

Release effect of an egg parasitoid, *Gryon philippinense* (Ashmead) (Hymenoptera: Scelionidae), for suppression of the winter cherry bug, *Acanthocoris sordidus* Thunberg (Hemiptera: Coreidae), in greenhouse

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Abstract

A release test was conducted to suppress the winter cherry bug, *Acanthocoris sordidus* Thunberg, using a scelionid egg parasitoid, *Gryon philippinense* (Ashmead), in a greenhouse with grown green bell peppers at Kochi University, Japan, from June to September, 2003. The study site was divided into two areas (6 m×5.4 m), a release area and a control area. Three pairs of field-collected *A. sordidus* were released to each plant in both areas on June 15. Just after the first oviposition of *A. sordidus* was observed, *G. philippinense* females (1-d old) cultured in a laboratory were dispersed in the release area. Starting on June 16, releases were made in 5 batches of 50 mated females 5–7 d apart. In the control area, the hatchability of *A. sordidus* was 98.4% in a total of 8,375 eggs. In the release area, the parasitism rate of *G. philippinense* was 98.8% in a total of 7,725 eggs, and its emergence rate was 99.8%. The last release of the parasitoid was on July 8; however, the emergence of *G. philippinense* continued until mid-September. *G. philippinense* persisted in greenhouse conditions with the highest temperature being 49.0°C in August. The density of new-generation adults of *A. sordidus* was extremely low in the release area. This study showed that *G. philippinense* could be considered a useful biological control agent of *A. sordidus*.

Key words: *Gryon philippinense*; *Acanthocoris sordidus*; parasitism; hatchability; biological control

INTRODUCTION

The use of chemical pesticides is restricted in greenhouses where pollinators and natural enemies are used. In those houses, several pests sometimes cause serious damage to the crops. The winter cherry bug, *Acanthocoris sordidus* Thunberg, is one of these pests in Kochi Prefecture, Japan. In the highland zone of Kochi Prefecture, overwintered *A. sordidus* adults invade greenhouses from the fields in early summer, reproduce, and damage eggplants and green bell peppers (Dasilao, unpublished). In this case, there is no effective method to control *A. sordidus* except for removing them by hand.

Mineo (1991) found that a scelionid egg parasitoid, *Gryon philippinense* (Ashmead), emerged from the egg of *A. sordidus*. It was found that *G. philippinense* was a major parasitoid in Kochi Prefecture (Dasilao, unpublished). The capability of

G. philippinense to suppress *A. sordidus* both in the field and in the greenhouse is not known. Knowledge of the effectiveness of the parasitoids as population regulators is of great importance for understanding their characteristics as potential biological control agents (Yeargan, 1982). This study was conducted to investigate the potential of *G. philippinense* to suppress *A. sordidus* in greenhouses.

MATERIALS AND METHODS

Greenhouse establishment. The release test was conducted in a greenhouse (12 m×5.4 m) at the Monobe campus of Kochi University, Nankoku, Kochi Prefecture in 2003. The greenhouse was divided into two areas (6 m×5.4 m), a release area and a control area, by a vinyl sheet. Both sides of the greenhouse were covered with nylon net (0.6 mm×0.95 mm mesh). Green bell peppers (*Capsicum annuum* L. cv. Sakigake No. 2) were

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planted in 4 rows (4.5 m×0.6 m) of 6 plants each. No supplemental light or heat was provided at nighttime. The maximum temperature in the greenhouse was 49.0°C in August and the minimum was 15.0°C in September.

Survey in control area. *A. sordidus* adults were collected from green bell peppers and sweet potatoes at vegetable plantings inside the Monobe campus of Kochi University on June 15. After being marked with white paint, three pairs of *A. sordidus* were released to each green bell pepper plant. When the egg masses were newly found, plastic tags were hung on the green bell pepper stems. The date of discovery and the number of *A. sordidus* eggs per egg mass were indicated on the tags. The numbers of released *A. sordidus* males and females, egg masses, eggs, nymphs and newly emerged adults were checked daily. Newly hatching nymphs were easily monitored because they remained on the egg mass for a few days. After dispersion of these nymphs, the remains of the *A. sordidus* egg masses were brought to the laboratory. *A. sordidus* eggs that failed to hatch were dissected under a microscope to determine the contents.

When the new generation adults were first observed, all released females and males were kept together and enclosed in a net cage (75 cm height, 36 cm diameter), which covered one of the green bell pepper plants inside the greenhouse, in order to determine the oviposition of new-generation females. The number of laid eggs and hatching nymphs inside the cage were also counted and added to the data. The test was finished on September 13 because the green bell peppers withered due to infection with powdery mildew disease.

Survey in release area. The release of *A. sordidus* adults in the parasitoid-release area was conducted as described above. *G. philippinense* were prepared from a laboratory culture (Dasilao and Arakawa, 2004). To facilitate dispersal, 50 mated females of *G. philippinense* (1-d old) were divided into 4 petri dishes and were evenly distributed throughout the rows. The first release of *G. philippinense* was on June 16 when the egg mass of *A. sordidus* was first observed. The next batches of *G. philippinense* were released on June 21, June 26, July 1 and July 8. A total of 250 *G. philippinense* females were released.

The discovered *A. sordidus* egg masses were taken to the laboratory when all *A. sordidus*

nymphs hatched or all *G. philippinense* emerged from the eggs. What remained of the *A. sordidus* eggs after hatching was a white membrane inside the chorion, and what remained of *A. sordidus* eggs with *G. philippinense* emergence was black feces inside the chorion. *A. sordidus* eggs that remained intact were dissected to determine the contents. When a dead adult of *G. philippinense* was found in the host, it was included in the count as a parasitized host egg. Other eggs were regarded as dead due to unknown factors. The parasitism rate in *A. sordidus* eggs by *G. philippinense* was calculated by dividing the number of parasitized eggs by the total number of eggs in an egg mass minus any eggs that were dead due to unknown factors. The estimated rate of increase in the new generation of *A. sordidus* in the control and release areas was calculated as the number of new generation females at the termination of experiments divided by the total number of released females.

RESULTS AND DISCUSSION

Figure 1 shows the daily number of eggs of *A. sordidus* newly found in the control and release areas from June 16 to September 13. Eggs were observed for the first time on June 16 in the release area and on June 22 in the control area. Totals of 8,375 and 7,725 eggs were discovered in the control and release areas, respectively, during the experiments. No eggs were laid by the newly emerged *A. sordidus* females in both areas.

Figure 2 shows the daily number of nymphs of *A. sordidus* found in the control and release areas. There were no nymphs in either area in June. The first eclosion of nymphs in the control area was observed on July 3, and a maximum of 2,650 nymphs were found on July 19. In the release area, the first eclosion of nymphs was observed on July 25, and this was the maximum number. The density of nymphs was evidently higher in the control area than in the release area.

Figure 3 shows the daily number of adults of *A. sordidus* found in the control and release areas. New generation adults were first detected on August 8 and a maximum of 716 females and 680 males was observed on August 28 in the control area. In contrast, only 3 female adults and no male adults were found from August 30 to September 13 in the release area. On these bases the rate of popu-

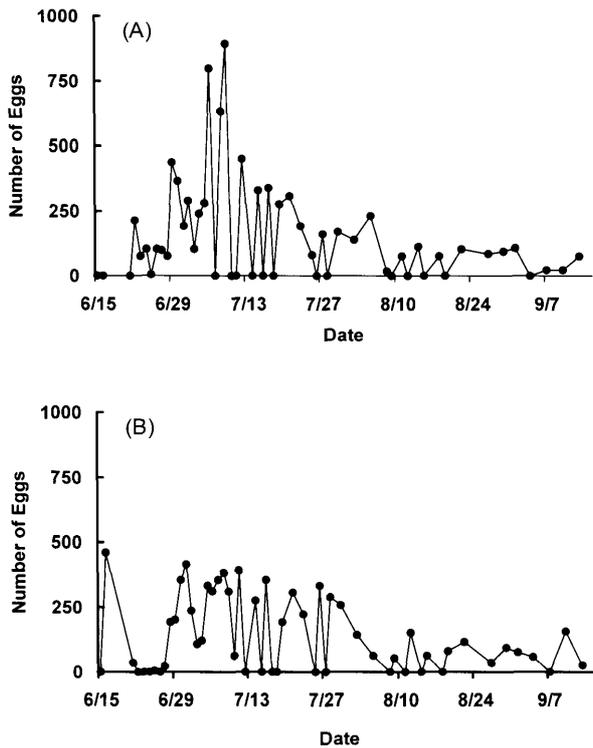


Fig. 1. Daily number of eggs of *A. sordidus* newly found in control (A) and release (B) areas from June 16 to September 13, 2003.

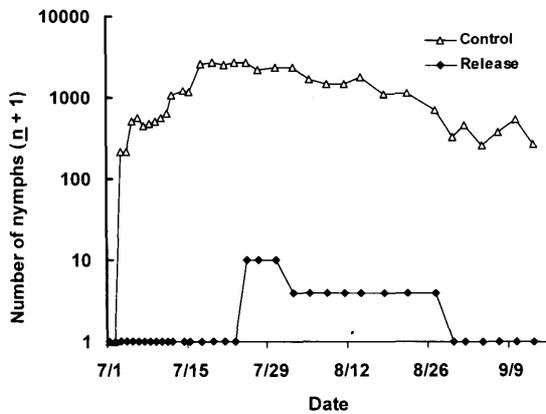


Fig. 2. Daily number of nymphs of *A. sordidus* ($n+1$) found in the control and release areas from July 3 to September 13, 2003.

lation increase of *A. sordidus* was calculated at 4.2% and 368.1% in the release area and the control area, respectively.

Table 1 shows the total hatchability of *A. sordidus* eggs and the parasitism rate of *G. philippinense* in *A. sordidus* eggs in the control and release areas from June 16 to September 13. The higher hatchability of *A. sordidus* in the control

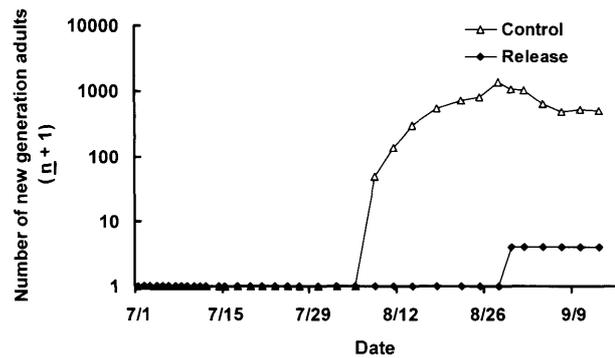


Fig. 3. Daily number of new generation adults of *A. sordidus* ($n+1$) found in the control and release areas from August 8 to September 13, 2003.

Table 1. Total hatchability of *A. sordidus* eggs and parasitism rate of *Gryon philippinense* in *Acanthocoris sordidus* eggs in the control and release areas of a greenhouse at Kochi University, Monobe campus from June 16 to September 13, 2003

Study area	No. egg masses	No. eggs	Hatchability (%)	Parasitism rate (%)
Control	379	8,375	98.4	0
Release	348	7,725	1.1	98.8

area is shown. In the release area, the parasitism rate of *G. philippinense* was 98.8% and the emergence rate of *G. philippinense* from the parasitized hosts was 99.8%. The high parasitism and emergence rates of *G. philippinense* were evidence of its ability to develop and emerge in *A. sordidus* eggs.

van Lenteren (1986) explained that one of the important characteristics of the parasitoid in a release program is its ability to develop in the host and emerge to the adult stage to facilitate ongoing control. Taylor (1975) explained that females of *G. gnidus* Nixon did not show any aggressive behavior, and two females were frequently observed ovipositing in a host egg at the same time. Romeis et al. (2000) made a similar observation on *Clavigralla scutellaris* Spinola (Hemiptera: Coreidae) eggs parasitized by *G. clavigrallae* Mineo. He explained that more than a single female visited and stayed on the egg mass for several days. During this experiment, it was observed that an *A. sordidus* egg mass was attacked by two to four *G. philippinense* females simultaneously in several cases. These *G. philippinense* females exhibited non-aggressive behavior while ovipositing simultaneously.

This non-aggressive behavior of *G. philippinense* may cause the high parasitism rate in this experiment.

Although only one time-release test was conducted, it was observed that the release of *G. philippinense* leads to high parasitism and emergence in *A. sordidus* eggs in a greenhouse located in the lowland. Hidaka (1958) showed that *Telenomus gifuensis* Ashmead (Hymenoptera: Scelionidae) usually appeared in the natural population comparatively later than the beginning of the oviposition of *Scotinophara lurida* Burmeister (Hemiptera: Pentatomidae). He clarified that if the parasitoids were to appear much earlier, they may be able to control the bugs. In this experiment, successful control of *A. sordidus* was obtained because *G. philippinense* were released just after the first oviposition of *A. sordidus*. The timing of the release is expected to be important in the control of *A. sordidus* by *G. philippinense*.

In August, the temperature peaked at 49.0°C inside the greenhouse, and a total of 798 host eggs yielded an emergence of 779 *G. philippinense* progenies in the release area. Romeis et al. (2000) made a similar observation that *G. clavigrallae* persisted through heat and dryness in India during the pigeon pea season. In fact, there is little green bell pepper cultivation in lowland greenhouses during the summer. However, in highland zones of Kochi, particularly in Otoyo, Motoyama and Tosa Towns, overwintered *A. sordidus* invades peppers and eggplants in greenhouses during the summer (Dasilao, unpublished). We hope that the findings of the present investigation are found to be useful in such highland zones. For the release of *G. philippinense* in highland zones to be put into practice, further investigation of existing environmental conditions such as temperature, humidity and other factors that may influence the population dynamics of pests and parasitoids is needed. Experiments on the optimum number of *G. philippinense* to be re-

leased in greenhouses and the development of a mass rearing method of *G. philippinense* in the laboratory are also needed.

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