Attractiveness of sex pheromone of *Pseudococcus cryptus* Hempel (Homoptera: Pseudococcidae) to adult males in a citrus orchard¹

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Abstract

The attractiveness of the sex pheromone of *Pseudococcus cryptus* to adult males and natural enemies was tested in citrus orchards in 1999 and 2000. Males were caught by the pheromone trap during two periods in 1999 and three periods in 2000, whereas natural enemies were not attracted in either year. When seasonal degree-day accumulations reached 302 DD above a base of 10°C from the periods that males were trapped, the first instars emerged.

Key words: *Pseudococcus cryptus*, sex pheromone, natural enemies, attractiveness, occurrence

INTRODUCTION

Pseudococcus cryptus is one of the most important citrus pests in Japan. Outbreaks of this mealybug that cause serious damage often occur in greenhouse cultivation. Control of this pest with insecticide is effective when the mealybug is in the first or second stadium. Discrimination of the nymphal stage is possible by visual observation (Arai, 1998). This pest tends to inhabit the shady parts of the citrus and, therefore, it is difficult to monitor the occurrence and stage composition of *P. cryptus* in orchards when its density is low.

As the sex pheromone of this mealybug was verified (Arai, 2000), it is expected that efficient monitoring of the pest could be realized by the sex pheromone. In this study, sex pheromone traps were set in fields and the attractiveness to males and natural enemies of the mealybug was tested.

MATERIALS AND METHODS

Pheromone trap. Sex pheromone used in the experiment was collected by an airborne collection apparatus (Arai, 2000). Sex pheromone was applied to a 1-cm² piece of filter paper (Toyo Roshi Co. Ltd., No. 1), and this paper was attached to the center of a yellow sticky board trap (20 cm in width and 10 cm in length). These traps were set in satsuma mandarin orchards of the Department of Citrus Research, Kuchinotsu, National Institute of

Fruit Tree Science. Studies were conducted in an orchard where insecticide had not been applied for 20 years in 1999 and for 3 years in the year 2000.

In 1999, four traps, which were treated with 50 female day-equivalents (hereinafter FDE) of the sex pheromone, were placed about 180 cm above the ground between citrus trees, and 100–200 cm apart from the trees. In the year 2000, eight traps, which had been treated with 10 FDE of the sex pheromone, were suspended from branches about 100–180 cm above the ground. Traps were set from 17:00 h till noon of the following day at 3–4 d intervals, and the number of males and natural enemies caught in each trap was counted. However, traps were set for 3–4 d in November 1999.

Seasonal development of *P. cryptus* and natural enemies. Twelve citrus trees in 1999 and eleven citrus trees in the year 2000 were selected and ten shoots with 5–10 leaves of each tree were collected at two week intervals. Numbers of *P. cryptus* and its natural enemies, and the stage composition of this mealybug on the leaves were investigated. Collected *P. cryptus* were reared on pumpkins at 25°C under a photoperiod of 16L:8D for a month. Mummies and mummified insects during rearing were collected and reared separately for one month in plastic sample cups with a lid (1.8 ml). Larvae of predators were reared on egg sacs of *P. cryptus* in plastic petri dishes (9 cm in diameter and 1.5 cm in depth), the bottoms of which were covered with a sheet of filter paper (No. 1, 9 cm in diameter).

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Fig. 1. Seasonal development of *P. cryptus* (A) and natural enemies (B) in the field, and trapped number of males and natural enemies of *P. cryptus* (C) in 1999.

RESULTS AND DISCUSSION

The seasonal development of *P. cryptus* and natural enemies in the field, and the number of *P. cryptus* males and natural enemies caught in the pheromone traps in 1999 and 2000 are shown in Fig. 1 and Fig. 2, respectively. Males were trapped from 9 to 13 August and from 16 to 21 September in 1999, and on 3 May, from 18 to 22 August and on 10 October in the year 2000. From the periods that males were trapped, the periods at which seasonal degree-day accumulations reached 302 DD above a base of 10°C, which was the thermal constant of the preovipositional period of *P. cryptus* females (Arai, 1996), were calculated. The calculated periods were from 28 August to 1 September and from 7 to 12 October in 1999, and on 6 June, from 10 to 15 September and on 11 November in the year 2000. These calculated periods were almost the same periods that the first instars emerged in the field in both years. Therefore, it is considered that the occurrence of the first stadium could be predicted from the time that the males were trapped with traps baited with 10 FDE pheromone.

It was reported that two species of natural ene-

mies of scale insects were attracted to the sex pheromone of their hosts (Rice and Jones, 1982; Dunkelblum et al., 2000). In this study, two species of mealybug parasitoids, *Allotropa* sp. and *Anagyrus subalbipes* were caught in the traps, although there were no relationships between trapped numbers and seasonal abundances of parasitoids in the field (Table 1). The mealybug gallmidge *Diadiplosis hirticornis* was collected from *P. cryptus* females with egg sacs in the field, although this predator was not caught in the trap. From these results, it is considered that the seasonal occurrence of these natural enemies could not be monitored by the pheromone or yellow sticky board traps.

Ladybird beetles whose larvae were collected from mealybugs were trapped from 10 May to 1 September in the year 2000. There was no relationship between trapped numbers and seasonal abundances of ladybird beetles in the field (Table 1). Although the number of the ladybird beetles collected from the mealybugs was less than that of the parasitoids, more ladybird beetles were caught in the traps, and it is considered that the occurrence of the ladybird beetles in the field might be monitored by the traps. Many ladybird beetles that did not

Fig. 2. Seasonal development of *P. cryptus* (A) and natural enemies (B) in the field, and trapped number of males and natural enemies of *P. cryptus* (C) in the year 2000.

Table 1. Relationship between the numbers of trapped and collected natural enemies in the field

Natural enemy species	Year	F	df	Probability
<i>Allotropa</i> sp.	1999	0.2526	df=1, 6	>0.6331
	2000	0.4788	df=1, 4	>0.5270
	1999, 2000	0.6537	df=1, 12	>0.4345
<i>Anagyrus subalbipes</i>	1999	0.5814	df=1, 6	>0.4747
	2000	0.0938	df=1, 4	>0.7747
	1999, 2000	0.3944	df=1, 12	>0.5418
Ladybird beetle	2000	0.0901	df=1, 7	>0.7728

emerge from *P. cryptus* were also caught in the pheromone traps and they seemed to be attracted to yellow color. In this experiment control traps were not set, and the attractiveness of the pheromone and trap color on ladybird beetles was not evaluated.

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