

OBSERVATIONS ON THE OVIPOSITION BEHAVIOUR OF  
METASYRPHUS CONFRA TER (DIPTERA, SYRPHIDAE) AND  
THE DEFENSIVE BEHAVIOUR OF SOLDIERS OF  
PS' EUDOREGMA BAMBUCICOLA (HOMOPTERA,  
PEMPHIGIDAE)

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OBSERVATIONS ON THE OVIPOSITION BEHAVIOUR OF *METASYRPHUS*  
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BEHAVIOUR OF SOLDIERS OF *PSEUDOREGMA BAMBUCICOLA*  
(HOMOPTERA, PEMPHIGIDAE)<sup>1</sup>

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**Abstract**

Observations on the oviposition behaviour of an aphidophagous syrphid fly *Metasyrphus confrater* and the defensive behaviour of soldiers of its prey aphid *Pseudoregma bambucicola* are reported. This syrphid lays its eggs in colonies of the aphid in winter when aphid soldiers are not a few in number, but weak in activity. In the autumn, on the other hand, when aphid soldiers numerous and active, oviposition occurs on nearby spider threads and not directly on the aphid colony. Thus, *Metasyrphus confrater* probably evolved an ovipositing strategy which is adapted to the activity of aphid soldiers. Soldiers of *Pseudoregma bambucicola* destroy the eggs and attack the first instar larvae of the syrphid when these two antagonistic organisms come into contact.

**Introduction**

The ovipositing habits of the syrphid flies are very variable, and are related both to the number and location of eggs deposited. The method of oviposition of several species of the Syrphidae belonging to widely separated genera has been studied by many authors. In the aphidophagous syrphids, the eggs are usually deposited singly upon leaves and twigs on which aphid colonies are found. In those cases, eggs are laid close to the aphid colony and on the plants, e. g., leaves or twigs (Banks, 1959 ; Dixon, 1959 ; Hughes, 1963 ; Sundby, 1966 ; Chandler, 1968c ; etc.). In certain melanostomine species, eggs are often deposited on uninfested plants (Metcalf, 1913 ; Heiss, 1938 ; Chandler, 1968c).

Over the last several years, I have observed the interesting behaviour of *Metasyrphus confrater* (Wiedemann, 1830), whose eggs were almost always laid on spider

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threads near colonies of the prey aphid, ***Pseudoregma bambucicola*** (Takahashi, 1921) during autumn and early winter. So far as I know, such behaviour has not been observed in other aphidophagous syrphid species. Females of *M. confrater*, although attracted by ***P. bambucicola***, nevertheless usually lay their eggs on neighbouring spider threads which may provide better tactile stimuli for oviposition.

The syrphine species, *Metasyrphus confrater* (Wiedemann), is widely distributed in the Oriental Region. In Japan, this species occurs in Shikoku, Kyushu and in the Nansei and Ryukyu Islands. Individuals of the species are scarce from spring to mid summer, but abundant from late summer or early autumn to winter. Adults may commonly be found around clumps of bamboo in lowland or coastal regions. The habitat and seasonal occurrence of this species appears to be correlated with the presence of its prey aphids.

Takano (1934) recorded *Ceratovacunalanigera* Zehntner, 1897, an aphid pest of sugarcane, as a prey aphid of *M. confrater* in Taiwan. Ninomiya (1959) recorded ***Pseudoregma bambucicola*** (Takahashi) as a prey of that species in Japan. Ghorpadé (1981) summarized published information on the prey insects of 47 carnivorous syrphid species in India and neighbouring areas, and listed more than 20 species of aphids as prey of *M. confrater*. However, ***P. bambucicola*** is not known in this area.

To the author's knowledge, *M. confrater* feeds specifically on ***P. bambucicola***, at least in Kyushu, and I have been unable to find any other syrphid species preying on this aphid.

***Pseudoregma bambucicola*** (Takahashi, 1921) is a hormaphidine aphid species known from Kyushu, Nansei Islands, Ryukyu Islands and Taiwan. This species infests bamboo of the genus *Bambusa*, and develops large and dense colonies. It seems probable that the species exists solely upon *Bambusa multiplex* Reaush (Japanese name : Hourai-chiku) in Japan. This aphid species produces "pseudoscorpion-like" 1st instar larvae, which are known as "soldiers" (Aoki et al., 1981).

The individuals of this aphid species are scarce from spring to summer, and begin to increase in late summer or early autumn. Population increases are synchronized with the growth of bamboo shoots ; thus, the aphids are usually most abundant in October and November. Percentage of "soldiers" to other morphs in the colonies is low in summer and early autumn. Their proportion gradually increases towards late autumn as the aphid population grows, and reaches its peak (about 20 %) during October or November. The percentage of "soldiers" gradually decreases again from mid winter to the following summer (Sunose et al., 1982).

During October and November 1975, I found many eggs of *M. confrater* which had been laid on spider threads. However, I was unable to interpret the meaning of this observation until October 1981 and November 1982, when I observed a defensive behaviour of aphid soldiers against both the 1st instar larvae and the eggs of *M. confrater*. In addition, in January 1983, I observed the eggs of *M. confrater* laid on the surface of the culms or stipules of bamboo close to aphid colonies. Some eggs had also been deposited directly on the aphid colonies. By contrast, a few eggs could be observed on spider threads. From winter to early spring (late December to next March

or April) the aphid soldiers were fairly abundant but they appeared to be inactive. Therefore, it may be suggested that *M. confrater* has developed an oviposition strategy which is related to the activity of aphid soldiers.

## Methods

Observations were made and photographs were taken of field populations of *M. confrater* and *P. bambucicola* at Kaseda City, Kagoshima Prefecture, Kyushu on November 28th–30th, 1982 and on January 1st–4th, 1983. The aphids were found infesting culms of bamboo in large colonies. A huge aphid colony was found on a tall and slender bamboo, about 4 m in height and 3 cm in diameter at the base and my observations were made principally on that colony.

## Observations and Results

### 1. Oviposition behaviour of *M. confrater*

Oviposition behaviour of several females of *M. confrater* was observed on November 29th–30th, 1982.

The female approached the infested bamboo in a straight line. She then hovered at variable height, and moved around the bamboo at a distance of a few centimetres (Fig. 1). She examined the aphids at an angle of 45–60 degrees as she repeatedly flexed and contracted her legs. Both the soldiers and other morphs of *P. bambucicola* in the colony reacted to the fly's proximity by lifting and shaking their hind legs. After these movements the *M. confrater* female withdrew and flew down to the basal portions of the bamboo in search of an oviposition site. When she found a proper site, which usually seemed to be the spider threads, she hovered close to the threads and grasped one with her anterior and middle legs. She then oviposited an egg by bending her ovipositor. *M. confrater* usually lay eggs singly, but sometimes 2 or 3 are laid in a batch.

### 2. Oviposition site of *M. confrater*

#### (1) Observations on November 28th–30th, 1982

Observations were made on the distribution of the eggs of the syrphid, *M. confrater* toward the end of November. It was found that the eggs of this fly were deposited predominantly on spider threads spun near the base of bamboo culm (Figs. 2 & 3). Of 127 eggs of *M. confrater* found, 108 were deposited on the spider threads 17, on hair roots of other plants, and 2 on the tip of the stipule near the base (Fig. 2, white arrow). These eggs were found within 15 cm of the culm of bamboo. The most distantly laid egg was about 1.5 m away from the base of the bamboo. It was noted that no eggs of *M. confrater* were deposited on the culm of the bamboo.

Several eggs of this fly were also found on the tips of needle-like unopened leaves of short bamboo which were not heavily infested by the aphid. Eggs were also found on other hairy objects, but rarely on the petioles of dead leaves on the ground.

(2) Observations on January 1st-4th, 1983

Observations were made on the distribution of the eggs of *M. confrater* in January. Most eggs of this fly were found on the culm of bamboo (Figs. 6 & 7); there were some on the surface of stipules and also even in a colony of the prey aphid. The population of the aphids was low at this time, probably due to predation by this syrphid. Interestingly, only a few eggs were found on the spider threads. The number of soldiers of a colony were not a few, but the soldiers appeared to be inactive.

3. Attacks on eggs of *M. confrater* by aphid soldiers

(1) On November 29th, 1982, I watched several soldiers of *P. bambucicola* wandering over a slender branchlet of small bamboo. One of the soldiers walked to a needle-like unopened leaf on which an egg of *M. confrater* had been laid on the tip. As soon as the soldier touched the egg, she clasped it with her enlarged anterior legs. Then she thrust at it with her frontal horns and pierced the egg's surface. After about 10 seconds or so, the soldier released the egg and walked away.

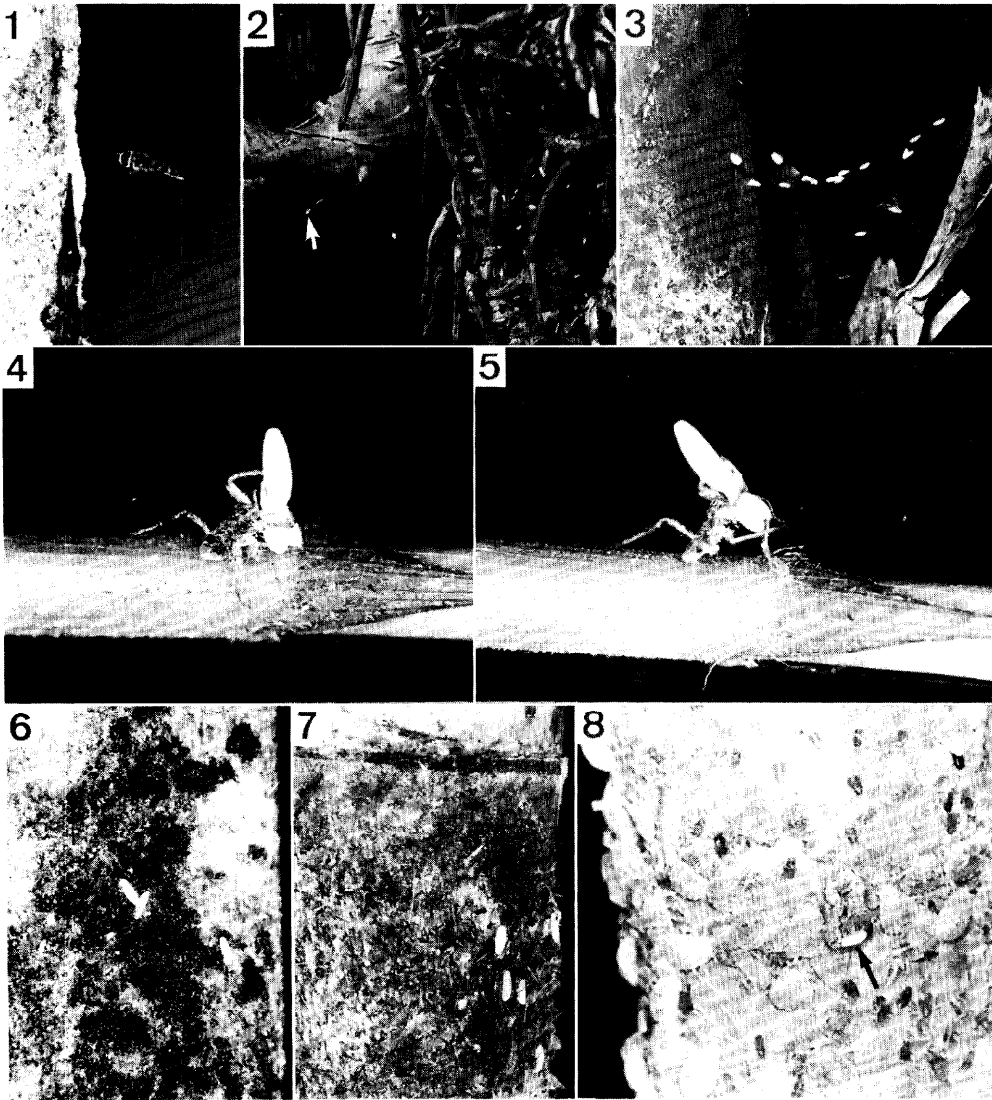
(2) On November 30th, 1982, I observed 2 syrphid eggs which were under attack by aphid soldiers. The eggs had been laid on the tip of a stipule at the basal portion of the bamboo (Fig. 2, white arrow). Many soldiers were wandering over the basal portion of this bamboo as if they were on patrol. One of the soldiers happened to come across the 2 eggs. She clasped them with her anterior legs, and pierced and crushed them with her frontal horns.

(3) On November 30th, 1982, I happened to see 4 eggs of *M. confrater* which had been laid on a batch on a long spider thread. The thread was hanging from the tip of a stipule on the middle portion of this bamboo and attached to a neighbouring one. On that particular day, this spider thread was gradually being stretched by a prevailing strong wind, and few hours later the batch of syrphid eggs on this thread reached the surface of an aphid colony. When contact was made, the 4 eggs were attacked and crushed almost immediately by several soldiers in the colony.

(4) After these observations, I conducted a small experiment. I picked up 4 eggs of *M. confrater* from a batch which had been laid on a spider thread, and placed them close to a small aphid colony on a very slender bamboo. After a while, the eggs were detected by a soldier who was walking around the colony. Immediately the soldier grasped the eggs (Fig. 4), and pierced them with her horns (Fig. 5). She tried to do so 2 or 3 times. After all, the soldier crushed 2 of the groups of 4 eggs, but then left the area, leaving the other 2 eggs intact.

## Discussion

As is well known most aphidophagous syrphid flies lay their eggs close to prey aphids (Banks, 1959; Hughes, 1963; Sundby, 1966; Chandler, 1968c; etc.). Chandler (1968c) recorded the mean distance between syrphid eggs and the nearest aphid. In species of the tribe Syrphini, the distance was usually found to be a few millimeters.



**Fig. 1.** Hovering female in seeking oviposition site, Figs. 2 & 3. Eggs of *M. confrater* oviposited on spider threads and tip of stipules (white arrow). Figs. 4 & 5. Pseudoscorpion-like soldier attacking eggs of *M. confrater*. Figs. 6 & 7. Eggs of *M. confrater* oviposited on the culm of bamboo. Fig. 8. Egg of *M. confrater* (black arrow) oviposited in a colony of *P. bambucicola*.

However, those aphid species do not produce soldiers\*.

*M. confrater* which is one of the specialized predators of a soldier-producing

\* Recently Aoki et al. (1984) recorded that the normal form of the 1st instar larva of *Ceratovacuna lanigera* attacks the eggs and larvae of Syrphidae and Chrysopidae by use of its frontal horns.

bamboo aphid *P. bambucicola*, lays its eggs on spider threads (frames of orb web, supporting threads or threads of wandering spiders) in autumn and early winter. During that season the bamboo is heavily infested by aphids and the soldiers are active. The aphid soldiers are unable to walk on the spider threads. From mid winter to early spring when aphid population is low and soldiers are inactive, however, *M. confrater* lays its eggs close to aphids, e. g., on the surfaces of culms or stipules or directly in the colony.

Thus, it appears that *M. confrater* selects oviposition sites to avoid attack by the aphid soldiers ; accordingly, the spider threads become the location of oviposition. On the other hand, it is dangerous for newly hatched larvae to get to their prey because the spider threads are not always attached to the bamboo on which their prey aphids live. Although I was unable to determine how the gravid females of *M. confrater* recognize the activity of aphid soldiers, it seems probable that they investigate the situation as they hover around the colonies.

The syrphid eggs were usually more numerous on some particular spider threads. It is probable that the ovipositing females were attracted by eggs deposited earlier and laid their eggs near them.

The pseudoscorpion-like 1st instar larvae of *P. bambucicola* thus appear to act as soldiers and play a defensive role against predatory insects, as assumed by Aoki et al. (1981). The defensive behaviour of aphid soldiers toward the eggs of other major predators, such as *Synonych grandis* Thunberg (Coleoptera, Coccinellidae) and *Cryptoblabes aphidivora* Yoshiyasu et Ôhara (Lepidoptera, Pyralidae), is not yet known.

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