Biological control of earth mites in pasture using endemic natural enemies

David G. James, New South Wales Agriculture, Yanco Agricultural Institute, PMB Yanco, New South Wales 2703, Australia.

Summary

Twenty endemic natural enemies (19 predators, one pathogen) of redlegged earth mite, *Halotydeus destructor*, and blue oat mite, *Penthaleus major*, were recorded in southern New South Wales during 1989–94. Evidence is presented supporting the idea that this natural enemy complex plays an important role in regulation of earth mite populations in unsprayed, established pasture. Integration of native biological control agents with selective insecticides could provide the basis of an IPM system for earth mites in pasture.

Introduction

It is remarkable that virtually no attention has been paid to the complex of endemic natural enemies associated with earth mites (redlegged earth mite (*Halotydeus destructor*) and blue oat mite (*Penthaleus major*)) in stable or semi-stable ecosystems such as roadsides, natural grasslands and pastures. The identification of components of this assemblage and evaluation of its impact on earth mite populations is a logical and essential step towards development of low-input management strategies. Biological control of earth mites is a resource available in every pasture, but one that we know little about and do not use in current chemical-based control strategies. It might be highly effective but remains an enigma; for example, it is common for neighbouring farmers to have contrasting earth mite situations: one farmer has to spray every year, the other never has a problem. Ultimately, biological control provided by endemic natural enemies will feature in whatever low-input management strategy we develop for earth mites. The use of resistant clover varieties will help to preserve natural enemy populations; better timing and reduction in use of chemical sprays will do the same thing. To maximize the potential and use of this bioresource, we must fully understand it. 'Classical biological control', used to describe the introduction of exotic natural enemies, monopolizes public awareness of biological control, but is in fact responsible for a minority of biocontrol solutions. Most biological control occurs in unstudied or little studied but highly effective indigenous systems which rarely receive any fanfare. Today, introductions of exotic natural enemies are invariably preceded by thorough ecological studies of the pest which expose inefficiencies of native predators, parasites and pathogens. Introduction of the predatory mites (*Anystis wallacei*) in 1965 from France for control of redlegged earth mite was, however, not preceded by any such studies. It is now (belatedly) time to do these studies.

In this paper, I examine some of the information on endemic natural enemies of earth mites which has been obtained, generally in the course of other work, over the past five years in southern New South Wales.

Endemic natural enemies of earth mites: What are they?

Although no systematic survey has been conducted, at least 19 predators and one pathogen are known to attack earth mites in the Leeton-Narrandera district of southern New South Wales (Table 1). This is a conservative assessment and a rigorous survey over the full earth mite range would undoubtedly reveal many more species. However, it is clear that no single species of predator dominates the natural enemy fauna associated with earth mites; rather, there is a characteristic complex of species. The most important predators appear to be those from the predatory mite families Parasitidae, Bdellidae, Erythraeidae, Anystidae and Cunaxidae. As far as is known, all the predator species associated with earth mites are general feeders meaning they can feed on a range of prey and in some cases on pollen and plant exudates. Some species such as *Balaustium murorum* may be omnivores feeding on both plant and animal matter. The predatory anystid mite, *Walzia australica*, which is very commonly found in association with earth mites in southern New South Wales, is closely related and very similar to the introduced *A. wallacei*. There is little evidence to suggest that the introduced anystid is any more effective as a predator of earth mites than the native anystid (Otto and Halliday 1991, Michael *et al.* 1991, James unpublished observations). All of the predators listed here have been observed either in the field or laboratory feeding on earth mites. The importance and value of complexes of generalist natural enemies has long been underrated due to the inherent difficulties of evaluating such species. However, research is now beginning to indicate that biological control provided by generalist natural enemies can be highly effective and sustainable without the instability often associated with specialist natural enemies (Murdoch *et al.* 1985, McMurtry 1992).

An entomophthoran pathogen, *Neozygites acaracida*, occurs commonly in earth mite populations in southern New South Wales. Infection levels range from 0–50% and the disease seems to be most prevalent among blue oat mites. Infected mites are yellowish (*H. destructor*) or red (*P. major*) and become sterile before their death which may take a week or two as the pathogen develops. The pathogen appears to be most common during wet winters and may be the prime cause of the frequently observed earth mite 'population crashes' in July-August.

Effectiveness of endemic natural enemies

Data collected on *H. destructor* and predators during 1993 from a single long-term (approximately 15 years) unsprayed pasture paddock in Leeton provide a rudimentary indication of population dynamics which may be characteristic of undisturbed systems (Figure 1). On each date a

Table 1. List of natural enemies observed causing mortality to redlegged earth mite in the Leeton-Narrandera district of southern New South Wales 1987–1993.

Chrysopa spp.	(Chrysopidae)
Hemerobius spp.	(Hemerobiidae)
Coccinella repanda, Harmonia conformis, Diomus notescens	(Coccinellidae)
Amblyseius victoriensis, Amblyseius messor, Amblyseius masiaka, Amblyseius dieteri, Typhlodromus occidentalis	(Phytoseiidae)
Parasitus fimetorum	(Parasitidae)
Walzia australica, Erythracarus sp.	(Anystidae)
Bdellodes affinis, Bdellodes lapidaria, Cyta latirostris	(Bdellidae)
Cunaxa sp.	(Cunaxidae)
Ledermuelleria sp.	(Stigmaeidae)
Balaustium murorum	(Erythraeidae)
Neozygites acaracida	(Entomophtharales)

vacuum sampler was used to collect ten suction samples from 50 random locations in the paddock. The overall *H. destructor* population remained small and at a level most farmers would not consider worth spraying. Populations of predatory mites and insects known to feed on earth mites were an important part of the system and comprised 8–76% of the organisms collected on each sampling date. Combined data (all sampling dates) show predators comprised 36% of the sampled biomass. Predators were dominated by anystid, bdellid, erythraeid and parasitid mites. On four occasions in August–September, there were more predators sampled than *H. destructor*. Unfortunately no data were collected on earth mite and predator populations in 'chemically disturbed' paddocks during the same season. However, observational and anecdotal evidence suggested earth mite populations were generally considerably larger than in the unsprayed paddock and usually warranted insecticide treatment. Predators were present in much lower numbers in these populations. This study suggests that earth mite populations can remain below damaging levels in a 'natural' pasture ecosystem. Similar data were obtained from the same paddock in 1992. Of particular significance was the absence of increasing *H. destructor* numbers normally seen during late August–September which did occur at other sites in the district. More rigorous and extensive evaluations of the impact of this complex need to be conducted.

Can natural enemies fit into spray-based earth mite management programs?

Despite the considerable amount of research being conducted into alternative strategies for earth mite management, it is likely that chemicals will remain an important component of control for the foreseeable future (James 1991). Modification of insecticide spray strategies (choice, rate, amount and timing) currently offers the greatest opportunity for improvement of control efficacy and concomitant reduction in input. Integration of natural enemies with insecticides would also improve earth mite control by using indigenous biological control in overall management which would in turn reduce insecticide inputs. Very little is known about the compatibility of natural enemies of earth mites with insecticides used in pasture. However, some data from laboratory bioassays have been obtained on the toxicity of alphacypermethrin and bifenthrin to five endemic predators of earth mites. These two synthetic pyrethroids are likely to be registered for earth mite control in the near future. The predators differed considerably in their susceptibility to these compounds; one species, the bdellid mite, *Cyta latirostris*, survived direct application of alphacypermethrin at 0.02% (10 g a.i. ha^{-1}). Another bdellid, *Bdellodes affinis*, was far more susceptible to this compound with less than 50% of individuals surviving 0.005% (2.5 g a.i. ha^{-1}). The erythraeid, *Balaustium murorum*, was similarly susceptible and no individuals of the parasitid mite, *Parasitus fimetorum*, survived this rate. Sixty percent of individuals of the anystid, *Walzia australica*, survived this rate. The mortality of *W. australica*, *B. affinis* and *B. murorum* was low (0–20%) at 0.0025% (1.25 g a.i. ha^{-1}). Bifenthrin was generally more toxic with most predators dying when sprayed with 0.005% and 0.0025% rates, However, at the lower rate 40% of *B. murorum* survived. Overall, the data indicated the five predator species tested should survive field applications of alphacypermethrin at 1.25 g a.i. ha^{-1} and significant survival of some species will also occur at 2.5 g a.i. ha^{-1}. Field studies support these conclusions (James unpublished data). Good control of *H. destructor* in pasture is provided by alphacypermethrin at either of these rates (James unpublished data) suggesting that this chemical has potential as an earth mite treatment within an IPM program. Bifenthrin appears to be a less likely candidate for incorporation in such a program. Data of the kind outlined above are needed for all chemicals used in pastures and should be extended to include all natural enemy species in the complex associated with earth mites.

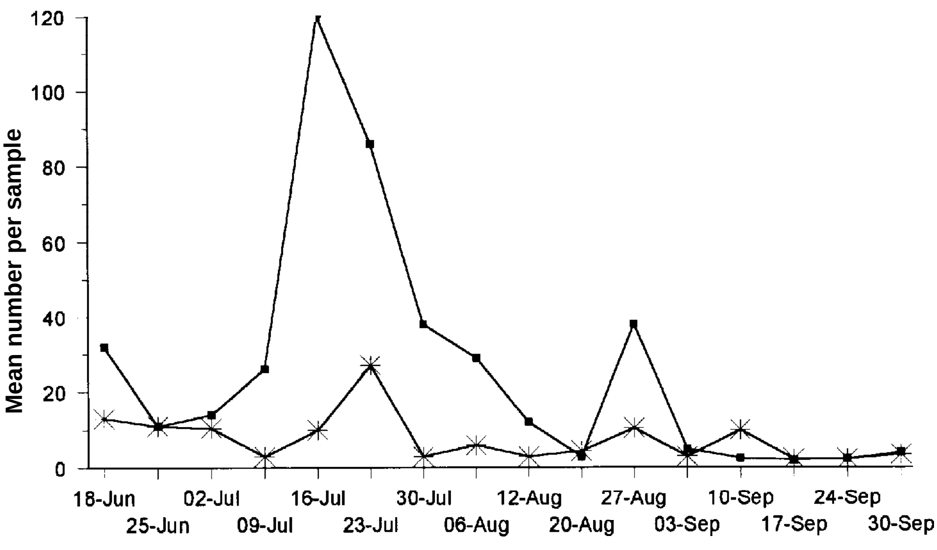

Figure 1. Redlegged earth mite (■) numbers and predator (✳) populations in an unsprayed pasture paddock at Leeton, New South Wales, during June–September 1993.

Conclusions

The preliminary data summarized here strongly support the idea that endemic natural enemies play an important role in regulation of earth mite populations in unsprayed, established pasture. This regulation is provided by a complex of predators and at least one pathogen. A detailed understanding of the ecology of this complex and its compatibility with pasture pesticides would, at the very least, facilitate its effective use in IPM programs (such as those based on resistant plant varieties) developed for earth mites. There is also a very real possibility that biological control provided by native natural enemies could provide the basis of an IPM system for earth mites.

References

James, D.G. (1991). Chemical control of earth mites and lucerne flea. Proceedings of a national workshop on redlegged earth mite, lucerne flea and blue oat mite, pp. 60-2.

Michael, P.J., Dutch, M.E. and Pekin, C.J. (1991). Successful spreading of *Anystis salicinus* (L.) (Acari: Anystidae) and *Neomolgus capillatus* (Kramer)(Acari: Bdellidae) and their effects on redlegged earth mite and lucerne flea. Proceedings of a national workshop on redlegged earth mite, lucerne flea and blue oat mite, pp. 121-6.

McMurtry, J.A. (1992). Dynamics and potential impact of 'generalist' phytoseiids in agroecosystems and possibilities for establishment of exotic species. *Experimental and Applied Acarology* 14, 371-82.

Murdoch, W.M., Chesson, J. and Chesson, P.L. (1985). Biological control in theory and practice. *American Naturalist* 125, 345-66.

Otto, J.C. and Halliday, R.B. (1991). Systematics and biology of a predatory mite (*Anystis* sp.) introduced into Australia for biological control of redlegged earth mite. Proceedings of a national workshop on redlegged earth mite, lucerne flea and blue oat mite, pp. 127-34.