Predation and Competition of Two Predators (*Pardosa pseudoannulata* and *Verania lineata*) on Different Densities of *Nilaparvata lugens* in Laboratory

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Abstract*: Pardosa pseudoannulata (Araneae: Lycosidae) and Verania lineata (Coleoptera: Coccinellidae) are common predator found in agro ecosystem. Several studies have described the ability of these predators to prey on Nilaparvata lugens (Hemiptera: Delphacidae). However, the study that explained the density impact of N.lugens on the ability predation in competition condition by both predators have not been completely known. A research had been conducted in the laboratory to study the predation and model of competition on different densities of N.lugens. The study used a completely randomized design in 10 replications. The prey densities for single predation were 5, 10, 15, 20 and for predation by competition were 10, 20, 30, 40 and without prey. This study revealed that the density of prey influenced the ability of predation of the two predators, which in turn, it also affected their growth. The impact of prey behavior on the predation and competition process between the two predators was also discussed in this article.*

Keywords: Interaction, Competition, Spider, Coccinellidae, *N.lugens*

1. Introduction

Brown planthopper or *N.lugens* was initially classified as secondary pests that were not so influential in tropical Asia. But since the1970s, the population increased dramatically and it was considered as one of the most devastating pest on rice in several Asian countries, including India, Indonesia, Philippines and Sri Lanka (Dyck &T homas1979, Sogawa & Cheng 1979). In Indonesia, the outbreak was reported in 1968-1969 and extended during 1974-1975 (IRRI 1979). Even today, the damage and the intensity of the attack still continue to increase.

Predator is one of the potential biological agents to control *N.lugens* population. *P.pseudoannulata* and *V. lineata* are among the commonest generalist predators found in rice field ((IRRI 1979, Heong *et al* 1990, Miranti *et al* 2000, Preap *et al* 2001, Lubis 2005, Karindah 2011). *P. pseudoannulata* has no specific preference for prey (Foelix 1982, Reissig *et al* 1985, Riechert & Lawrence 1997). *P.pseudoannulata* is also noted as the time generalist that can capture the prey without time limit (Suana 1998). Meanwhile, *V.lineata* is classified as a generalist predator that has specific preference in capturing and preying the prey during the day (Karindah 2011).

In terms of generalist predator there were two contradictive existed issues. Firstly, there is an assumption that the high diversity of natural enemies in the field might benefit the control and pressure on herbivore (Morin 1999, Riechert 1999) such as sharing the prey. However, secondly, due to their flexibility to accept prey, it is possible to emerge intra guild predation with other predators which might reduce their capability to suppress prey population (Foelix 1982, Snyder & Ives 2001, Denno 2002, Lucas 2005).

Moreover, Yasuda & Kimura (2001) and Synder *et al* (2004) stated that spider and coccinellid are not only classified as the top predators but also top intra guild predation. So far, there are few studies have reported the potency of intra guild predation between the two predators, since they often shared places for gaining preys (Syahrawati *et al* 2012).

Based on *compression hyphothesis* (Mac Arthur 1972 *cit* Menge & Sutherland 1976), a strong competition reduces the predation, while a weak competition increases the predation on prey. Lucas (2005) mentioned three possibilities on interspecific competition: (1) kill and prey on competitors, (2) kill but not prey the competitors, and (3) not kill but cause sub-lethal effect. This research was conducted to understand the outcome of both predation and competition between two predators, *P.pseudoannulata* and *V.lineata* on different densities of *N.lugens*.

2. Materials & Methods

The experiment was done at the laboratory of Basic Entomology Faculty of Agriculture, University of Gadjah Mada, Indonesia, from January to May 2014.

The research was divided into (1) single predation by each predator to examine the preying potential of each species, and (2) predation under competition condition (*P.pseudoannulata* and *V.lineata* in the same arena) under different prey densities. Those were arranged as follows: The densities of *N.lugens* for single predation were 5, 10, 15, 20 and for predation under competition were 10, 20, 30, 40. Each treatment was replicated 10 times. As a control, competition between the two predators in without prey condition was also tested.

The research used 2nd and 3rd in star of nymphs of *N.lugens* that were obtained from rearing in the laboratory since

January 2013,and adults of *P.pseudoannulata* and *V.lineata* that were collected from rice field. For preparation, after cached from the field, the predators were maintained in the laboratory for 3 weeks, and then starved for 3 days prior to be treated.

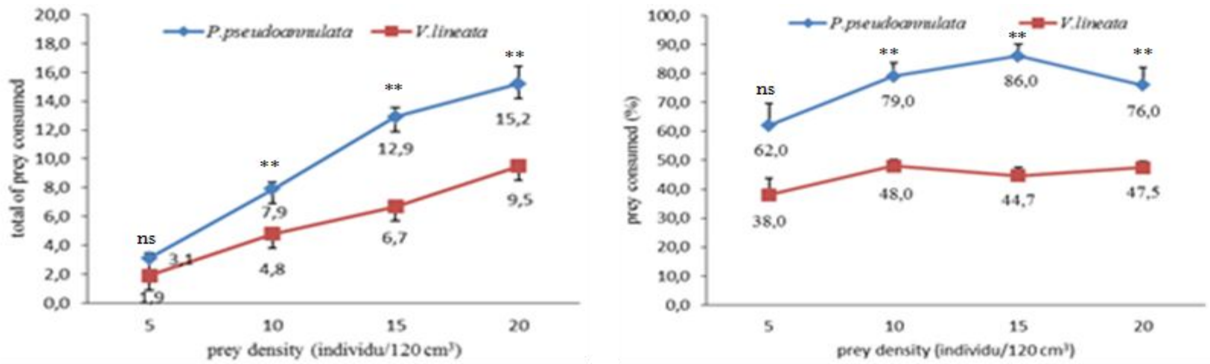
Mekongga rice varieties were planted in jars. After four days, two seedlings were transferred into a plastic cup and then followed by placing nymphs of *N.lugens*. Prior to treatment, the predators were weighed and then put into plastic cup at the same time. All treatments were carried out in the laboratory (RH: 76-86%, T = 26-29^{o}C).

Observation was made on the number of prey eaten by predator on single predation and competition treatment and the body weight of predators after treatment. The competition model was composed by observing the condition of two predators in the plastic cup during the treatment, then it was assessed quantitatively using the following numbers: 2=win, one predator still alive while competitors dead, 1= equal, both predators still alive and active, and 0=lose, the predator dead while competitors still alive. All data were analyzed statistically by using analysis of variance (software statistic 8). To determine differences among treatments, the data were analyzed by using Tukey HSD test (single predation) and LSD (competition) at 5% significance level.

3. Results

Single Predation and Competition

Single predation and competition between the two predators increased along with the increasing of prey densities and correlated closely (R^2 *P.pseudoannulata* = 0.07789, R^2 *V.lineata* = 0.7062, R^2 both= 0.7774). Single predation of *P.pseudoannulata* was higher than *V.lineata*. Statistical analysis showed that the single predation at 5 density of prey were not significantly different, but significantly different at 15 and 20 (Figure 1).



ns = no difference; *diferent significantly; **very different significantly (Tukey Test at 5% significance level)

Figure 1: Total of prey consumed (*left*) and percent of consumed (*right*) of *P.pseudoannulata* and *V.lineata* at different densities of prey (single predation)

Despite the predation rate tended to increase, either on single predation and competition, but predation percentages was fluctuated. On single predation, the predation percentage of *P.pseudoannulata* tended to increase until 15 (87%) but then declined. The predation percentage of *V.lineata* tended to increase until 10 (48%) and then fluctuated, while on competition, predation percentage of both predators decreased when the number of prey increased. The highest percentage occurred on the lowest prey density (10 individual of prey (Figure 2).

Body weight (gram)

The body weight of *P.pseudoannulata* was higher than *V.lineata* on both single predation and competition. In single predation, the body weight of two predators increased along with the increment of prey density. The highest body weight of *P.pseudoannulata* and *V.lineata* obtained at 20 (0.015 and 0.007 g respectively). On competition condition, the densities of 10, 20, 30 prey tended to increase the body weight of *P.pseudoannulata* but not for *V.lineata.* Statistical analysis showed that the body weight in single predation at 5 were not significantly different, but different at 10 and 15, and very different at 20. Whereas the body weight in joint predation was not significantly different at 10, but different at 20 and 40 and very different at 30 (Figure 3).

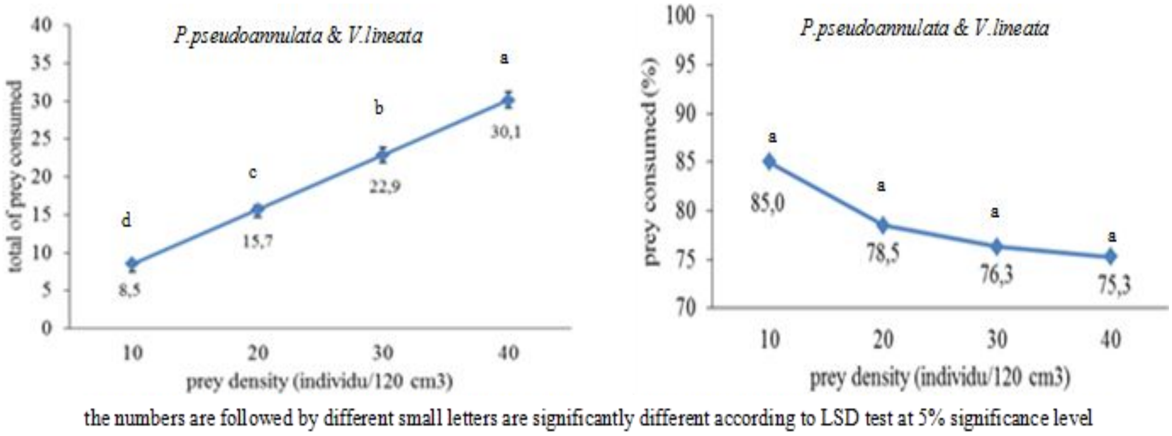


Figure 2: Total number of prey consumed (*left*) and percent of consumed (*right*) of *P.pseudoannulata* and *V.lineata* at different densities of prey (competition condition)

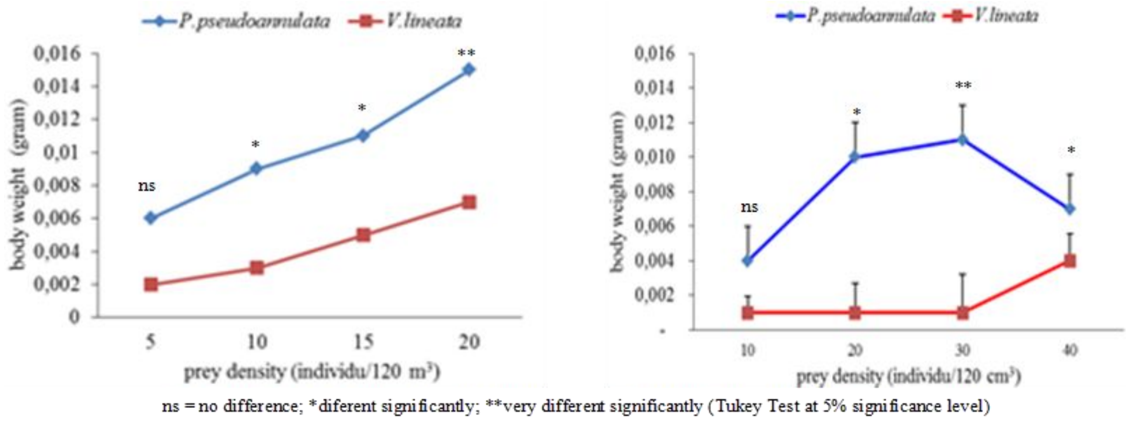
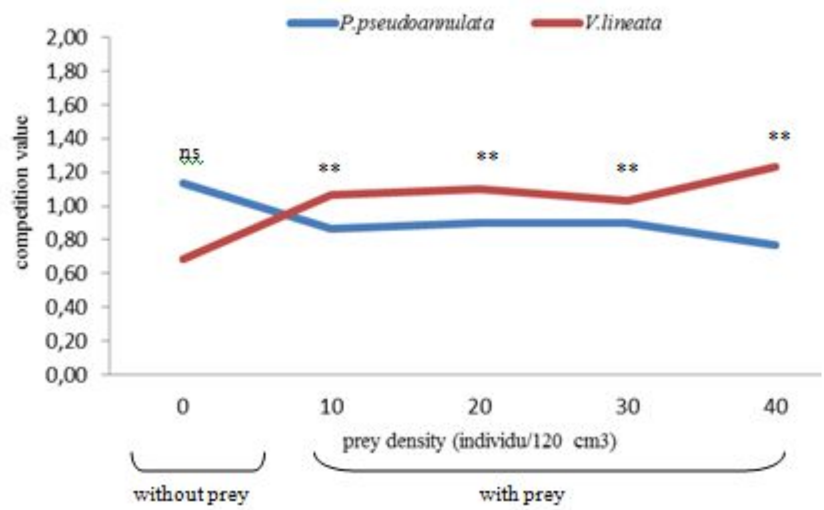


Figure 3: The body weight (gram) of *P.pseudoannulata* and *V.lineata* at different densities of prey (*left*: single predation; *right*: competition condition)

Competition Model

P.pseudoannulata tended to win the competition without prey; otherwise *V.lineata* win the competition with prey, it was increasingly clear on prey density of 40. The interpretation toward the appearance numbers in competition without prey was 1<P.p<2: V.l<1, while in competition with prey was 1 <V.l<2; P.p< (Figure 4).



ns = no difference; *different significantly; **very different significantly (Tukey Test at 5% significance level)

Figure 4: Competition model between *P.pseudoannulata* dan *V.lineata* at different densities of *N.lugens* (the interpretation number: 2= win, 1= equal, 0 = lose)

4. Discussion

Prey density influenced the predation of *P.pseudoannulata* and *V.lineata*, either in single or under competition condition. Total number of prey consumed increased along with the increasing prey density (Figure 1), as also shown in study on predatory hoverfly done by Putra *et al* (2006). This corresponded to the spending time in searching and handling the prey (Maloney *et al* 2003). At low prey density, time was spent to search the prey and a fewer time was used for handling prey, and vice versa. According to Jervis & Kidd (1996), the predation was tended to increase on higher prey density and it would be reduced on low prey density.

Figure 1 also showed the higher ability of *P.pseudoannulata* to prey on *N.lugens* than *V.lineata*. The same pattern was also shown by the percent of predation where it was higher in *P.pseudoannulata* as well as the body weight (Figure 3). This result assumed that the ability of *P.pseudoannulata* to suppress *N.lugens* was higher in the field. Meanwhile, Figure 2 also showed that the percent of consumed reduced along with the higher prey density, although the total number of prey consumed increased.

V.lineata seems to gain more benefit than *P.pseudoannulata* in the increment of prey density as shown by Figure 3.The body weight of *P.pseudoannulata* decreased at prey density of 40 where it exactly increased in *V.lineata*. This result explained that there was a decrement in the ability of predation due to competition between *P.pseudoannulata* and *V.lineata*. The biological nature of predator species might determine the outcome of this competition, i.e. body weight and size, aggressiveness and voracity (Edgar 1970, Wise 1995, Maloney *et al* 2003). In this study, the body weight of *P.pseudoannulata* was 0.017 g which was heavier than *V.lineata* (0.010 g).

Moreover, Figure 4 showed that *V.lineata* was superior against *P.pseudoannulata* when they were competing for obtaining prey, particularly at density of 40. During the test, *P.pseudoannulata* tended to avoid the interaction with *V.lineata and V.lineata* did not indicate an effort to attack P.pseudoannulata physically. It means both predators did not make its competitors as a target for the predation. Foelix (1982) stated that the spiders usually avoid the interaction with the insects that used chemicals for self-defense. Meanwhile Amir (2002) reported *V.lineata* is the insect that has ability to produce the fierce-smelling yellow compound when disturbed.

Even though *P.pseudoannulata* was not known as webs builder but Craig (1997) cit Craig *et al* (1999) reported that all spiders could produce the silk for many purposes, including providing shelter, protection for eggs and tools for prey capture. In this treatment of competition without prey, *P.pseudoannulata* more actively build the webs in horizontal position and randomly upward stratified, while *V.lineata* survived on permanent position at the top. The result showed that there was no found the *P.pseudoannulata* dead in the plastic cup but was found *V.lineata* dead at the webs. Spider web enabled *P.pseudoannulata* to restrict *V.lineata* movement and to trap *V.lineata*. *V.lineata* was defeated on defense strategies during the competition without prey.

When there were high populations of prey, the predators did not require much time and energy to search and to hunt the prey. *P.pseudoannulata* only needed time to capture and to handle the prey without having to build the webs. The absence of trap were beneficial to *V.lineata*, it created more space to search and to hunt, so that the predation increased. The crossing between two predators without webs also easily occurred that promoted *V.lineata* releasing the fierce-smelling which was not favored by *P.pseudoannulata*. This caused *P.pseudoannulata* to be recessive. When the prey population was higher, *P.pseudoannulata* would build the trap less, the pressure of *V.lineata* on *P.pseudoannulata* would also greater and the predation would be higher.

5. Conclusions

Competition between two predators would reduce the predation and their activities in disrupting existence of competitors, so the pressure toward the prey was reduced. Although both of them are generalist predators but their biological nature such as body weight and size, aggressiveness and voracity would affected the interaction patterns. In addition, the outcome of this experiment showed the negative potencies of predator competition might reduce their potency of suppression on insect pests.

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