The effect of *Plesiochrysa ramburi* (Schneider) (Neuroptera: Chrysopidae) to the resilience of papaya invested by *Paracoccus marginatus*

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Abstract. *Paracoccus marginatus* is one of the important pests on papaya. This study was conducted to evaluate the presence of one of the Chrysopa predators, *Plesiochrysa ramburi* to papaya invested by *P. marginatus*. The study used the non-factorial design with the factor of the number of predators (1, 3, 5, 7), which was released to oneovisac of *P. marginatus*. All treatments in the experiment had five replications. Descriptively, this study showed that the presence of *Pl. ramburi*, positively, affected the resilience of the plant, in this case through the mechanism of population control of *P. marginatus*. The presence of predators, negatively, affected *P. marginatus* eating behavior, which was reduced food intake behavior, which was influenced by feeding behavior. Thus it could increase plant resilience. If the presence of predators negatively affected pest eating behavior, the presence of predators could positively influence plant resilience.

1. Introduction

Mealy bug, *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Pseudococcidae), is an important species of pest insects in various types of fruit, vegetable and ornamental plants. The host plants include papaya plants (*Carica papaya* L.), oranges (*Citrus* sp. L.), avocados (*Persea americana* P. Mill.), eggplant (*Solanum melongena* L.), hibiscus (*Hibiscus* sp. L.), plumiera (*Plumeria* sp. L.), and ekorkucing (*Acalypha* sp. L.) [1].

Management control of *P. marginatus* has been carried out in the countries of the Americas through chemical methods and also with natural enemies. Chemical methods include the application of insecticides with active ingredients including acephate, carbaryl, chlorpyrifos, diazinon, dimethoate, malathion, and white mineral oils. Because of concerns about the adverse effects of insecticides, chemical control is not the main choice in controlling mealy bug [2].

Controlling methods with natural enemies that have been tested include parasitoid from the Encyrtidae (Hymenoptera) family, *Acerophagus papayae*, *Anagyrus loecki*, *Pseudleptomastix mexicana* [3] [4]. In addition to parasitoid, predators of several Chrysopa species have been introduced.
in New Zealand to be used in controlling mealy bug and also against Chermidae which attack pine, for example: Chrysopa insects that prey on various soft-bodied insects such as aphids, white fleas, mites and others. One type of Chrysopa, *Plesiochrysa ramburi*, a predator of several types of mealy bug that attack aquaculture plants, for example cassava [5].

Meanwhile, papaya plants are one of the important fruit crops in the tropics with a variety of benefits they produce. Many factors influence the production of papaya fruit in the field, one of which is the simple cultivation factor and the presence of pests and diseases. One of pests that attack papaya plant, *P. marginatus*, is an exotic pest from abroad. This pest can reduce the harvest up to 100%. The high potential could be a threat to the production of papaya in Indonesia.

The information and potential predation of Chrysopa on *P. marginatus* in papaya in Indonesia is not well documented. Thus, the information and behavior of Chrysopa predatory on *P. marginatus* is needed in an effort to develop pest control strategies for mealy bug in Indonesia. The study aimed to evaluate the presence of one of the Chrysopa predators, *Pl. ramburi* on the damage of papaya invested by *P. marginatus*.

2. **Method**

2.1. **Rearing of P.marginatus**

*P. marginatus* was collected from papaya plants in the field. *P. marginatus* was inoculated and maintained in 4-month-old papaya seedlings grown in polybags. Then each of these plants was enclosed in cages made of wood/plywood covered by screen.

2.2. **Rearing of Pl.ramburi**

*Pl. ramburi* larvae were collected from papaya plant and then were kept in petri dishes (d = 17 cm) to become pupae. Pupa that will become an imago was moved into a screen cage (40x40x60 cm) which was intended for breeding. Imago maintenance was carried out by giving a mixture of honey, yeast and water (ratio of 1: 1: 1) [6] which serves as a substitute for nectar. This mixture was applied to paper and affixed to the wall of the cage. Imago usually places eggs on the surface in confinement attached to screen. After the eggs were placed, they were immediately removed by using a fine brush and were kept until they hatch. After hatching the larvae were fed with *P. marginatus*.

2.3. **Experimental design**

The study was conducted at the Pest and Screen Laboratory in the Department of Agroecotechnology, Faculty of Agriculture, Universitas Sumatera Utara and papaya plantations in Deli Serdang District from May 2016 to December 2017. Four-month papaya plants were put into box of modified insects (size 120x80x80 cm) (Figure 1).

![Figure 1. Experimental box (120x80x80 cm)](image-url)
Each plant is released numbers of predator *Pl. ramburi* instar III larvae (1, 3, 5, and 7). Then one *P. marginatus ovisac* was inoculated in each of the plants. The plants which were able to survive due to *P. marginatus* are observed until one of the plants died. The study used the non-factorial method with the factor given was the number of predators. All treatments in the experiment were replicated by five.

### 3. Results and Discussions

The study showed that the plant could survive until seven days when there was one predator, 10 days when there were three predators, 13 days when there were five predators, and 16 days when there were seven predators (Table 1, Figure 2).

#### Table 1. Plant resilience (days) which was invested *P. marginatus* and controlled by *Pl. ramburi*

| Number of *Pl. ramburi* | 1 | 2  | 3  | 4  | 5  | Mean (days) |
|-------------------------|---|----|----|----|----|-------------|
| 1                       | 7 | 8  | 7  | 8  | 8  | 7.60        |
| 3                       | 10| 10 | 10 | 11 | 11 | 10.40       |
| 5                       | 13| 13 | 14 | 13 | 13 | 13.20       |
| 7                       | 16| 16 | 17 | 16 | 16 | 16.20       |

![Figure 2](image.png)

Figure 2. Plant appearance invested by *P. marginatus* which controlled by three *Pl. ramburi* in first day (left), 6th day (center), 10th day (right).

Descriptively this study showed that the presence of *Pl. ramburi* (predator) positively affected the resilience of plants in this case through the control mechanism of *Pl. ramburi* to *P. marginatus* (mealy bug) (Figure 2). This showed the interaction caused by predation risk on the tri-trophic system. The control mechanism by the presence of predators was caused by three related factor: predation by *Pl. ramburi*, volatile compound of infected plant, and the change of eating behavior of the mealy bug.

The presence of the predators can certainly suppress the population of the mealy bug. In the wild, this can lead to cyclical patterns of predator and prey abundance, where prey increase in number and then, with abundant food, predator number increases until the predators begin to suppress prey numbers and then decrease as well. As long as predator and prey numbers do not drop to zero, this cycle can repeat indefinitely. In this study, as the mealy bug population was constant among treatments, the increasing of the predator number could decrease the mealy bug simultaneously among treatments. The biggest decrease of mealy bug worked in the highest number of predator. It was assumed that the scare of herbivore could increase the vigor of plant.
The plant when was attacked by herbivore could expressed a defense mechanism as well, direct and indirect. Papaya plant was not shown a direct defense to the mealy bug, as it was still found some of them in the dead plant. The plant was shown such indirect defense. The mealy bug-infested plant was the primary source of the volatile chemicals that attract the predator. It was assumed that the major source of volatiles that attract the predator in the habitat of the host is the systemically released papaya volatiles induced by mealy bug infestation. Plants may also defend themselves indirectly. This defense strategy is based on tri-trophic interactions involving plants, herbivores and carnivores [7]. When damaged by herbivores, plants emit a diverse array of volatiles which attract natural enemies, either carnivorous predators or parasitoids, of the herbivores to the herbivore-damaged plants [8]. Further damage to the plant by the herbivores may thus be prevented or reduced. This phenomenon is therefore called indirect defense.

The presence of predators can negatively influence mealy bug eating behavior, in reducing food intake behavior of pests, one of which is influenced by feeding behavior. This was as a study conducted by Kaplan et al [9] on tomato pests. In his study, the presence of predators reduced the food intake of pests by 29%. Thus it was thought that it could increase crop resilience. If the presence of predators negatively affect mealy bug eating behavior, the presence of predators can positively influence plant resilience.

![Figure 3. Plant resilience (days) which was invested P. marginatus and controlled by Pl. ramburi](image)

4. Conclusions

The presence of Pl. ramburi depressed the number of P. marginatus which negatively affect it eating behavior as well. The presence of Pl. ramburi could positively influence plant resilience.

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