PREDATION ON AUSTRALIAN SOLDIER FLY BY PASTURE WIREWORM

L. N. ROBERTSON AND R. P. POTTINGER

*Ruakura Soil and Plant Research Station
Ministry of Agriculture & Fisheries
Hamilton*

Summary

Results of a pot trial and a field experiment aimed at determining the degree of predation pressure that pasture wireworm (*Conoderus exsul*) can apply on populations of Australian soldier fly (*Inopus rubriceps*) are presented. Each wireworm present at the completion of the pot trial was correlated with an average 27% decrease in soldier fly numbers in 3 months and the survival of wireworms was enhanced by the presence of soldier fly. A 40% decrease in soldier fly numbers was measured after 4 months in field enclosures with an initial pasture wireworm density of 36/m². Predation by pasture wireworm may be a significant contributor to the recent decline of soldier fly numbers in former outbreak areas.

INTRODUCTION

Australian soldier fly larvae can damage pastures and cereal crops in the northern North Island but in recent years the importance of this pest has diminished. Soil populations of 6000 - 10 000 larvae/m² were common throughout certain areas of the Bay of Plenty, Waikato and South Auckland between 1965 and 1975 (unpublished MAF reports). Numbers are now low in these areas and generally appear to have stabilised at about 200 - 500/m² over the last 3 years (Robertson unpublished). High levels are currently being attained in newly infested areas near Whangarei and New Plymouth.

There is no evidence that disease or parasitism are responsible for the decline in numbers of soldier fly. Neither is the decline likely to be due to adverse climatic conditions as populations have been increasing elsewhere over the same period.

Found in close association with soldier fly in the former out-break areas is a predator, pasture wireworm. This species is common throughout New Zealand pastures although usually at low densities. Pasture wireworm was first described from New Zealand (Sharp 1877) but it is probably endemic to Australia. It has been little studied here or overseas. Stone (1976) stated that pasture wireworm in California normally takes 1 year to complete development but a 2 year life cycle may be more common in New Zealand (pers obs). Adults are present in northern New Zealand from November until March.

Pasture wireworm has been observed to prey on grass grub (*Costelytra zealandica*) in New Zealand (Farrell 1972) and on other scarab and weevil larvae in Hawaii (Williams 1931). The species readily attacks and consumes soldier fly (pers obs). However pasture wireworm has been reported as a crop pest (East and Watson 1978) and Stone (1976) was able to rear wireworms successfully on germinating grain seeds.

Wireworm numbers appear to be high in areas where soldier fly

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larvae have been present for several years (Robertson In prep) but previous records of the soil fauna associated with infestations of soldier fly in the Bay of Plenty list wireworms only rarely (C. R. Wilcocks unpublished MAF reports 1969-71). In the recent soldier fly infestations at Whangarei and New Plymouth, populations of pasture wireworm are generally low ($0-24/m^2$) whereas in the Bay of Plenty, Waikato and South Auckland where there is a longer history of soldier fly, wireworm numbers are commonly within the range $20-60/m^2$. This suggests that pasture wireworm may be capable of a numerical response to large populations of soldier fly.

There is some circumstantial evidence to suggest that pasture wireworm was severely limited in areas of the Bay of Plenty where DDT was used in the 1960s. This predator has been shown to be very susceptible to DDT, whereas soldier fly is tolerant (Robertson In prep).

This present study was aimed at determining the degree of predation pressure that pasture wireworm can exert on populations of soldier fly under laboratory and field conditions.

METHOD

Pot Trial

Pasture wireworms were collected from Opotiki in August 1977 and combined with soldier fly from Hamilton, in pots 18 x 18 cm x 19 cm deep, filled with sterilised silt loam and containing 15 ryegrass (*Lolium perenne*) seedlings. Four densities of pasture wireworm (0, 2, 4 and 8/pot) were factorially combined with four densities of soldier fly (0, 25, 50 and 100/pot) and five replicates of each treatment were used. No attempt was made to classify the instars of either pasture wireworm or soldier fly as both species have several ecdyses. Medium to large sized larvae of both species were used in this experiment (pasture wireworm lengths 12-25 mm, soldier fly 4-9 mm).

The experiment continued for 3 months (mid August to mid November) with the pots receiving sufficient water to maintain satisfactory plant growth. All pots were destructively sampled by washing and sieving to extract all insects for counting. The root and shoot dry matter weights were assessed at sampling.

Field Experiment

Medium and large sized pasture wireworms were collected from Hamilton in September 1978 and seeded into $0.5 m^2$ plots near Whangarei where a high infestation of soldier fly was present. There were two treatments, each replicated three times:

1. Fifteen wireworms were placed in each plot in evenly spaced holes 5 cm deep made by a 2.5 cm diameter corer and the holes then refilled with the soil plug. These plots were enclosed by 'fibrolite' boards to a depth of 25 cm.
2. Unenclosed field plots received no additional wireworms. Previous work has shown that enclosures of the type used have no adverse effect on soldier fly populations (P. J. Gerard pers comm).

The field population of pasture wireworm was estimated by soil sampling in a systematic pattern (120 cores, 12.5 cm diameter) in June 1978 and found to be approximately $6/m^2$ in the area of the trial.

The dispersion of wireworms, measured by comparing the variance (S^2) to the mean density (m) was approximately random ($S^2=m$) and it was assumed that each plot contained a natural density of six wireworms/ m^2 before the seeding of an additional $30/m^2$ into the enclosures.

The plots were sampled after 4 months, in January 1979. Twenty

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7.65 cm diameter soil cores were taken from each plot and soldier fly numbers assessed by extraction in a wet-sieving-salt flotation system (modified from Wilcocks and Oliver 1971). Wireworm numbers were estimated in the field by complete hand-sorting of the soil remaining in the plots.

RESULTS AND DISCUSSION

Pot Trial

A highly significant ($P < 0.001$) negative exponential relationship between soldier fly numbers and pasture wireworm numbers at the completion of the trial was evident (Fig. 1). Each wireworm per pot at completion of the experiment was correlated with an average decline of 27% in soldier fly numbers over the 3 month period. The survival of wireworms was enhanced by the presence of soldier fly larvae, although survival was poor at the high wireworm densities (36% survival at 4 and 8/pot). At two wireworms/pot, 83% of the wireworms survived. This mortality was attributed to the high degree of larval cannibalism this species exhibits. The upper densities observed in the field ($50\text{--}60/\text{m}^2$) are similar to two wireworms per pot ($62/\text{m}^2$).

Fig. 1. Results from pot experiment.

No significant depression of ryegrass root or shoot production was measured at any density of soldier fly or wireworm although the greatest density of soldier fly ($3100/\text{m}^2 = 100/\text{pot}$) is about the level at which pasture damage may become measurable (Wilcocks 1974; Dixon 1977; Pottinger *et al* 1977).

Field Experiment

The average densities of wireworms and soldier fly at sampling in January 1979 are shown in Table 1. The presence of mature larval exuviae and adults indicated that adult wireworm emergence was underway at the

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time of sampling. The enclosures contained an average of 40% fewer live soldier fly larvae than the field plots at sampling in January ($P < 0.01$).

TABLE 1. Average densities (no./m²) of wireworms and soldier fly in Whangarei field experiment (Jan. 1979).

		Wireworm enclosures	Field plots
Pasture wireworm	larvae	3.3	0
	pupae	2.0	0
	adults	3.3	0.7
	Total	8.6	0.7
Soldier fly		1785	2964

The results of this experiment support the pot trial results in which predation by pasture wireworm was shown to depress populations of soldier fly. The initial density of pasture wireworm in the enclosures (36/m²) was within the range of commonly observed densities in areas where soldier fly have been present for several years (20-60/m²). The results of these experiments suggest that these populations are capable of exerting significant predation pressure on soldier fly in the northern North Island.

CONCLUSIONS

Soldier fly appears to be subject to predation by pasture wireworm in the field and this predator has been shown to significantly depress population levels of soldier fly under controlled conditions. As little has been published in New Zealand or Australia on invertebrate predators of soldier fly larvae, this is a largely unknown field but worthy of further investigation.

ACKNOWLEDGEMENTS

Dr N. R. Cox, for assistance with statistical interpretation of results; Mr R. H. Davison, Mr A. C. Firth and other colleagues, Ruakura, for valuable discussion and assistance with field work.

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