

Fig. 2. Examples of free-running oviposition rhythm of individual females in *R. clavatus*. The observation was started at light-on on Day 1 when the females reached 14–18 days old. Open bar, photophase; solid bar, scotophase.

the insects is necessary to obtain further information on the oviposition rhythm of *R. clavatus*.

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### Egg Protection with Feces in the Lady-beetle, *Pseudoscymnus kurohime* (MIYATAKE) (Coleoptera: Coccinellidae)<sup>1</sup>

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An aphidophagous ladybeetle, *Pseudoscymnus kurohime* (MIYATAKE), is a common natural enemy of the sugar cane woolly aphid, *Ceratovacuna lanigera* (ZEHNTNER), which is a notorious pest of sugar

cane (AZUMA and OSHIRO, 1971). It is interesting to note that females of *P. kurohime* protect their eggs by covering them with a feces-like secretion. There has heretofore been no record of an egg covering behavior using the insect's own feces in the lady-beetle. AZUMA and OSHIRO (1971) briefly described the life history of *P. kurohime*, but they did not mention such behavior.

This paper reports the results of preliminary observations on oviposition behavior of *P. kurohime*, including the protecting of its eggs.

#### MATERIALS AND METHODS

Oviposition behavior of *P. kurohime* was observed in the laboratory under conditions of natural light (ca. L13) and room temperature (22–24°C).

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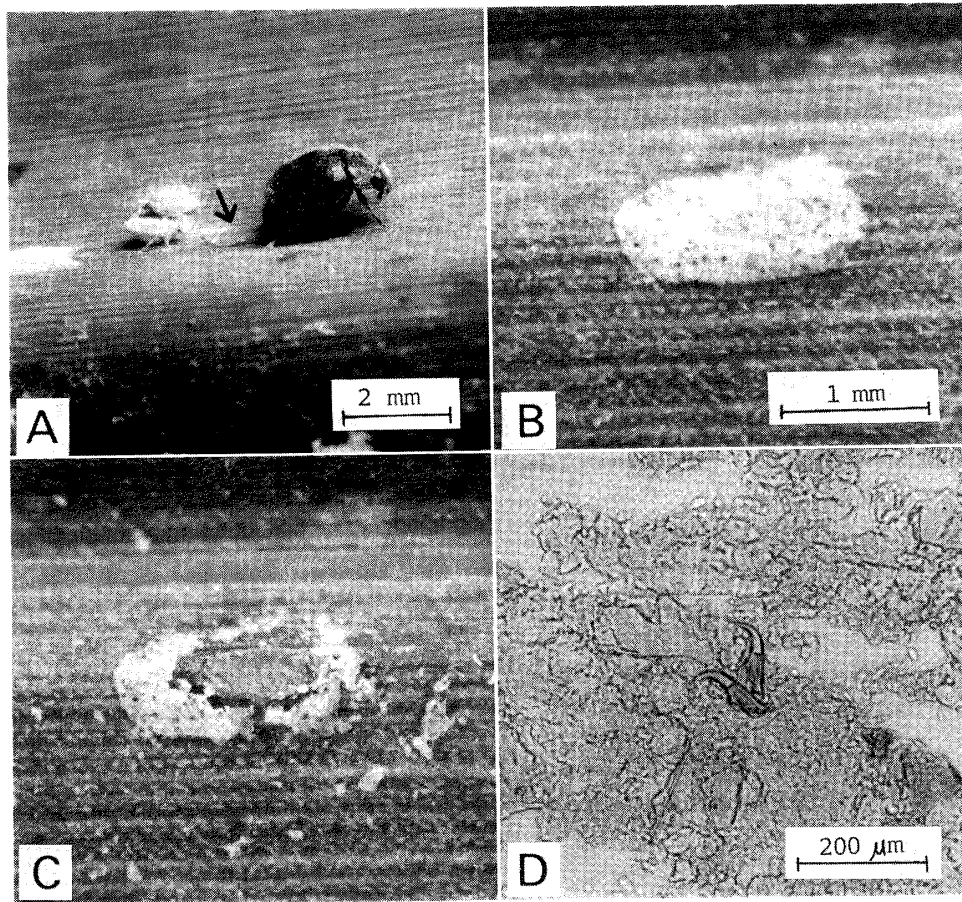


Fig. 1. A: Female covering eggs with feces-like material. Arrow indicates the egg covering. B: An egg covered with feces. C: An egg with the covering removed. D: Claws of a prey aphid found in the material covering the egg.

Seven females in copula were collected in a sugar cane field in the vicinity of Okinawa Prefectural Agricultural Experiment Station (26° 12' N, 127° 43' E) in Sakiyama-cho, Naha city, on the 14th of April, 1988. They were kept individually in transparent plastic cups (11.3 cm in diameter, 9.8 cm in height). Each cup contained a piece of sugar cane leaf with aphids as prey. The base of the leaf piece was set in water to avoid wilting, and the cup was covered with a transparent plastic bag to prevent the adult from escaping. Females under such conditions were continuously observed from 6:00 to 19:00 on the 16th of April to learn their oviposition behavior. Preliminary observations showed that this beetle lays eggs only during the daytime hours. To determine the material used to cover the eggs, part of the covering was scraped off and examined under a microscope.

## RESULTS

*Eggs.* The eggs were flat and elliptical, the average size being  $0.70 \times 0.31$  mm ( $N=20$ ), and their covering measured  $1.59 \times 0.71$  mm ( $N=20$ ) (Fig. 1 B and C). The newly deposited eggs were milky white and the covering brown.

*Material of the egg covering.* The covering of the eggs included many undigested claws from the legs of the prey aphid, *C. lanigera* (Fig. 1D). This strongly suggests that *P. kurohime* used its feces as the covering material.

*Oviposition behavior and egg covering.* Females laid eggs near the aphid colony on the underside of the sugar cane leaf. They laid eggs in a position parallel to the vein and had a tendency to concentrate them near the midrib of the leaf.

Females exhibited the following behavioral sequences composed of several kinds of events.

Searching for an oviposition site, they stopped walking, extruded their genitalia toward the leaf surface and repeatedly rocked forward and backward 45–100 times. Then they bent their abdomen forward, and laid the eggs while moving backward. They then extended their tail plate backward and covered the oviposited eggs with a feces-like secretion, from backward to forward dragging their tail plate (Fig. 1 A). The time required for egg covering ranged 74–116 sec and one entire sequence of oviposition behavior lasted 4.5–9.5 min. In the intervals between two ovipositions, females usually fed or rested and infrequently they flew.

#### DISCUSSION

Some species of leaf beetles are known to cover their eggs with feces, but such behavior has not been recorded for coccinellids. KAWAUCHI (1985) reported that the female of aphidophagous coccinellid, *Scymnus hoffmanni* WEISE, protected her eggs by covering them with exuviae of the prey aphid. The material of the egg covering of *P. kurohime* included many undigested claws of the legs of their prey aphid. As described above, it appears that *P. kurohime* uses its feces as covering.

Why does *P. kurohime* use this egg covering behavior? One assumption is that they protect the eggs from aphid attack. To date, two aphid species have been observed as host of *P. kurohime* in the Ryukyu Islands. One is *C. lanigera* and the other *Pseudoregma bambusicola* (ARAKAKI, un-

published). *P. bambusicola* produces soldiers which attack predators or eggs of the predators using their frontal horns (AOKI et al., 1981). *C. lanigera* produces monomorphic nymphs that also attack a predator's eggs using their frontal horns (AOKI et al., 1984). I observed an actual spot where 1st-instar nymphs of *C. lanigera* had crushed the syrphid eggs on a sugar cane leaf (ARAKAKI, unpublished). Therefore, egg covering could be a defensive device against the 1st-instar nymphs of these aphids. Other possibilities also remain: that the covering was evolved against other factors such as desiccation, natural enemy and cannibalism.

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