Original Article

Effect of the Kairomone on the Parasitization Rates of *Apanteles kariyai* to *Pseudaletia separata**

Junji TAKABAYASHI and Shozo TAKAHASHI

Pesticide Research Institute, Faculty of Agriculture, Kyoto University,
Sakyo-ku, Kyoto 606, Japan

(Received November 4, 1987)

An arrestant to keep *A. kariyai* in the host habitat was synthesized by Wittig reaction followed by hydrogenation from a furan compound. Using this synthetic arrestant, its effect on the parasitization rate of *A. kariyai* to *P. separata* was examined in laboratory and greenhouse conditions. In both conditions, treatment of the host habitat with the arrestant increased the parasitization.

INTRODUCTION

Apanteles kariyai is a gregarious parasitoid of common armyworm *Pseudaletia separata*. It is the most predominant parasitoid of *P. separata* in the field, and Hirai therefore suggests that it could be an important factor in regulating a host population.¹⁾

Female *A. kariyai* showed a sequential oviposition behavior in the laboratory. Immediately after exposed to feeding trace, exuviae or feces of a host larva, they started to walk slowly, searching the host around. Such a behavior was also elicited by a filter paper disk containing a hexane extract of the above materials. While searching, they found the host by antennal contact, then immediately mounted on larvae and oviposited. These observations confirmed the presence of a chemical stimulus in the feeding trace, exuviae and feces of a host larva which keeps *A. kariyai* in the host habitat.²⁾ According to definitions by Dethier *et al.*, a chemical stimulus which induces such a searching behavior is

called an arrestant.³⁾ The arrestants from three different sources consisted of the same compound 2,5-dialkyltetrahydrofuran,⁴⁾ a kairomone to *A. kariyai*. Some of the arrestants were synthesized, and all the synthetic compounds different in length of alkyl chain from natural arrestants showed similar arresting activity to *A. kariyai* in the laboratory.⁵⁾

This paper is to report the effect of a synthetic arrestant of *A. kariyai* on the parasitization rate of *P. separata* in laboratory and greenhouse conditions.

MATERIALS AND METHODS

1. Insect

P. separata was reared on either corn leaves or an artificial diet at $24 \pm 2^\circ\text{C}$ and on a 17L-7D light cycle. The fourth to fifth instar larvae were introduced to *A. kariyai* for oviposition and the emerged wasps were kept in a test tube (22 mm in diameter, 200 mm long) with a small piece of paper towel moistened with 50% aqueous honey solution, on which they could live.

2. Arrestant

Synthetic 2,5-dihexadecyltetrahydrofuran was used as an arrestant for the parasitization experiment of *A. kariyai*.⁵⁾

* Effect of Kairomone in the Host Searching Behavior of *Apanteles kariyai*, a Parasitoid of Common Armyworm *Pseudaletia separata* (Part 4). A part of this paper was presented at the 12th Annual Meeting of Pesticide Science Society of Japan.

3. Parasitization Experiments in Laboratory

Filter paper (20 cm×30 cm) was folded in an "accordion" manner and one sheet was placed on top of another cross-wise. The paper served as an artificial shelter for *P. separata* and parasitization experiments were conducted with the shelters impregnated with hexane solution of 2 mg of 2,5-dihexadecyltetrahydrofuran. In each experiment, forty fourth instar *P. separata* larvae were first put into the shelter, and 30 min later forty female *A. kariyai* were released from a corner. After 3 hr, *P. separata* were collected and reared another 10 days, and then the hatched parasitoids were counted. The parasitization rate was compared with the one in control experiments in three replications.

4. Parasitization Experiments in Greenhouse

About forty corn plants (40–50 cm tall) were grown in a pot and five pots were placed in a net cage (160 cm×240 cm×160 cm). The arrangement of the pots is shown in Fig. 1. As

Fig. 1 Arrangement of corn pots and release points of *Apanteles kariyai*.

Squares indicate corn plant pots. Stars indicate release points of female *A. kariyai*.

the control, forty fourth instar *P. separata* larvae were raised on the corn plants for 24 hr and then forty female *A. kariyai* were released. The next day, *P. separata* larvae were collected and raised another 10 days, and then the hatched parasitoids were counted. In the treated experiments, the synthetic arrestant was sprayed on the corn plants before *P. separata* were introduced. The experiment was repeated four times.

RESULTS AND DISCUSSION

A. kariyai recognized a host habitat through antennal perception of chemical cues present in feeding traces on host plants, exuviae and frass. The perception behavior and the effect on oviposition behavior were tested in a box with folded filter paper. The results are in Table 1. The mean parasitization rate by *A. kariyai* was 21.7% in the control experiments, whereas it was 50.8% in the treated experiments. The parasitization rates were significantly higher in the treated experiments than in the control. Most of female *A. kariyai* flew away from the control pots immediately after released, because they served no sign of the presence of host larvae in the folded filter paper forming the shelter (habitat). Even in this artificial condition, however, a few females found host larvae and parasitized them. In the treated plots, females responded to the arrestant absorbed in the folded filter paper and showed a strong antennal contact behavior toward it. As a result, the females in the treated plots did not disperse immediately,

Table 1 Parasitization rates (%) of *A. kariyai* to *P. separata* larvae in the laboratory.

	Experi- ment 1	Experi- ment 2	Experi- ment 3	Mean ^{c)}
Control ^{a)}	7.3	15.0	42.5	21.7
Treated ^{b)}	20.0	42.5	90.0	50.8

^{a)} Folded filter paper without the arrestant.

^{b)} Folded filter paper with 2 mg of the arrestant sprayed.

^{c)} Means significantly differ at the 10% level as determined by χ^2 test. In each experiment, forty forth instar *P. separata* and forty female *A. kariyai* were released.

Table 2 Parasitization rates of *A. kariyai* to *P. separata* larvae in the greenhouse.

Repetition No.		No. of <i>P. separata</i> released (recovered)	No. of <i>A. kariyai</i> released	Parasitization rate (%)
1	Control	50 (48)	50	16.7
	Treated	50 (48)	50	33.3
2	Control	50 (35)	50	14.3
	Treated	50 (40)	50	25.0
3	Control	50 (40)	50	7.5
	Treated	50 (45)	50	33.3
4	Control	50 (44)	50	29.5
	Treated	50 (45)	50	42.2
Mean ^{a)}	Control	50 (41.7)	50	17.4
	Treated	50 (44.5)	50	33.7

^{a)} Means are significantly different at the 10% level as determined by χ^2 test.

finding host larvae more easily than the females in the control experiments.

The results of the greenhouse experiment are shown in Table 2. Mean parasitization rates in the control experiments and in the treated experiments were 17.4% and 33.7%, respectively. The parasitization rates were again significantly higher in the treated experiments than in the control. Even in the control experiments, corn plants of the host habitat (ca. 200 plants) were partly fed on by the host larvae during a 24-hour period, and consequently there were some feces and feeding traces on and under the corn leaves. Therefore, the control experiment plot had already contained some information about the host larvae habitat. Spraying the synthetic arrestant in this condition meant a further increase of information (kairomones), and this resulted in an increase in the parasitization rate of *A. kariyai* to the host larvae.

Searching behavior of parasitoids is usually stimulated by the perception of kairomones. According to Gross,⁶⁾ host-finding efficiency by parasitoids depends primarily on their frequency of encounter with allelochemicals (kairomones, synomones, pheromones, etc.) and their inherent nature to orient *via* these allelochemicals to a high host probability site. The employment of kairomone for control of entomophagous insects has been studied by Lewis *et al.*,^{7,8)} who used *Trichogramma* spp.

as a generalist parasitoid on Lepidopteran eggs for managing Lepidoptera pests. Their results show that the application of kairomone increases the parasitization rate of *Trichogramma* on Lepidopteran pests. In our experiment, the parasitization rate of *A. kariyai* to *P. separata* was also higher when a synthetic arrestant (2,5-dihexadecyltetrahydrofuran) was sprayed on folded filter paper and corn plants because spraying could prevent dispersing from the host habitat. This result also indicates that an arrestant is an important factor in the host-finding behavior of *A. kariyai*.

Treatment of a host habitat with arrestants would thus improve the use of parasitoids for pest management.⁹⁾ The effect of host and parasitoid densities on the parasitization rates is suggested as an important factor in the management of entomophagous insects by *Trichogramma pretiosum*.⁹⁾ Further study on kairomone-treatment pattern as well as effects of host and parasitoid densities on the parasitization rate of *A. kariyai* to *P. separata* has yet to be studied.

REFERENCES

- 1) K. Hirai: *Kitanihonbyoutyuhou* **35**, 154 (1984)
- 2) V. G. Dethier, L. B. Browne & C. N. Smith: *J. Econ. Entomol.* **53**, 134 (1960)
- 3) J. Takabayashi, T. Noda & S. Takahashi: *Appl. Entomol. Zool.* **20**, 484 (1985)
- 4) J. Takabayashi & S. Takahashi: *Appl. Entomol. Zool.* **21**, 114 (1986a)
- 5) J. Takabayashi & S. Takahashi: *Appl. Entomol. Zool.* **21**, 519 (1986b)
- 6) H. R. Gross, Jr.: "Semiocchemicals," ed. by D. A. Nordlund, R. L. Jones & W. J. Lewis, Wiley Interscience, pp. 137-150, 1981
- 7) W. J. Lewis, R. L. Jones, D. A. Nordlund & A. N. Sparks: *J. Chem. Ecol.* **1**, 343 (1975)
- 8) W. J. Lewis, R. L. Jones, D. A. Nordlund & H. R. Gross, Jr.: *J. Chem. Ecol.* **1**, 349 (1975)
- 9) W. J. Lewis, M. Beever, D. A. Nordlund, H. R. Gross, Jr. & K. S. Hagen: *J. Chem. Ecol.* **5**, 673 (1977)

要 約

カリヤサムライコマユバチのアワヨトウに対する寄生率に及ぼすカイロモンの影響*

高林純示, 高橋正三

寄主アワヨトウ幼虫の糞, 嚙み跡, 脱皮殻中には, カ

リヤサムライコマユバチを寄主生息域内に留めておく作用をもつ定着因子が含まれている。定着因子がカリヤサムライコマユバチの寄生率に及ぼす影響を、合成した定着因子 (2,5-dihexadecyltetrahydrofuran) を用いて調べた。実験室内およびガラス室内に人為的に寄主アワヨト

ウの生息域を設け、そこにカリヤサムライコマユバチを放飼し寄生率を調べた (対照区)。処理区では、寄主生息域を合成定着因子であらかじめ処理した後に蜂を放飼した。両放飼実験において、定着因子を処理した区のほうが高い寄生率を示し、定着因子 (カイロモン) とカリヤサムライコマユバチを用いたアワヨトウ管理の可能性が示唆された。

* アワヨトウ幼虫寄生蜂カリヤサムライコマユバチの寄主発見におけるカイロモンの作用 (第4報)