ASSAYS TO DETERMINE THE PREDATORY ABILITY OF *PERGAMASUS* AGAINST CLOVER FLEA

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ABSTRACT

Clover flea (*Sminthurus viridis*) is found throughout New Zealand and is a major economic pest of white clover (*Trifolium repens*) in localised areas of the North Island. Predatory mites are important biocontrol agents of clover flea in Australia, but little is known of the efficacy of the predatory mite species present in New Zealand. A major challenge to assessing mite efficacy has been poor survival of clover flea in laboratory assays. It was found that adult clover flea survival was higher when they were contained with soil, whereas soil was not essential for the survival of younger nymphs. The predatory ability of *Pergamasus* is still unclear, as there was significant mortality in one experiment containing the mites, but no significant difference in mortality in the assay that followed.

Keywords: clover flea, *Sminthurus viridis*, *Pergamasus*, biocontrol agent.

INTRODUCTION

Although clover flea (*Sminthurus viridis* L.) is present throughout New Zealand (Dumbleton 1938), severe damage to white clover (*Trifolium repens*) occurs in localised areas of the North Island only (Townsend et al. 1979; Wrenn et al. 1983). Pasture damage is caused by the nymphs and adults that can be present in high numbers from April through to December (Dumbleton 1938; Addison et al. 1992), with populations peaking in spring and autumn (Willoughby et al. 2002). In cases of heavy clover flea infestation, only the veins of the clover leaf and cuticle remain, giving the clover a white appearance (Dumbleton 1938). Clover flea damage reduces yield and deters stock which avoid eating pasture fouled by clover flea faeces (Pottinger 1983).

Insecticides and tolerant clover cultivars are currently used to manage clover flea populations in New Zealand. However, predatory mites are used successfully in Australia as biocontrol agents of clover flea. The predatory mites considered most important in Tasmania for the control of clover flea are the pasture snout mite, *Bdellodes lapidaria*, the spiny snout mite, *Neomolgus capillatus*, the European whirlingig mite, *Anystis baccarum*, and the parasitid, *Pergamasus longicornis* (Ireson et al. 2001). In the high rainfall dairy pastures of Tasmania, it is thought that *Pergamasus* may replace *B. lapidaria* as the major predator of pasture Collembola (Ireson et al. 2001). While *B. lapidaria* and a *Pergamasus* species are found in New Zealand and have been observed to attack clover flea (D.J. Wilson, pers. comm.), their impact on clover flea populations is not clear.

This paper reports on assays to determine the predatory ability of *Pergamasus* on clover flea. The importance of containing the clover flea with soil was also evaluated.

METHOD

Pergamasus mites and clover flea were collected from AgResearch, Ruakura, using a modified Homelite HB 180V blower/vac. The test apparatus used in the assays consisted of a 100 ml specimen vial inverted over a 50 ml vial, the two vials connected by taping the vial lids together. A clover leaf was placed in the upper vial with its petiole in tap water in the lower vial, having been threaded through a 3 mm hole pierced through

both lids. A 30 mm diameter hole had been made in the upper vial for aeration and was covered with mesh voile.

In Experiment 1, three adult clover flea and two *Pergamasus* mites were contained in each specimen vial with a clover leaf. This was replicated 10 times. A further 10 vials were set up with clover flea only as controls. The vials were kept in a 18°C Controlled Environment Facility at 16:8 h light:dark for the duration of the experiment. The experiment was assessed at Day 7 whereby clover flea and *Pergamasus* survival was recorded. A clover flea feeding score was given for each clover leaf whereby 0=no feeding and 5=severe feeding damage.

For Experiment 2, the previous experiment was repeated except that approximately 5 g of untreated soil (Horotiu sandy loam) at 28% moisture content was placed in the upper vial lid. Two adults and one late-stage nymph were contained in each replicate instead of three clover flea adults as in Experiment 1. The experiment was assessed as above but on Day 6 instead.

Experiment 3 was a repeat of experiments 1 and 2 but clover flea nymphs were used instead of adults. The nymphs were younger than those used in Experiment 2. The experiment was assessed at Day 7 as in Experiment 1.

All data were analysed by a one-way analysis of variance (ANOVA) to separate the means. The data from Experiment 3 was analysed as four treatments due to the lack of mites in the treatment without soil.

RESULTS

Results from the three experiments are summarised in Table 1. Clover flea survival was very low in Experiment 1. However, the addition of soil in Experiment 2 improved clover flea survival to 97% in the controls. Survival in Experiment 2 was significantly higher in the controls than in the mite treatment, as was feeding damage ($P<0.05$). Mite survival did not change with the addition of soil from Experiment 1 to Experiment 2.

TABLE 1: Percent survival of clover flea and *Pergamasus* mites, and clover flea feeding score, from Experiments 1 and 3 at Day 7 and Experiment 2 at Day 6.

	Soil present		Soil absent		SED	P-value
	Mites	Control	Mites	Control		
Expt 1 (adults)						
% clover flea survival	nd ¹	nd	17	4	6.5	0.055
Feeding score	nd	nd	1.8	2.2	0.56	0.494
% <i>Pergamasus</i> survival	nd		70			
Expt 2 (adults+nymphs)						
% clover flea survival	57	97	nd	nd	12.1	0.004
Feeding score	2.3	3.5	nd	nd	0.31	0.004
% <i>Pergamasus</i> survival	70		nd			
Expt 3 (nymphs)						
% clover flea survival	73	88	80	67	12.7	0.457
Feeding score	2.7	4.0	2.8	3.7	0.47	0.027
% <i>Pergamasus</i> survival	70		5			

¹nd=not determined.

The presence of soil made no significant difference to clover flea nymph survival in Experiment 3. However, in the presence of soil, clover flea with mites fed significantly less ($P<0.05$) than the controls. The presence of mites had no significant effect on clover

flea survival either with or without soil. In contrast to the first two experiments mite survival was significantly lower in vials without soil than in vials with soil.

DISCUSSION

Clover flea and the predatory *Pergamasus* mites have frequently been found together in pasture suction samples throughout the Waikato and Wairarapa regions. In Tasmania, Ireson et al. (2001) found *Pergamasus* to have a similar phenology as clover flea, with numbers of both species increasing to a seasonal maximum in late spring/early summer and mid-late autumn. *Pergamasus* play a role as predators of clover flea in Tasmania, as they have frequently been observed attacking this pest (Ireson et al. 2001).

Clover flea show a preference for the Leguminosae, particularly clover over other broad-leaved plants (Dumbleton 1938), with white clover (*Trifolium repens*) being the preferred host (Wrenn et al. 1983). Since white clover was provided as the food source, the poor survival of clover flea adults in Experiment 1 was unexpected. Adult survival was improved by adding soil in Experiment 2. Holdaway (1927) found that clover flea are soil eaters, and that adult females eat more soil during egg laying than at any other time. However, Holdaway (1927) also found that nymphs can survive for at least one generation without soil. This may explain the lack of difference in survival in Experiment 3 with and without soil when only nymphs were used.

Survival of the *Pergamasus* mites appeared not to be affected by the presence or absence of soil, with 70% survival in Experiments 1 and 2 and the treatment with soil in Experiment 3. However, there was very high apparent mortality in Experiment 3 without soil. Very few mite cadavers were found in this treatment, which was unexpected, as mite cadavers had been seen in the previous experiments. It is possible that the mites may have been omitted in error or adult cannibalism had occurred. Cannibalism is rare amongst *Pergamasus longicornus* adults (Harris & Usher 1978) and it is possible this is the same species used in the assay which is common in improved pastures in Europe and Australia (Ireson et al. 2001). The high mite mortality made it difficult to compare the effectiveness of the mites on the nymphal stage of clover flea with and without soil.

Due to the low survival of clover flea in the control treatment of Experiment 1, the predatory ability of the mites could only be assessed from Experiments 2 and 3. The mites had a significant effect on clover flea survival in Experiment 2 only. It is possible that adults are slower moving and easier prey than the nymphs. The mites may be more effective predators of the adults when soil is available. The mites were seen to hide amongst the soil, whereas the clover flea were either on the clover or the soil surface. Clover flea feeding was also significantly less when the mites were present but only when soil was included in both experiments 2 and 3. This may also be due to the mites being more effective predators in the presence of soil, and so disrupting the feeding behaviour of the clover flea.

In conclusion, the age of the clover flea used in each experiment was found to affect the results. This indicates the importance of understanding the life stage and biology of the clover flea in order to develop good assays. The results from this work show that *Pergamasus* are a likely natural enemy of clover flea in New Zealand. Further work is required to determine the efficacy of this mite as a biocontrol agent of clover flea in New Zealand.

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