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Preference of adults of *Allothrombium pulvinum* Ewing (Acari: Trombidiidae) for eggs of *Planococcus citri* (Risso) and *Pulvinaria aurantii* Cockerell on citrus leaves in the laboratory

ALIREZA SABOORI[1], MOJTABA HOSSEINI[2] & BIJAN HATAMI[2]

1 Department of Plant Protection, College of Agriculture, Tehran University, Karaj, Iran; E-mail: saboori@ ut.ac.ir
2 Department of Plant Protection, College of Agriculture, Isfahan University of Technology, P.O. Box 84154 Isfahan, Iran

Abstract

The adults of *Allothrombium pulvinum* Ewing (Acari: Trombidiidae) have a wide range of prey . Herein we review the prey range of these adults and report, from northern, Iran eggs of *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) and *Pulvinaria aurantii* Cockerell (Hemiptera: Coccidae) as new prey for adults of this mite. We examined the preference of *A. pulvinum* for eggs of *P. citri* and *P. aurantii* in no-choice and two-choice tests . The experiments were conducted on sour orange (*Citrus aurantium* L.) leaf discs over a 24h period at 261 C, 755% RH and a 12L:12D photoperiod. The predatory mite preferred *P. citri* eggs over *P. aurantii* eggs ($P<0.05$), and the mean number of eggs consumed by adults of *A. pulvinum* in the two-choice test was higher than that in the no-choice test. The potential of *A. pulvinum* as a biocontrol agent against these two important citrus pests from that region is discussed.

Key words: Acari, Trombidiidae, *Allothrombium pulvinum*, preference, preys, *Planococcus citri*, *Pulvinaria aurantii*, Iran.

Introduction

The velvet mite *Allothrombium pulvinum* Ewing (Acari: Trombidiidae) is a natural enemy of a variety of pest species (Zhang 1991). The larvae are ectoparasites of aphids, whereas the deutonymphs and adults are free-living predators of spider mites, various small arthropods and especially aphids, (Zhang 1992a, 1996 & 1998). In Europe, adults of *A. pulvinum* attack pea aphids in alfalfa fields (Sunderland 1988) and in Jiangsu, China, this species is an important natural enemy of *Aphis gossypii* Glover (Chen & Zhang 1991). Furthermore, adults of *A. pulvinum* ,may daily consume seven newly hatched aphids (Zhou et al. 1989). This species thus seems to have a wide range of prey in its adult stage, particularly eggs of various pest arthropods.

The adults of *A. pulvinum* prey on eggs of the moths *Ephestia cautella* Walker, *Heliothis armigera* Hbner, *Ostrinia furnacalis* Gunce and *Pectinophora gossypiella* Saunders (Chen 1987, Zhang & Xin 1989). In Xingjiang, China, the adults of *A. pulvinum* are important predators of the spring cankerworm eggs, *Paleacrita vernata* Peak, in peach orchards. Each mite consumed an average of 4.68 *P. vernata* eggs per day in the laboratory. Since these mites were abundant during the oviposition period of *P. vernata*, they could be important in reducing egg populations of this species (Zhou et al. 1989). In northern Iran, *A. pulvinum* was found on many plants such as citrus, apple, walnut and forest trees (Zhang & Faraji 1994).These adults were most abundant in citrus orchards from September to June of the next year (Saboori & Zhang 1996).

Feeding on the eggs of *Planococcus citri* (Risso) (Hemiptera: Pseudococcidae) and of *Pulvinaria aurantii* Cockerell (Hemiptera: Coccidae) by *A. pulvinum* adults was observed for the first time by the senior author in citrus orchards from that region at the end of spring. Most of thuis feeding was seen between early May and mid-June, when the population of primary prey (nymph and adult of aphid species, such as *Toxoptera aurantii* Boyer de Fonscolombe and *Macrosiphum rosae* L.) were low or absent in citrus orchard.

The adults of *A. pulvinum* are abundant and widely distributed in citrus orchards in northern Iran and they are fast moving and have high searching abilities (Saboori & Zhang 1996). Furthermore, *P. citri* and *P. aurantii* are the most important pests of citrus in this region. It seems, therefore, that data on the host preferences of this predator could be helpful for predicting its potential in the biological control of these pests. The present paper examines the host preferences of *A. pulvinum* adults for eggs of *P. citri* and *P. aurantii*, using no-choice and two-choice tests in the laboratory.

Materials and methods

Predator / prey sources and rearing

The adults of *A. pulvinum* were collected on 12 April 2002 in Chalus, Mazandaran province, in northern Iran. Thirty adults of *A. pulvinum* were brought back in a plastic dish with moist soil as substrate to the laboratory, which maintained conditions of 26±1×C, 80±5% RH and a 12L:12D photoperiod. The mites were fed daily with 4 adults of the cotton aphid, *Aphis gossypii* Glover, obtained from a laboratory culture maintained at 22±1°C at the College of Agriculture, Isfahan University of Technology. The mites were fed for 1 month and then starved for 24 hours before the beginning of each experiment. The citrus mealybug and the orange pulvinaria scale used in this study were reared on pumpkins in the insectary at 28±1°C, 80±5% RH and a 12L:12D photoperiod. The leaf discs used as test arenas originated from sour orange (*Citrus aurantium* L.) growing in a greenhouse at the Isfahan University of Technology.

Experimental conditions

The experimental design consisted of Petri dishes (diameter 60 mm and height 18 mm) padded with a thin wet cotton layer covered by filter paper. Each test arena was prepared by placing a leaf disc (diameter 30 mm) on the filter paper in the center of the dish. All experiments were conducted at 26±1°C, 75±5% RH and a 12L:12D photoperiod.

Two-choice test

Ten eggs of each host (a total of twenty eggs) were placed on a leaf disc with a fine brush (size 0000). The eggs were arranged on both side of the main vein of the leaf disc (Fig. 1). One *A. pulvinum* adult was then introduced to each leaf disc, which was then checked 24 hours later. The number of eggs consumed (seen by turning milky in color and crumpled, with a hole in the middle) were counted (Figs. 2 & 3). This trial was replicated 8 times.

No-choice test

This test was carried out for each host separately. Twenty eggs of each host were arranged on both side of the main vein of the leaf disc with the aid of a fine brush. One *A. pulvinum* adult was then introduced onto each leaf disc. The number of eggs consumed was counted 24 hours later. There were 8 replicates for each host.

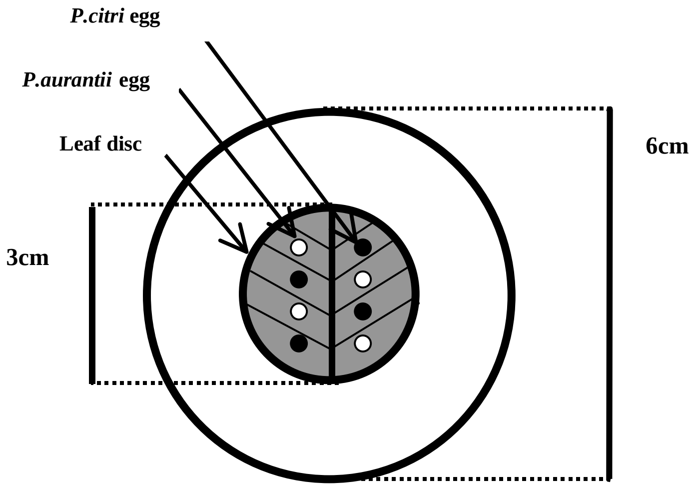

FIGURE 1. Arrangement of the eggs of *P. citri* and *P. aurantii* on a sour orange leaf disc in a Petri dish.

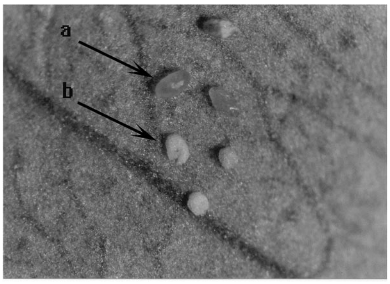

FIGURE 2. (a) Consumed eggs of *P. citri* by *A. pulvinum* adult (milky in color and crumpled, with a hole in the middle) and (b) unconsumed or healthy eggs of *P. citri*.

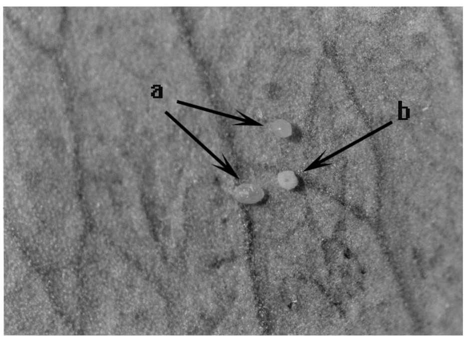

FIGURE 3. (a) Consumed eggs of *P. aurantii* by *A. pulvinum* adult (milky in color and crumpled, with a hole in the middle) and (b) unconsumed or healthy eggs of *P. aurantii*.

Results

In the two-choice tests, 70% of the P. citri eggs and 49% of the P. aurantii eggs were consumed by *A. pulvinum* adults. Analyses of the data indicated that the mean number of consumed hosts eggs was significantly different ($P< 0.05$, df = 14, t = 2.5505). In the other words, the predatory mites preferred the eggs of *P. citri* to those of *P. aurantii.*

In the no-choice tests, where prey was separately offered to *A. pulvinum*, the predatory mites consumed 40% of the *P. citri* eggs and 25% of the *P. aurantii* eggs. There was also a significantly difference between the rate of host eggs killed by *A. pulvinum* ($P< 0.05$, df = 14, t = 2.4225).

Results of two-choice and no-choice tests analyses indicate that the mean number of consumed eggs in two-choice test (a mean of 11.9 for eggs of both prey) was higher than in the no-choice tests (7.9 mean for P. citri eggs and 5.0 mean for P. aurantiieggs) ($P<0.001$, df = 2, 23, f = 13.17). The presence of the two prey eggs together thus encouraged the predatory mites to increase their feeding (Fig. 4).

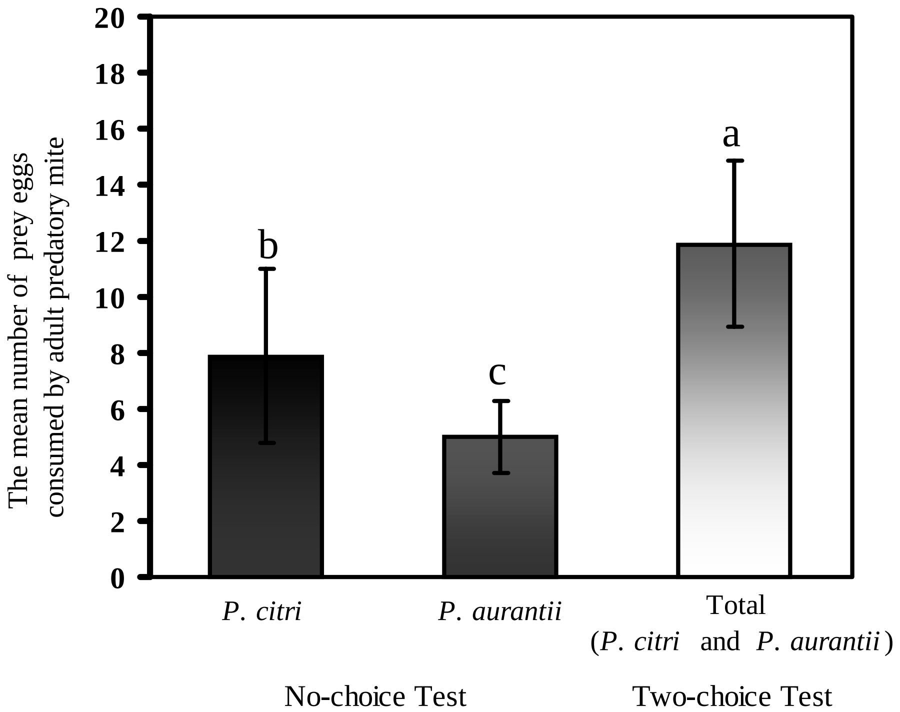

FIGURE 4. The mean number of eggs of *P. citri* and *P. aurantii* consumed by individual adults of *A. pulvinum* in no-choice and in two-choice tests during 24 hours. The letters (a, b and c) indicated that differences among treatments are significant ($P<0.001$).

Discussion

The adults of *A. pulvinum* clearly preferred the eggs of *P. citri* over those of *P. aurantii* the in two-choice and no-choice tests ($P<0.05$). Also, when the predatory mite was given the two prey together, it consumed more eggs than when prey were offered separately (P<0.001). The mite's preference of *P. citri* eggs over those of *P. aurantii* could have resulted from extrinsic and from intrinsic factors (egg size, thickness of egg shell and body odour). For example, the egg of *P. citri* is larger than that of *P. aurantii*. Also, the temporal priority of the presence of *P. citri* eggs to *P. aurantii* eggs could have an be effect. Furthermore, the difference of egg contents from the view point of the presence of nutrients (proteins, carbohydrates and lipids) for the mite could have caused this preference.

Due to the wide occurrence and abundance of the adults of *A. pulvinum* in citrus orchards in the north of Iran, and because they are fast moving and have high searching abilities, they could be good candidates as biocontrol agents of some pests (Saboori & Zhang 1996). *P. citri* and *P. aurantii* have a synchronized presence in citrus orchards and ornamental plants in this region, and at this time (mid to late spring, from early May to mid-June) *A. pulvinum* adults are at the end of their annual cycle, after mating and ovipositing. For this reason, we consider this mite as a biocontrol agent that could reduce the populations of these two pests by consuming their eggs. The eggs of these pests could serve as an alternate diets and may increase the longevity of the adult mites from early May to mid-June. In this study, the maximal feeding rate of *A. pulvinum* adults was 17 eggs per day (*P. citri* and *P. aurantii* eggs with together). This is very low in comparison with*A. pulvinum* deutonymphs that consume a maximum of 55.6 *Tetranychus urticae* Koch eggs per day (Zhang 1992b), or adult *A. pulvinum* consumption of 85 popular lace bug, *Hegesidemus habrus* Drake,(mostly third and fourth nymphal instars) per day that reduces prey numbers by 70% in 20 days at predator-prey ratios of 1:40-50 (Zhao 1992). However, because *P. citri* and *P. aurantii* are important pests of citrus orchards and ornamental plants in this region, the use of this mite should be taken into account and efforts should be made to conserve its populations in their natural habitats. Furthermore, some integrated pest management (IPM) programs should be planned, incorporating the use of this mite with other biocontrol agents in citrus orchards ((such as *Cryptolaemus montrozieri* Mulsant and *Chilocorus bipustulatus* Gordon (Col.: Coccinellidae)) in order to reduce the populations of these important pests. For this reason, further research is needed to understand the population dynamics of *A. pulvinum* feeding on these prey and their interactions with other natural enemies. In considering habitat conditions, it would be essential to to reduce pesticide application that are hazardous to this predatory mite, other natural enemies and to the environment.

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