* ground densities and their associated levels of parasitism from 7 May to 18 November 1986. On each occasion the litter in 15-20, 0.2 m² quadrats was sampled using a modified high-powered vacuum cleaner; this was subsequently hand-sorted for weevils using a hot-tray. A sub-sample of 20-30 weevils was dissected to ascertain their percentage parasitism.

At the end of the 1986-87 season, additional sampling was conducted to estimate the parasitoids' success in transferring from the old and rapidly dying weevil population to the emergent pre-aestivatory (teneral) population. Larval sampling was conducted at 2 weekly intervals between 17 September 1986 and 9 December 1986 to gauge the peak population; from this an estimate of the likely cumulative teneral emergence was obtained. Thirty weevils were also collected at the completion of their emigratory flight on 17 March, 1987, from an aestivating population in a nearby shelter-belt. Their level of parasitism was ascertained by dissection.

RESULTS AND DISCUSSION

Using the insectary-derived results and the threshold data of Morales and Hower (1981), it was calculated that the egg and larval stages of the Canterbury *M. aethiopoulos* population required 111 day-degrees (°C) to develop to prepupal emergence and pupal development required an additional 88 day-degrees (°C). Conversely Morales and Hower (1981) found corresponding day-degree (°C) requirements of 123 and 134 respectively. The reasons for these differences are uncertain although it is known that there is significant biotypic variation in the species' development rate and morphology. For example, Aeschlimann (1983a) found at a constant temperature of 19°C, the Moroccan *M. aethiopoulos* biotype required only 70-80% of the development time of its Greek counterpart. The parasitoids released in Canterbury were imported from Australia where there has been introductions of both Greek and Moroccan origin (Aeschlimann 1983b). The same could apply to the development threshold temperature.

During the 1986 reproductive season of *S. discoideus* (mid-March to mid-December) it was calculated from the logged ground temperature data that 797 day-degrees had accumulated. Since each generation required a total of 199 day-degrees to complete its development, it was deduced that about four parasitoid generations

Fig. 1: Ground density of the sitona weevil parasitoid *Microctonus aethiopoulos* at Ashley Dene in 1986. Parasitoid generation durations are indicated on the X-axis.

occurred prior to the weevils' natural mortality through ageing. Figure 1 indicates the likely duration of each generation based on day-degree accumulation and shows a period of much reduced developmental activity during the cooler mid-April to late September period. In general this result conforms to the 4-5 generations observed in South Australia by Cullen and Hopkins (1982) and Aeschlimann's (1983a) observation of five generations in Mediterranean France.

Figure 1 also shows the number of immature parasitoids/m² that occurred during the 1986 season derived from the weevil ground densities and their associated levels of parasitism. Parasitoid densities fluctuated widely, but their incidence was particularly low in September and early October. Such a decline was apparent at a number of other Canterbury sites (Goldson and Proffitt unpublished). Although the reasons for this are unclear it had been noted during the insectary study that wet conditions do not favour the survival of *M. aethiopoides* emergent pre-pupae. Weather data indicated that conditions in July and August 1986 were much wetter than average, with rainfall 114% higher than the mean. This may have caused a scarcity of mature wasps and accounted for the low density of immature parasitoids during September-early October (Figure 1).

In their earlier study, Goldson *et al* (1984) found that a total of 380 teneral adults/m² emerged from a peak larval population of 774/m². In this study a peak larval population of 712 larvae/m² was measured on 11 November 1986. Assuming a similar ratio, it can be calculated that c. 350 teneral adults/m² probably emerged in December. On March 17 1987 60% of these weevils found in an aestivation site were parasitised. This was surprising since at the end of November immature parasitoid densities were comparatively low at 3.3/m² (Figure 1) and there was no reason to suspect that higher densities of adult wasps prevailed in December. This implies that in spite of a lifespan of less than 2 weeks (Loan and Holdaway 1961) they were able to infect c. 210 weevils/m². This attests to the highly efficient nature of *M. aethiopoides* as a parasitoid of *S. discoideus* and effectively dismisses Goldson *et al*'s (1984) concern that the transfer of the parasitoid between one weevil generation and the next may be a problem. The levels of parasitism found in the aestivation sites in this study were far higher than those reported from elsewhere (e.g. Cullen and Hopkins 1982). This lends real promise to the prospect that *M. aethiopoides* may impart a useful degree of control against *S. discoideus*.

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