Predatory ability of two species of phytoseiid mites (Acari: Phytoseiidae) on the peach silver mite, *Aculus fockeui* (Nalepa et Trouessart) (Acari: Eriophyidae)

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Abstract

The numbers of nymphs and adults of the peach silver mite, *Aculus fockeui*, consumed by females of the two phytoseiid mites, *Amblyseius sojaensis* and *A. eharai*, were 9.2 and 13.3, respectively, when feeding was observed for 10 min. Functional responses of the two phytoseiid mites to the density of *A. fockeui* showed saturation curves, in which the maximum number of *A. fockeui* consumed per female per day was estimated to be ca. 300 and 400 for *A. sojaensis* and *A. eharai*, respectively. Thus, the two phytoseiid mites had great abilities to prey on *A. fockeui*, although the ability of *A. sojaensis* was somewhat inferior to that of *A. eharai*.

Key words: *Aculus fockeui*, *Amblyseius sojaensis*, *Amblyseius eharai*, predation, peach

INTRODUCTION

The peach silver mite, *Aculus fockeui* (Nalepa et Trouessart), is a universal pest of the peach, nectarine and almond (Jeppson et al., 1975; Kadono, 1985). In Japan, silvery injuries of peach leaves caused by the mite became remarkable in the late 1980's (Kunugi et al., 1993), reaching a high level of economic threat at present. In a peach orchard of Okayama Prefecture where no insecticides were sprayed, two species of phytoseiid mites, *Amblyseius sojaensis* Ehara and *A. eharai* Amitai et Swirski, occurred at high densities, and they successfully suppressed the population density of *A. fockeui* (Kondo and Hiramatsu, 1999). Thus, the two phytoseiid mites seem to play important roles in controlling the density of *A. fockeui*.

A. sojaensis has been found on the sour cherry, grapevine, pear, peach and other woody plants in Japan (Ehara, 1964, 1972; Amano, 1994; Kondo and Hiramatsu, 1999), and can control the density of the citrus red mite, *Panonychus citri* (McGregor), when given tea pollen as alternative foods, although it has no effect on the density of the kanzawa spider mite, *Tetranychus kanzawai* Kishida (Osakabe et al., 1987). *A. eharai* occurs on such plants as the

kudzu-vine, chestnut, pear and peach (Amano, 1994; Kondo and Hiramatsu, 1999), and is well known as an effective predator of *P. citri* in Japanese citrus groves (Tanaka and Kashio, 1977), preying also on *T. kanzawai* (Osakabe, 1963). However, little is known about the predatory abilities of the two phytoseiid mites on *A. fockeui* for evaluating their effectiveness as its predators as compared to those on spider mites. Therefore, we examined in this study the potential abilities of *A. sojaensis* and *A. eharai* to prey on *A. fockeui* under laboratory conditions.

MATERIALS AND METHODS

Prey consumption rate per 10 min. Predatory behaviors of female *A. sojaensis* and *A. eharai* on *A. fockeui* were directly observed under a microscope at ca. 30× magnification in the daytime of 2 and 7 November 1995 in a laboratory kept at ca. 25°C and 50–80% R.H. *A. sojaensis* and *A. eharai* were collected from potted peach trees (variety: Hakutô) in a greenhouse of Okayama Agric. Exp. Stn. on 23 and 28 July 1995, respectively. About 10 females of *A. sojaensis* or *A. eharai* per peach leaf, which had sufficient *A. fockeui* and was placed on water-soaked cotton in a plastic petri dish (9 cm in diameter and 2 cm in depth), were main-

tained at $25 \pm 1^\circ\text{C}$ and 70–90% R.H. under a 16L–8D photoperiod, and the leaves were replaced with new ones when prey became scarce, i.e., every several days. For the experimental observations, a leaf disc (ca. 2×2 cm) with more than 300 nymphs and adults of *A. fockeui* from the potted peach trees, in which the leaf qualities were somewhat lowered but *A. fockeui* densities were high, was placed on water-soaked cotton in a plastic petri dish (same as mentioned above). Then, a female phytoseiid mite starved for ca. 24 h was released onto the leaf disc, and the number of nymphs and adults of *A. fockeui* consumed was counted for 10 min. For each species, the experiment was replicated 15 times.

Functional response to prey density. Functional responses of female *A. sojaensis* and *A. eharai* to the density of nymphs and adults of *A. fockeui* were examined at $25 \pm 1^\circ\text{C}$ and 70–90% R.H. under a 16L–8D photoperiod on 16–27 October 1995. A leaf disc (ca. 2×2 cm) with a different number of nymphs and adults of *A. fockeui* from the potted peach trees mentioned above was placed on water-soaked cotton in a plastic petri dish (same as described above). A female phytoseiid mite starved for ca. 6 h was released onto the leaf disc for ca. 24 h, and the numbers of nymphs and adults of *A. fockeui* consumed per day was estimated. Here, the numbers of surviving and dead *A. fockeui* before release (A_0 and B_0 , respectively), and the number of dead, surviving and drowned *A. fockeui* on the day after release (A_1 , B_1 and C , respectively) were counted, and then the number of individuals consumed per day was calculated in terms of $(A_0 + B_0) - (A_1 + B_1 + C)$. The experiments were replicated one time for each of 42 and 48 densities of *A. fockeui* for *A. sojaensis* and *A. eharai*, respectively. Relationships between densities and consumed numbers of *A. fockeui* were fitted to the disc-equation (Holling, 1959).

RESULTS AND DISCUSSION

Prey consumption rate per 10 min

The numbers of nymphs and adults of *A. fockeui* consumed within 10 min by female *A. sojaensis* and *A. eharai* under the starved condition were 9.2 and 13.3, respectively, in which

the value was significantly greater in the latter (Mann-Whitney's *U* test, $p < 0.05$, Table 1). Although the two phytoseiid mites also consumed eggs of *A. fockeui*, the frequency was much lower than that for nymphs and adults. In this experiment, the initial numbers of *A. fockeui* given to the two phytoseiid mites as prey were not significantly different (Mann-Whitney's *U* test, $p > 0.05$).

Functional response to prey density

As shown in Fig. 1, functional responses of the two phytoseiid mites, *A. sojaensis* and *A.*

Table 1. Number of nymphs and adults of *Aculus fockeui* consumed within 10 min by two species of female phytoseiid mites, *Amblyseius sojaensis* and *A. eharai*

	<i>n</i>	No. of mites consumed	Initial <i>A. fockeui</i> density
<i>A. sojaensis</i>	15	9.20 ± 0.82^a * ^b	389.00 ± 6.05^a n.s. ^c
<i>A. eharai</i>	15	13.27 ± 1.43	385.73 ± 7.17

^aMean $\pm$ S.E.

^b $p < 0.05$, ^c $p > 0.05$ (Mann-Whitney's *U* test).

Fig. 1. Functional responses of two species of female phytoseiid mites, *Amblyseius sojaensis* and *A. eharai*, to the density of nymphs and adults of *Aculus fockeui*. Curves were fitted to Holling's disc-equation (*A. sojaensis*: $y = 0.673x / (1 + 1.245 \times 10^{-3}x)$, $n = 42$, $r = 0.794$, $p < 0.001$; *A. eharai*: $y = 0.883x / (1 + 1.136 \times 10^{-3}x)$, $n = 48$, $r = 0.832$, $p < 0.001$).

eharai, to the density of *A. fockeui* showed significant saturation curves with high correlation coefficients (*A. sojaensis*: $r=0.794$, $p<0.001$; *A. eharai*: $r=0.832$, $p<0.001$). From these relationships, the maximum number of nymphs and adults of *A. fockeui* consumed per female per day was roughly presumed to be ca. 300 and 400 for *A. sojaensis* and *A. eharai*, respectively. This tendency of predatory abilities of the two phytoseiid mites corresponded well to those per 10 min (Table 1).

This study is the first report that showed the two phytoseiid mites having such high abilities to prey on *A. fockeui*, although the ability of *A. sojaensis* was somewhat inferior to that of *A. eharai*. This substantiates the result that the population density of *A. fockeui* in a peach orchard with no insecticides was markedly suppressed by the two phytoseiid mites (Kondo and Hiramatsu, 1999). Another phytoseiid mite that preys freely on *A. fockeui*, *Typhlodromus caudiglans* Schuster, was described in a peach orchard of Ontario, Canada, but it has no effect on the population density of *A. fockeui* (Putman and Herne, 1966). Some phytoseiid mites belonging to *Amblyseius* have been investigated for their abilities to prey on eriophyid mites by the number per day, i.e., female *A. olivi* Nasr and Abou-Awad consumes 120 females of the olive patch mite, *Eriophyes olivi* Zaher and Abou-Awad (Abou-Awad and El-Banhawy, 1986); female *A. gossipi* El-Badry consumes 91 females of the tomato erineum mite, *E. lycopersici* Wolffenstein (Abou-Awad, 1983), but their values are obviously inferior to those of *A. sojaensis* and *A. eharai* (Fig. 1). These also suggest that the two phytoseiid mites are highly effective as predators of *A. fockeui*, and this information seems to be important for developing an integrated pest management (IPM) program including *A. fockeui* in peach orchards.

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