ATTEMPTED NEW ASSOCIATION BIOLOGICAL CONTROL OF *DICRANOSTERNA SEMIPUNCTATA* CHAPUIS (COLEOPTERA: CHRYSOMELIDAE: PAROPSINI)

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ABSTRACT

The new association theory of biological control predicts that novel enemies may be more effective in controlling pest species than their natural enemies. This theory was tested using the egg parasitoid *Enoggera nassaui* Girault (Hymenoptera: Pteromalidae) on the *Acacia* tortoise beetle, *Dicranosterna semipunctata* (Chapuis) (Coleoptera: Chrysomelidae) in New Zealand. In no choice laboratory bioassays, parasitism on the new host was significantly lower than on a natural host, *Paropsis charybdis* Stål (Coleoptera: Chrysomelidae) (5.7 cf. 8.9 eggs/h, P=0.02). The fecundity and oviposition rate of *D. semipunctata* were approximately half that of *P. charybdis*. A field release of 1500 *E. nassaui* directed against *D. semipunctata* did not result in sustained field parasitism. It is suspected that *E. nassaui* will not normally encounter *D. semipunctata* because it searches *Eucalyptus* not *Acacia* species. The ability of biological control agents to locate the target species in the field needs to be considered when evaluating new association biological control.

Keywords: *Dicranosterna semipunctata*, *Paropsis charybdis*, *Enoggera nassaui*, biological control

INTRODUCTION

The Acacia tortoise beetle, *Dicranosterna semipunctata* (Chapuis), was first detected in Auckland, New Zealand, during 1996. Its natural distribution includes New South Wales and Victoria in Australia (Nicholas & Brown 2002). The main host is Tasmanian blackwood, *Acacia melanoxylon* (R. Br.), a timber species with about 3000 ha planted in New Zealand. Biologically, *D. semipunctata* is similar to other paropsine species, with four larval instars, and a prepupal and pupal stage.

Biological control is considered a likely means for long-term sustainable control of *D. semipunctata*. Classical biological control uses natural enemies to control the target species when it becomes a pest outside its normal distribution. For instance, the paropsine *Paropsis charybdis* Stål is partially controlled in New Zealand following introduction of the Australian egg parasitoid *Enoggera nassaui* Girault (Kay 1990). However, natural enemy exploration can prove expensive, and introduction of novel organisms, even beneficial ones, is highly regulated in New Zealand.

An alternative approach is new association biocontrol, where new parasite-host associations are used to control pests (Hokkanen & Pimentel 1984; Pimentel 1991). This approach proposes that parasitoids and their natural hosts may be in an 'evolved balance', preventing natural enemies being effective regulators. As an example, when comparing Tasmanian and Australian Capital Territory strains of *E. nassaui*, Nahrung & Murphy (2002) found the parasitoid was more effective on a novel population than the home population of *Chrysophtharta agricola* (Chapuis) (Coleoptera: Chrysomelidae).

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An analysis of biocontrol cases by Hokkanen & Pimentel (1984) led to the claim that use of new or novel enemies may be 2.3 times more likely to control coleopteran pests than classical methods.

To test the effectiveness of the new association method, the parasitism by *E. nassaui* on both a novel host (*D. semipunctata*) and a natural host (*P. charybdis*) was evaluated. As specific natural enemy surveys in New Zealand and Australia have not detected *E. nassaui* with *D. semipunctata*, this is considered a new association relationship. The fecundity of *D. semipunctata* was also measured so it could be compared against *P. charybdis* and other paropsine species.

METHODS

Trial conditions

Rearing and experiments were undertaken at 22°C under16:8 h light:dark conditions.

Fecundity measurements

Fecundity was measured using 20 male/female pairs of field-collected adults for each species. Each pair was reared in plastic containers and fed with flush foliage (*A. melanoxylon* for *D. semipunctata* and *Eucalyptus nitens* for *P. charybdis*). Eggs laid per female were recorded daily until oviposition stopped or females died. Males were replaced upon death. Mean eggs per day and fecundity were compared by two-sample *t*-test at $P<0.05$.

Parasitism bioassays

Parasitism rates were examined using the no choice tests of Nahrung & Murphy (2002). All wasps had been reared from *P. charybdis* eggs. Female wasps were exposed to 30 host eggs in a Petri dish and observed for one hour. Ovipositor probing was considered to indicate host acceptance and the time to host acceptance was recorded. The wasps were then allowed one hour to parasitise host eggs. Eggs were removed and monitored for parasitism symptoms (presence of dark spots after several days). Ten replicates were completed for each host, with the mean acceptance times and parasitism rates compared by two-sample *t*-test at $P<0.05$.

Field release and monitoring

Parasitoid releases were made into a 1 ha, 9-year old stand of *A. melanoxylon* located in the Hunua Valley, approximately 20 km south-east of Auckland. *Enoggera nassaui* were released on 18 October 2000 (n =700) and 2 November 2000 (n = 800). Releases were of approximately equal numbers of free adults and parasitised eggs of both hosts to stagger the release. Adults were placed onto host eggs where possible and their behaviour observed after release. Prior to the initial release, and on four occasions between October 2000 and January 2001, a total of 668 *D. semipunctata* eggs were removed from the stand and monitored for parasitism.

Statistical analyses were carried out using the SAS statistical package. Mean values are presented ± SE.

RESULTS

Fecundity measurements

The fecundity and oviposition rate of *D. semipunctata* were significantly lower than for *P. charybdis* (Table 1).

TABLE 1: Fecundity (total eggs/female) and oviposition rate (eggs/day) of *D. semipunctata* and *P. charybdis*. Values are the mean±SE, with the range indicated in parentheses.

	D. semipunctata	*P. charybdis*	P-value
Fecundity	521±76.6 (107–1270)	1007±78.9 (416–1638)	P<0.001
Oviposition rate	7.6±0.7 (2.7–15.1)	14.7 ±1.0 (5–22.1)	P<0.001

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Parasitism bioassays

Eggs of *D. semipunctata* and *P. charybdis* were accepted by *E. nassaui* in all replicates. Parasitism by *E. nassaui* was significantly lower on *D. semipunctata* than *P. charybdis* (Table 2). Mean acceptance time did not significantly differ between the two hosts.

TABLE 2: *Enoggera nassaui* parasitism rate (eggs/h) and acceptance times (min) on *D. semipunctata* and *P. charybdis*. Values are the mean±SE, with the range indicated in parentheses.

	D. semipunctata	*P. charybdis*	P-value
Parasitism rate	5.7±0.8 (2–9)	8.9±0.9 (5–13)	P=0.02
Acceptance time	13.6±5.5 (1–59)	4.7±1.9 (1–21)	P=0.15

Field-releases and monitoring

Enoggera nassaui were observed parasitising *D. semipunctata* eggs during both releases. No *E. nassaui* were recovered from any field-collected eggs.

DISCUSSION

New association theory is claimed to be a superior alternative to classical methods (Hokannen & Pimentel 1984) but has received strong criticism (Waage & Greathead 1988). Ngi-Song et al. (1999) found evidence supporting both schools of thought, but noted that success of new association control depends on the capabilities of the parasitoids used.

The new association theory was evaluated by introducing *E. nassaui* to *D. semipunctata* under laboratory conditions. Despite the fact that parasitism was significantly lower on the new host than a natural host, the fact that parasitism and successful development occurred was a significant finding. Unfortunately, this did not translate into biological suppression in the field.

A weakness of new association theory is that it does not take into account early host location steps, i.e. locating host plants where the target species occurs. Host acceptance and parasitism in laboratory trials do not always reflect field results (e.g. Kitt & Keller 1998), which is probably a result of early and essential host-location steps not being required in the laboratory (Knipling 1992). Although *D. semipunctata* is a suitable host for *E. nassaui*, it is suspected that the parasitoid only searches *Eucalyptus* species (Tribe & Cillié 2000). Therefore, adults emerging from eggs that were observed being parasitised during the field releases probably left the site to initiate host location.

Dicranosterna semipunctata fecundity was modest in comparison to that of *P. charybdis* but similar to published data for other paropsine species. de Little (1983) recorded a fecundity of 674 ± 127 eggs for *C. bimaculata* (Olivier) and Carne (1966) estimated *P. atomaria* (Ol.) fecundity at about 640 eggs. This fecundity level implies that even moderate suppression by *E. nassaui* would have helped reduce any economic impact of this pest.

CONCLUSIONS

The new association theory was tested using the egg parasitoid *Enoggera nassaui* as a novel enemy of *Dicranosterna semipunctata*. Parasitism occurred in laboratory trials, although the rate was significantly lower than on the natural host *Paropsis charybdis*. A field release of 1500 *E. nassaui* did not result in detectable levels of parasitism on the novel host. It is concluded that although *D. semipunctata* is a suitable host, new association biocontrol does not take into consideration the fact that the control agent may not search the host plants where the target species is located.

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