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PERSISTENCE OF THE PREDATORY MITE, *HEMISARCOPTES COCCOPHAGUS* MEYER (HEMISARCOPTIDAE), ON LOW POPULATIONS OF *HEMIBERLESIA LATANIAE* (SIGNORET) (DIASPIDIDAE) IN NEW ZEALAND

J.G. CHARLES[1], M.G. HILL[2] AND D.J. ALLAN[1]

[1]*HortResearch, Private Bag 92 169, Auckland, New Zealand*

[2]*International Institute of Biological Control, Kenya Station, Nairobi, Kenya*

ABSTRACT

Population fluctuations of *Hemisarcoptes coccophagus* Meyer (Hemisarcoptidae) and *Hemiberlesia lataniae* (Signoret) (Diaspididae) on a row of Lombardy poplar shelter trees were measured, in the absence of any pesticide applications, from the initial establishment of the mite in January 1990 until May 1994. *H. lataniae* numbers declined from an average of about 50 adult females per 100 cm^2 of bark in January 1990 to less than 10 adult females per 100 cm^2 from August 1990 to May 1994. Adult scale parasitism by *Hemisarcoptes coccophagus* peaked at 65% in May 1990 before slowly declining. The mites were found for the first time on non-release trees in the same row as the release trees in April 1991, arriving presumably by crawling. They subsequently controlled//, *lataniae* on those trees as well. Low numbers of both scale insect and mites were found in all shelter trees from February 1993 to May 1994. *Hemisarcoptes coccophagus* thus persisted at the one location for nearly 5 years, and showed an ability to contribute to the biological control of *H. lataniae* in the long run, despite the absence of *Chilocorus* spp.

KEY WORDS: Diaspididae, *Hemiberlesia lataniae*, Hemisarcoptidae, *Hemisarcoptes coccophagus*, biological control, shelter trees, kiwifruit, New Zealand.

INTRODUCTION

Armoured scale insects are important pests of kiwifruit in New Zealand. The greedy scale, *Hemiberlesia rapax* (Comstock), is the most widely distributed and commonly found species, but the latania scale, *H. lataniae* (Signoret), can be dominant in two regions (Berry et al., 1989), whereas the oleander scale, *Aspidiotus nerii* Bouche, is an occasional pest. Their natural enemies in kiwifruit orchards include parasitoids, especially *Encarsia citrina* (Craw), *Signiphora merceti* Malenotti and *S.flavella* Girault [not *S.flavopalliata* Ashmead as recorded by Hill et al. (1993)], and predators [e.g. *Scymnusfagus* (Broun)] (Hill, 1989). However, natural enemies are not always common, and scale insect populations often exceed economic thresholds. In 1989, as part of a biological control programme against Diaspididae in kiwifruit, we introduced *Hemisarcoptes coccophagus* Meyer into a row of shelter trees heavily infested with *H. lataniae*, surrounding a kiwifruit orchard near Gisborne, on the east coast of the North Island of New Zealand. We subsequently recorded an increase in the population of this mite and a corresponding decline in scale insect numbers on the trunks of the shelter trees from January

1990 to April 1991 (Hill et al., 1993). We concluded that three key points in these interrelationships needed further resolution: (i) The ability of *Hemisarcoptes coccophagus* to persist over time at low host densities; (ii) the ability of the mite to control *H. lataniae* invading previously inhabited, but now "locally extinct" patches of bark on the trunk of the shelter trees; and (iii) the ability of *Hemisarcoptes coccophagus* to disperse widely, in the absence of phoretic *Chilocorus* species, which had failed to establish in New Zealand (Hill et al., 1993).

We have continued the monitoring programme in the same orchard since 1991. In this paper we discuss the above points in the light of new data, collected after April 1991.

METHODS

The site and sampling methods used are described in Hill et al. (1993). Briefly, *Hemisarcoptes coccophagus* was released during March and May 1989 into nine trees in a row of shelter trees (Lombardy poplar, *Populus nigra* var. *italica*) heavily infested with the latania scale. Bark samples (50–100 cm^2) from the release trees and from four non-release trees were subsequently collected from 1, 2, 3, 4 and 5 m above ground and examined for scale insects and mites. Data were recorded at approximately 2–3-month intervals until April 1991 and then at six monthly intervals until May 1994.

For consistency with our earlier study (Hill et al., 1993), the same measure of predation was used, so that "predation by *Hemisarcoptes*" was defined as a simple summation of the numbers of live adult scale insects with any stage of *Hemisarcoptes*, divided by the total number of adult scale insects, expressed as a percentage. Predation was almost certainly underestimated, as only the proportion of *live* scale found with mites attached was considered. Recently dead scale insects with associated *Hemisarcoptes coccophagus* were not included in the analysis, even though the mites probably caused, or at least contributed to, death.

No insecticides were applied to the trees at any time.

RESULTS AND DISCUSSION

Scale insect numbers and predation by *Hemisarcoptes* for the entire sampling period are presented in Fig. 1. The main results are:

(i) *Hemisarcoptes coccophagus* persisted in the shelter trees for 5 years. For most of that time it survived at low host densities (<10 adult female *Hemiberlesia lataniae* per 100 cm^2 of bark) (Fig. 1). Mite numbers increased rapidly as they spread first among the release trees (see Hill et al., 1993), and then, presumably by crawling, into the non-release trees. Host numbers in both sets of trees declined respectively to 1.4 and 4.2 adult females per 100 cm^2 in February 1993. *H. lataniae* numbers subsequently increased until May 1994, but so did those of the mite, and they probably reflected seasonal variation rather than incipient control failure.

(ii) In January 1990 there was no significant difference between the numbers of any of the *H. lataniae* developmental stages at different heights in the trees (Hill et al., 1993). However, from November 1991 to May 1994 most scale insects were found on samples from 3–5 m above ground level. More than 80% (52/64) of the total number of bark samples with mites were also found on the 3–5-m samples.

The numbers of bark samples with "local extinctions" (see Hill et al., 1993) of scale insects on them — i.e. samples with no live scale, but with dead insects or old tests to show previous

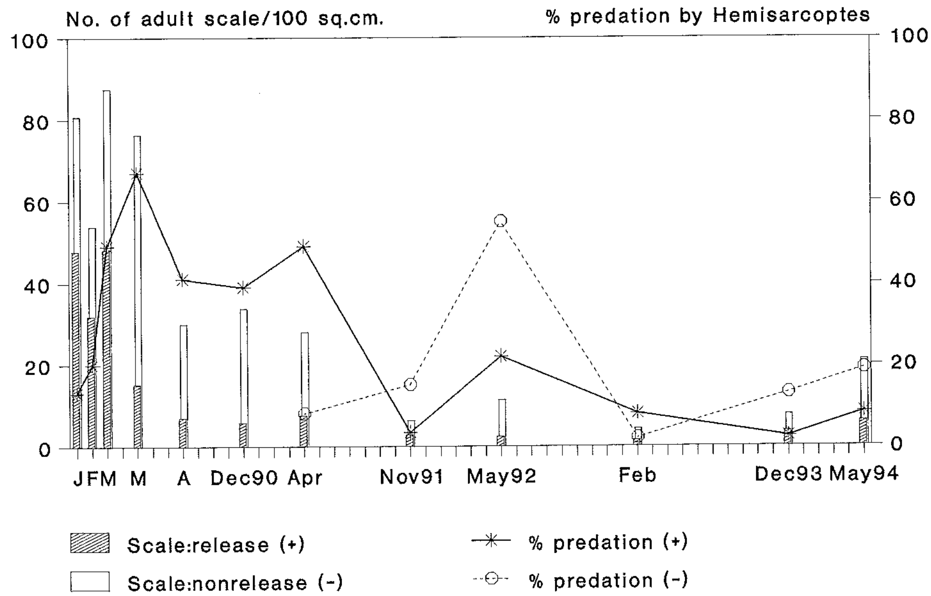

Fig. 1. Scale density on bark and percent predation, January 1990–May 1994.

occupancy — increased over time (Table 1). From November 1991 to May 1994, 53 out of a total 91 such samples (58%) were collected from the 1-m and 2-m levels. The trend was apparent in both the release and non-release trees, even though all samples from the non-release trees held at least a few live scale insects in May 1994 when the populations increased (Fig. 1).

From the predominance of *Hemisarcoptes coccophagus* high in the trees and the greater number of "locally extinct" patches of *H. lataniae* lower down, we can generalise that host populations retreated up the trees as they declined in size, leaving increasing numbers of empty, but previously occupied, patches at low levels. *Hemisarcoptes coccophagus* survived well higher up the trees with low scale populations, and mites were quick to colonise an expanding host population. These data show the importance of sampling and monitoring *Hemisarcoptes coccophagus* populations at various heights of host plants, especially if they are tall shelter trees.

TABLE 1

Proportion of bark samples from the study site at Gisborne, New Zealand, from trees in known foraging range of *Hemisarcoptes coccophagus*, which had no live *Hemiberlesia latania* (i.e. constituted "locally extinct" patches) from February 1990 to May 1994

	% "locally extinct" patches										
	1990					1991		1992	1993		1994
Sites	II	III	V	VIII	XII	IV	XI	V	II	XII	V
Release	3	16	5	20	15	18	31	40	49	33	31
Non-release	–	–	–	–	–	–	10	5	35	19	0

(iii) In May 1992 we recovered mites from *H. lataniae* on shelter trees, up to 200 m away from the release trees. It is improbable that the mites could have crawled this far, and we do not know how they reached these trees. Previously we considered that *Chilocorus* ladybirds, by carrying the phoretic hypopodes (the heteromorphic deutonymphs of the mite), were obligatory for long-distance dispersal of *Hemisarcoptes*. However, these recoveries give cause for optimism that the mites will continue to spread and establish elsewhere, even in the absence of *Chilocorus*.

We have found some evidence for a wider *Hemisarcoptes*–ladybird association than that provided by the *Hemisarcoptes–Chilocorus* genus specific model proposed by Houck and OConnor (1991). In Hill et al. (1993) we showed that *Hemisarcoptes coccophagus* hypopodes could complete their ontogenesis on *Halmus chalybeus* (Boisduval) (Coccinellidae: Chilocorini) and *Scymnus fagus* (Broun) (Coccinellidae: Scymnini) in the laboratory. On two occasions since then (although not at this property) we have collected *Halmus chalybeus* from *H. lataniae* infested shelter trees, and found a single *Hemisarcoptes coccophagus* hypopus under one elytron. We do not know whether these hypopodes would have completed development successfully or not.

Finally, our data were from a release site, not from an experiment carefully designed to demonstrate the exclusive impact of *Hemisarcoptes coccophagus* on *H. lataniae*. Other species of predators and parasitoids were also regularly found at the study site, although at very low numbers. The pathogenic fungus, *Nectria aurantiicola* Berk. and Br., was also common. None of these mortality factors, nor weather conditions, were closely studied by us. We should perhaps assume that, at some time or another over the 5-year period, all mortality factors played roles in the control of the latania scale.

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