Predation by *Amblyseius* spp. (Acarina:
Phytoseiidae) and *Orius* sp.
(Hemiptera: Anthocoridae) on
Thrips palmi KARNY
(Thysanoptera: Thripidae)¹

Hiroshi KAJITA

*Institute of Biological Control, Faculty of Agriculture,
Kyushu University, Fukuoka 812, Japan*

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Thrips palmi KARNY is a potential pest of crops mainly in the Asian tropics (BHATTI, 1980). In Japan this thrips was discovered attacking greenhouse sweet peppers in Miyazaki Prefecture in 1978. Recently the pest has occurred in almost all prefectures of Japan except Tohoku and Hokkaido districts causing much damage to important vegetable fruits both in the greenhouse and the field unless insecticides are heavily applied. The anthocorids, *Orius maxidentex* GHOURI (SURESH KUMAR and ANANTHAKRISHNAN, 1984) and *O. similis* ZHENG (WEI et al., 1984) are known as predators of thrips in India and China, respectively. However, there is a paucity of information concerning such natural enemies in Japan. In the present study, the prey stage preference, prey consumption and feeding behavior of three polyphagous predator species were investigated under laboratory conditions.

Predators used here were 2nd-instar nymphs of *Orius* sp. and ovipositing adult females of *Amblyseius mckenziei* SCHUSTER et PRITCHARD and *A. okinawanus* EHARA. Both *A. okinawanus* and *Orius* sp. were collected from field cucumbers infested with *T. palmi* on the campus of Kyushu University during June to August, 1984. *A. mckenziei* was imported to Japan from the Glasshouse Crops Research and Experiment Station, Naaldwijk, the Netherlands in July of 1984. Rearing the predatory mite was done in glass vials (6 cm in length and 1.5 cm in diameter), each containing about 40 individuals of the mold mite, *Tyrophagus putrescentiae* (SCHRANK) at different stages fed on dry yeast (Ebios, Asahi Breweries Co., Ltd.) in a room of 25°C and 16L-8D photoperiod. After being starved for 24 hr at 25°C, individual predators of the three species were tested once against *T. palmi* of the selected stage. Prey thrips and leaves for test arenas were obtained

from field cucumbers on the campus of the University.

All the experiments and observations were made in the room described above. The test arena consisted of a 2-cm-square piece of the lower surface of a young or median cucumber leaf. It was placed on a moistened filter paper (5.5 cm in diameter) covering the bottom of a glass petri dish (6 cm in diameter and 1 cm in depth) as a base, with an 8-cm-square piece of parafilm (Sealon Film, Fuji Photo Film Co., Ltd.) serving as a covering for the dish. The parafilm for the lid was removed when behavioral observations of predators were made under a binocular microscope.

To determine the stage of *T. palmi* chosen in predation by each species of the selected stage, each predator was introduced into the arena of a median cucumber leaf and provided with a total of 9 thrips, three individuals of each of the 1st- and 2nd-instar larvae and adults. Four hours after predator release, the number of consumed prey was counted under the microscope. To determine the prey consumption for a 24 hr period and observe the searching and feeding behavior, each predator was placed by a young leaf and provided with five 1st-instar thrips individuals. The number of prey consumed by the anthocorid for a 24 hr period also was determined in the arena of a median leaf with lower hair density. Each behavioral observation lasted about 1 hr. Measurements of the length from the top of the head to the tip of the abdomen, the width of the abdomen and the distance between a hair and its nearest neighbour on the lower leaf surface were taken under a microscope with a micrometer fixed in its ocular.

Table 1 shows the results of prey stage preference by the three predator species of the selected stage. Adult female *A. mckenziei* and *A. okinawanus* preferred 1st-instar thrips to 2nd-instar and adult thrips. *A. cucumeris* (OUDEMANS) and *A. mckenziei* on sweet peppers occur in the crop layer where hatching eggs of *T. tabaci* LINDEMANN are present (RAMAKERS, 1978). *A. rubini* SWIRSKI et AMITAI and *A. swirskii* ATHIAS prey on larvae and pupae of the thrips, *Retithrips syriacus* (MAYET) (SWIRSKI et al., 1967). However, species of the genus *Amblyseius* never prey on adult thrips to the author's knowledge. The great difference in body length between predator and prey suggests that no adult

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Table 1. Prey preference by *A. mckenziei*, *A. okinawanus* and *Orius* sp.^a

Predator	No. of experiments	% prey consumed			Total no. of prey consumed ($\bar{x} \pm \text{SD}$)
		1st-instar larva	2nd-instar larva	Adult	
<i>A. mckenziei</i>	6	100.0	0.0	0.0	1.0 $\pm$ 0.0
<i>A. okinawanus</i>	6	91.7	8.3	0.0	1.3 $\pm$ 0.5
<i>Orius</i> sp.	6	44.4	55.6	0.0	2.0 $\pm$ 1.3

^a Three individuals of each of the three prey stages were offered to a single predator.

Table 2. Body length and width of predator and prey used for the experiments and observations

Predator or prey	No. of individuals measured	Body length (mm, $\bar{x} \pm \text{SD}$)	Body width (mm, $\bar{x} \pm \text{SD}$)
Adult female of <i>A. mckenziei</i>	10	0.43 $\pm$ 0.01	0.18 $\pm$ 0.01
Adult female of <i>A. okinawanus</i>	10	0.42 $\pm$ 0.02	0.27 $\pm$ 0.02
2nd-instar nymph of <i>Orius</i> sp.	10	0.80 $\pm$ 0.07	0.36 $\pm$ 0.02
1st-instar larva of <i>T. palmi</i>	10	0.48 $\pm$ 0.06	0.12 $\pm$ 0.02
2nd-instar larva of <i>T. palmi</i>	10	0.80 $\pm$ 0.05	0.19 $\pm$ 0.01
Adult of <i>T. palmi</i>	10	0.96 $\pm$ 0.06	0.21 $\pm$ 0.02

Table 3. The number of 1st-instar thrips consumed by three species during a 24 hr period^a

Predator	No. of experiments	No. of prey consumed ($\bar{x} \pm \text{SD}$)
<i>A. mckenziei</i>	10	2.0 $\pm$ 1.6
<i>A. okinawanus</i>	10	1.0 $\pm$ 1.0
<i>Orius</i> sp.	10	1.4 $\pm$ 1.3

^a Five individuals of 1st-instar thrips were offered to a single predator.

thrips can be killed by adult *Amblyseius* (Table 2). On the other hand, the number of prey consumed by 2nd-instar nymphs of *Orius* sp. in the three prey stages does not differ greatly. Unlike those of the genus *Amblyseius*, active stages of the genus *Orius* are able to kill adult thrips (BAILEY, 1933; RAMAKERS, 1978; ISENHOUR and YEARGAN, 1981). However, 2nd-instar nymph of *Orius* sp. killed no adult thrips in this test. It is likely that the anthocorid killed smaller thrips first when various instar thrips were present. Feeding behavior similar to this is known with *O. insidiosus* var. *tricolor* WHITE attacking the bean thrips, *Hercothrips fasciatus* (PERGANDE) (BAILEY, 1933).

The number of 1st-instar larvae of *T. palmi* consumed by each species of predator in a 24 hr period is presented in Table 3. *Orius* sp. does not differ significantly in the number of prey consumed from *A. mckenziei* and *A. okinawanus* ($P > 0.05$, KRUSKAL-WALLIS test). To date there is no de-

tailed information on prey consumption by *Amblyseius* feeding on thrips. Individual *A. cucumeris* may consume 5 or 6 individuals of *T. tabaci* per day (MACGILL, 1939). On the other hand, 2nd-instar nymphs of *O. similis* consume about 10 individuals of *T. palmi* per day (WEI et al., 1984). This value is apparently high as compared with that by *Orius* sp. in this study.

The common escape behavior of encountered thrips was not to release a blob of excrement, but to raise and lower the body rapidly. Such an attempt was frequently a successful escape reaction to capture and feeding by *A. okinawanus*, but less successful to *A. mckenziei*. After an encounter *A. mckenziei* sometimes pursued, captured and consumed the thrips. This behavioral difference between the two predatory mites may support the results of prey consumption tests. Capture by *Orius* sp. was infrequently observed because the young leaf was used as the test arena. When the

median leaf was used, the prey consumption by *Orius* sp. for a 24 hr period was 4.1 ± 0.7 (mean $\pm$ SD, $n=10$), significantly higher than that determined in the young leaf ($P < 0.05$, MANN-WHITNEY's *U*-test). The distance between a hair and its nearest neighbour on the young leaf was 0.20 ± 0.08 mm (mean $\pm$ SD, $n=40$), while that on the median leaf was 0.51 ± 0.17 mm (mean $\pm$ SD, $n=40$). Therefore, on the young leaf *Orius* sp. frequently walked on the top of hairs about 0.5 mm long and lost contact with the thrips on the substrate.

It is impossible for small predators to consume many large prey. Therefore, determination of the rate of increase of predator and prey populations is more important than the rate of prey consumption (RAMAKERS, personal communication). Biological control of *T. palmi* would require a wide survey of natural enemies and ecological studies of thrips and its natural enemies.

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REFERENCES

- BAILEY, S. F. (1933) *Hilgardia* **7**: 467–522.
 BHATTI, J. S. (1980) *Syst. Entomol.* **5**: 109–166.
 ISENHOUR, D. J. and K. V. YEARGAN (1981) *Environ. Entomol.* **10**: 496–500.
 MACGILL, E. I. (1939) *Ann. Appl. Biol.* **26**: 309–317.
 RAMAKERS, P. M. J. (1978) *Med. Fac. Landbouww. Rijksuniv. Gent* **43**: 463–469.
 SWIRSKI, E., S. AMITAI and N. DORZIA (1967) *Israel J. Agric. Res.* **17**: 101–119.
 SURESH KUMAR, N. and T. N. ANANTHAKRISHNAN (1984) *Proc. Indian Nat. Sci. Acad.* **B50**: 139–145.
 WEI, C. S., Z. J. PENG, G. Q. YANG, Y. CAO, B. Z. HUANG and X. CHEN (1984) *Natural Enemies of Insects* **6**: 32–40 (in Chinese).

Role of Postcopulatory Courtship in Insemination of Two Aphelinid Wasps (Hymenoptera: Aphelinidae)¹

Hiroshi KAJITA

*Institute of Biological Control, Faculty of Agriculture,
Kyushu University, Fukuoka 812, Japan*

(Received February 15, 1986)

It is of interest to note that aphelinid wasps spend much time in exhibiting postcopulatory courtship (GORDH and DEBACH, 1978; VIGGIANI and BATTAGLIA, 1983) because GORDH and DEBACH (1978) considered the postcopulatory courtship in the *Aphytis lingnanensis* group equivalent to guarding the female. Recently I observed that *Encarsia* sp. and *Prospaltella* sp., solitary wasps of the greenhouse whitefly, *Trialeurodes vaporariorum* (WESTWOOD) exhibited postcopulatory courtship. The courtship and mating of these two species

included the following behavioral sequence: contact, mount, precopulatory courtship, dismount, copulation, remount, postcopulatory courtship and final dismount. Females of both species laid fertilized, female-producing eggs in healthy whitefly pupae, whereas unfertilized male-producing eggs on full-grown larvae or pupae of their own species or of other species such as *Encarsia formosa* GAHAN (KAJITA, unpublished). The purpose of this study was to determine the role of the postcopulatory courtship in the insemination of aphelinid wasps using *Encarsia* sp. and *Prospaltella* sp. I artificially interrupted remount by males immediately after copulation to determine whether or not the mated females laid fertilized eggs.

The *Encarsia* sp. and *Prospaltella* sp. used are the same as *Encarsia* sp. A and *Prospaltella* sp. in the previous paper (KAJITA, 1981). Both species were originally obtained in the form of immature stages from field crops infested with the greenhouse whitefly and then reared through a few generations

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