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Research Article

Potentials of Predators of *Weaver Ants* Towards *Caterpillar* in Palm Plantation with The Test Preferences Method

Irham Falahudin[1*], Shafira Septriani[2]
[1] Department Biology, Faculty of Science and Technology Universitas Islam Negeri Raden Fatah Palembang, South Sumatera, Indonesia
[2] College of Science and Engineering, James Cook University, North Queensland, Australia
* Email: irhamfalahudin_uin@radenfatah.ac.id

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ABSTRACT
The problem that arises in palm oil plantation operation on a huge scale is the appearance of caterpillar pest that attacks palm oil plants. There are several important pests that attack palm oil plants such as caterpillars which are the sort of Setora nitens. The appearance of the past becomes an important concern for the world's plantation. How to eradicate the pest naturally is the performed effort. This effort can be done by using weaver ant. Weaver has the potential as the natural enemy of palm oil because they can be nesting in arboreal areas. So, this research object will focus on observing the weaver ant (Ocoephylla smaragdina) predator ability by using the forage preference test method toward several types of dominant pests in palm oil plants, especially caterpillars. Preference for choice and no-choice tests. The material used is an oil palm plantation with four species of caterpillar as the main pest on a palm plantation. The tool used in the test box amount to four in which each of the six different types of caterpillars are inserted. This research is conducted on a laboratory scale by using a complete random program experiment (CRP) and was conducted in April 2016 at Biology Laboratory UIN Raden Fatah Palembang. The research results show that the weaver ant (O. smaragdina) can prey on the S. nitens caterpillar the similarity test average is 87,50% by using a nonchoice technique. The choice methods O. smaragdina can be prey 41,67% S. nitens. In the similarity test average choice techniques are different (83,33%).

Key words: *Caterpillar; Choice; Non-choice Methods, O. Smaragdina; Preference test.*

Introduction

The plantation subsector plays an important role in the Indonesian economy. Palm oil is an excellent commodity that has grown rapidly since the 1990s, recorded at 1.1 million hectares with the production of Crude Palm Oil (CPO) of 17.37 million ton (Wigena et al., 2016). South Sumatra is one of the provinces in Sumatra with the third-largest palm plantation. Oil Palm Plantations in South Sumatra in 2011 reached 2.2 million hectares or number three in Indonesia after Riau and North Sumatra. In 2012, South Sumatra targets the plantation area to reach 2.4 million hectares. Meanwhile, the quota of plantations outside the horticulture is based on the layout of about 2.8 million hectares, meaning there are still about 600 thousand hectares again that have not been explored. The extensive data on Palm oil plantations in South Sumatra does not include the people's plantations.

The importance of the role of oil palm in the national economy is of concern to the government. This concern is still high as reflected by the issuance of the plantation revitalization program. For oil palm plantations, the total targeted area is about

1,550,000 hectares with details of 1,375,000 hectares area expansion, rejuvenation of 125,000 hectares of old plants, and 50,000 hectares of land rehabilitation (Directorate General of Plantation, 2009) So the importance of oil palm plantations in its development can refer to the Roundtable on sustainable palm oil (RSPO). This concept refers to the eight principles and criteria of sustainable palm oil plantations that are capable of fulfilling the biophysical (planetary), economic (profit), and social (people) aspects (Dja'far, Ratnawati, and Akmal, 2005).

In the early stages of palm oil plantation operations, several problems arose. Problems arising from these operations include heterogeneous forests into homogeneous plantations (L. & J., 1998). After becoming homogeneous the plantation becomes heterogeneous based on age stratification at the time of its incomplete planting process. This began to realize many problems such as decreasing soil fertility (land degradation due to improper application of fertilization), the emergence of pest organisms that damage palm oil crops among others *Setora nitens caterpillars, Sethosea asigna, Darna trina Lepidoptera* order, there are also small beetles such as *Rhynchophorus Ferrugineus* production to decline, the extinction of flora and fauna, and environmental pollution, social conflicts and even global environmental changes. This problem increases over time as the area of forest is converted into other business lands (Wigena et al., 2009).

The pest problems that arise are of concern to the plantation world. For that effort made for the prevention. One of the efforts made is the control of natural enemies. The utilization of predatory organisms is still not widely utilized, for example, the utilization of weaver ant *O. smaragdina.* Ants play a role in a tropical ecosystem. The role of ants in the ecosystem is as a predator of other insects. The social behavior of ants as predators, decomposers and herbivors in the ecosystem has become an intensive subject of interest to be examined in all its aspects. There are many species of ants that commonly invade homes for finding food and nesting sites (Fatiqin et al., 2023). According to Majid et al (2016), the most common species of household ants found based on the surveyed residence in Pulau Pinang, Malaysia are Tapinoma indicum (17.74%), Paratrechina longicornis (22.09%), Tapinoma melanocephalum (17.0%), Pheidole sp. (5.22%). and Monomorium pharaonis (10.61%). In addition, predator ants can also be used as biological indicators of linkage changes because of the relatively easy-to-collect and environmentally sensitive living conditions. Thus ants can be used to help understand ecological principles with the aim of conservation and management of the area (Wigena et al., 2016).

Some research on the use of weaver ants as pest control has been done on cocoa (Mele & Cuc, 2004), and rambutan (Tsuji et al., 2004), whereas in oil palm crops is still limited information obtained especially on caterpillar pests. This study aims to see the potential relation of the weaver ant (*O. smaragdina*) and its role as a pest-controlling agent, especially caterpillars in oil palm plants. The potency of this weaver ant is seen in its ability to eat. This study is expected to be recommended for the use of the weaver ant (*O. smaragdina*) as the biological control agent against the caterpillars on oil palm plantations.

Materials and Methods

The next *weaver ant* potential observed is the ability of its predators(Simanjuntak & Susanto, 2011). To see its role as a predator is performed by the feeding preference test (Simanjuntak & Susanto, 2011). The research is carried out on a laboratory scale by using the complete random program (CRP) experiment method and the data analysis is using type variant of analysis (ANOVA) (Mujijah et al., 2019). The study was conducted on a laboratory scale after field observation. Weaver ants and fire caterpillars have been identified and have high significance and dominance in oil palms. To see the potential, the preference test is to feed the prey to the weaver ant and see his favorite of the type eaten by several pests found in caterpillars. To see feeding preferences used choice feeding and nonchoice techniques (Bockoven et al., 2015; Cole et al., 2008).

Prior to the implementation of the feeding preference test, all test animals should be acclimatized first in order to adapt to the new environment. This activity is done for 24 hours to see the adaptation of the test animals used. Tools and materials used are a feeding test box, *weaver ant* (*O. smaragdina*), various types of caterpillars, gauze, gel oil, digital camera.

Non-choice techniques

The feed preference test with the nonchoice technique provided 16 boxes made of plastic with a size of 23x40 cm (Withers & Mansfield, 2005). The study was designed using a complete randomized design model with four treatments and four replicates (4x4). The first form of treatment (A) of the text box was inserting fi res larvae of type *S. nitens* (Lepidoptera: Limacodidae) of six caterpillars (Exelis, 2014). Then the second treatment (B) of S flame worm asigna (Lepidoptera: Limacodidae), while the third treatment (C) caterpillar type *T. sinensis* (Lepidoptera: Limacodidae) and the fourth treatment (D) Caterpillar type *P. lapida* (Lepidoptera: Psychodidae).

Observations were made daily for four days. To see the ability to eat *weaver ant* (*O. smaragdina*) to pest caterpillars, then on the fourth day is calculated the percentage of the number of species of caterpillars that died or were eaten.

Choice technique

In the feeding preferences test with choice technique provided 16 boxes made of plastic with size 23x40 cm. The first treatment (A) was introduced to two types of caterpillars, the first type of caterpillar *S. nitens* (Lepidoptera: Limacodidae), and the second type of *P. lapida* (Lepidoptera: Psychidae). The second treatment (B) type of caterpillar *S. nitens* (Lepidoptera: Limacodidae) and the second type *S. asigna* (Lepidoptera: Limacodidae). The third treatment (C) type of caterpillar *S. nitens* (Lepidoptera: Limacodidae) and *M. plana* (Lepidoptera: Psychidae). The fourth treatment (D) type of caterpillar *S. nitens* (Lepidoptera: Limacodidae) and *T. sinensis* (Lepidoptera: Psychidae) each of six caterpillars.

Observations were made daily for four days. To see the ability to eat *O. smaragdina* and to the type of caterpillar fire, then on the fourth day is calculated the percentage of the number of major pests (*S. nitens*) that died or were used by *weaver ants* (*O. smaragdina*). After the end of the observation, then the data analysis is done by using a statistical test with the formula of analysis of variance (ANOVA).

Results and Discussion

The ability to colonize *weaver ants,* especially *O.smaragdina* not be separated from the availability of food sources. To see the ability of the *weaver ant* planted with oil palm can be tested with feeding preferences. The availability of food is inseparable from the diversity of pests that are found. The dominant pest diversity results are found in the Limacodidae family, namely the caterpillar and the Psychidae family, the caterpillar in the arboreal area of the oil palm plant. The distribution of the caterpillar abundance types, especially the *S. nitens* species, has a high significance index. The high importance of this type of potential is a major pest in oil palm crops (Anggraitoningsih, 2012). The colonies were divided into small and large types; colonies that have 63 workers and below (35.87 ± 14.446) were considered as small (S) and the colonies that have 63 above workers (104.60 ± 40.098) were considered as large (L) colonies. Out of 30 colonies, there were 15 small and 15 large colonies. The colony with 30 workers (small colony) discovered the nest slowly in about 26 mins but took only 10 mins after the first brood transfer to complete emigration and the large colony (130 workers) discovered the nest faster (Kamarudin et al., 2011).

The potential of the *weaver ant* in this oil palm plant was then tested with a foraging system (feeding) to caterpillar pests found in palm plants on a laboratory scale (Figure 2). The results of the *O. smaragdina* and feed preference test with nonchoice technique on the four types of caterpillar pests in the palm plant on the second day have been seen in Table 1, that the insect pest type of *S. nitens* is more attacked by *O. smaragdina ants* (45,83 %) Of other insect pests. Like wise the third and fourth days tends to be the dominant insect pests of *S. nitens* attacked by *O. smaragdina* (45.83% and 87.5%) of the insect pest of *S. asigna, Thosea sinensis,* and *P. lapida*.

Table 1. Average percentage of the nonchoice weaver ant (O. smaragdina) feeding preference against four types of pest insects (Lepidoptera: Limacodidae) on the fourth day.

Pest types	Average (%)	
A *(Setoranitens)*	87,50	Aa
B *(Setothoseaasigna)*	66,67	Ab
C *(Thoseasinensis)*	37,50	B
D *(Parasalapida)*	25,00	B

Description: The number that follows the capital letters indicates a very real different effect (p <0,01) and the letter that follows by small letters indicates a real different effect (p < 0,05).

The result of the analysis of variance (%) of predation. Smaragdina against four types of pests, on the fourth day, is very different significantly (p <0.01). Based on the Advanced Test of DMRT, the attack of the O. smaragdina ant on the insect pest type A (*S. nitens*) was significantly different from the type B (*S. asigna*) (p <0.05), but the attack of the *O. smaragdina* ants against the insect pest type *S. Nitens* (A) and *S. asigna* (B) were significantly different (p <0.01) with insect species *T. sinensis* (C) and P. *lapida* (D). While the attack of *O. maragdina* ant on the insect pest type *T. Sinensis* (C) and *P. Lapida* (D) did not differ (p> 0,05). In Table 1, it was observed that the preferred *O. smaragdina* and food type of the four different pests ie the average *S.nitens* fire worm on the fourth day was devoured by *O. smaragdina* ants of 87.50%, *S. asigna*. 66,67%, *T. sinensis* 37,50% and P. *lapida* 25,00%. For more details, the average difference of *O. smaragdina* ant attack against pest insect species can be seen in Table 1.

This preference test shows that the *weaver ant* has a large potential and is seen in Table 1 ants smaragdina Averages mostly attack the caterpillar type *S. nitens*. It is allegedly due to the morphology of this caterpillar with striking features, the movement is active. While *P. lapida* larvae are not favored by ants because of their sheltered and passive morphology. These four types of caterpillars such as caterpillars (Lepidoptera: Limacodidae) and caterpillars (Lepidoptera: Psychidae) are very harmful to oil palm plantations (Exelis, 2014).

The number of caterpillar pests in oil palm crops resulted in a decrease in the amount of oil palm production reaching 40% or about 6.4 tons/ha. But the more active is the caterpillar attack (*S. nitens, S. asigna,* and *T. sinensis*) (Van Mele & Cuc, 2007). The problem of caterpillar pests in oil palm plantations is generally overcome by using synthetic chemical insecticides but will have a negative impact on the environment. For that, it has strived for various ways of natural control. Therefore it can be said there is a great potential that the weaver ant especially ants smaragdina acts as a predator or predator insect pest caterpillar on oil palm plants. Other studies have also reportedly played an important role of arboreal ants as predators of pest insects on plantations (Dunn et al., 2007; Schultz & McGlynn, 2000; Sitthicharoenchai & Chantarasawat, 2006). In addition, most ants are also expected to help control agricultural pests (Van Mele & Cuc, 2007). The *O. smaragdina* ants are one of several types of arboreal ants that are important predators and are predicted to protect plants from pests if properly investigated (Philpott, Stacy, M and Armbrecht, 2006).

Research on the control of caterpillars and other insect pests on oil palm has been done before, such as the use of viruses, bacteria, and so forth. The use of ants (*O. Smaragdina*) on oil palm plantations has not been reported. Therefore this research can be used as one of the control models of insect pests (Lepidoptera: Limacodidae) on palm oil plants. The developed model is to create a tanglefoot against the colonies found on palm leaf midrib. It is possible to develop because the dominance of ants is much more arboreal in palm oil plants and has the potential to create new colonies with large numbers of individuals (Falahudin et al., 2015).

Based on the result of research with choice technique on a combination of treatment A on the third and fourth day of predation of ants smaragdina to insect pest is preferred from other treatment combinations. When viewed from the analysis results, the percentage of predatory results on the treatment of the combination of the fourth day is not different ($p > 0.05$). Previous research (Falahudin, 2012) has seen that based on the preference for eating, weaver ants are more likely to eat caterpillars (Lepidoptera: Limacodidae), Compared to caterpillars (Lepidoptera: Psychidae) or other insect pests. This tendency is one of the contributing factors due to the striking shape of the florist morphology compared with the hard caterpillars. The movement and luminescence of the caterpillars may attract the attention of ants, besides the limited availability of natural enemies (Falahudin, 2012; Falahudin et al., 2015).

Ants *O. smaragdina* prefer to prey on *S. nitens* (Table 1). The preference for this caterpillar is thought to be an interesting morphological form of the caterpillar. The feeding of ants is inseparable from the effects of pheromones. The Isingrini & Lenoir (1988), research reports found that the CHC pheromones of communication could detect the colony's origin and the caste reproduction (fertility of the signal). Can cause conflict in the ant. Feromone this as a means of communicating information about the availability of food to the environment, so that if there is food detected will be communicated.

O. smaragdina ants' predominance increases with time (Table 2). Based on the observation of attack by type of *S. nitens* as the main pest, the percentage of ant predation increased from the second, third, and fourth day in each treatment combination. The second-day observation showed that the insect pests of *S. nitens* were more attacked by *O. smaragdina* ants than *P. lapida* type (18.75%), than other insect pests. The predation tendency of *O. smaragdina* at the treatment of B and C is relatively the same (16,67%) that is a type of *S. asigna* and *M. plana*. Likewise on the third and fourth days tend to be insect pests type *S. nitens*. More dominantly attacked by *O. smaragdina* ants (29.17% and 41.7%) than insects of *S. asigna*, *T. sinensis, M. plana,* and *P. lapida*. On the fourth day, the ants' prediction of *S. nitens* from a combination of treatment A (*S. nitens* with *P. lapida*) and C (*S. nitens* with *M. plana*) was relatively the same, but different from treatment combination B (*S. nitens* with *S.*

asigna) and D (*S. nitens* with *T. sinensis*). For more details, the average difference of *O. smaragdina* ant attack against the main insect pests (*S. nitens*) from the combination of treatments can be seen in Table 2.

Table 2. The feeding preference average by using the choice technique of weaver ant (*O. smaragdina*) against another combination of pests types (Lepidoptera: Limacodidae) on the fourth day.

Pests Type	Average (%)	
A (*S. nitenswith P. lapida)*	41,67	a
B *(S.nitenswith S. asigna)*	29,17	b
C (*S.nitenswith M.plana)*	41,67	a
D (*S.nitenswith T.Sinensis)*	37,50	ab

Description: The numbers followed by different small letters show significantly different effects (p <0.05

In Table 2, the results of variance analysis (%) predation of ants smaragdina against S. Nitens in each treatment combination showed significantly different results (p <0.05). Based on the Advanced Test of DMRT, the attack of the *O. smaragdina* ant on the insect pest type *S. nitens* on the combination of treatment A (*S. nitens* with *P. lapida*) with B (*S. nitens* with *S. asigna*) and B (*S. nitens* with *S. asigna*) with C (*S. nitens* with *M. plana*) was significantly different (p <0.05). The combination of *O. smaragdina* ants' attack against treatment A is significantly different from treatment combination B. The ant feeding is more likely to eat the caterpillar (Lepidoptera: Limacodidae) than the caterpillar (*P. lapida*) and *M. plana*, so the combination of A and C is No different. The main factor is that the *S. nitens* form of the caterpillar type is striking and attracts the attention of the ants compared to the second pest. In addition, other factors are that this feeding activity can be done by these ants depending on dietary needs and interest in prey (Barbani, 2003; James et al., 1999).

The result of the feed preference test of nonchoice technique and choice of *O. smaragdina* ant to four types of pest shows all the results have a real effect (Table 1 and Table 2). The presence of ants smaragdina can affect the presence of pest insects (caterpillars) on oil palm. These results can be used as recommendations for pest control on oil palm crops. Referring to (Dejean et al., 2010; Kluge, 2000) that this technique of natural control is more effective and environmentally friendly, and sustainable it needs to be applied, one of which maximizes the role of predators or predators.

Figure 1. Oil palm plantations occupied by colonies of *O. smaragdina* have no symptoms of caterpillar attack.

Field observations show that palm trees with ant colonies ranging from the presence of caterpillars are reduced, and even tend to be absent (Figure 1). In palm crops with no ants, many of the oil palm leaves are eaten by caterpillars. There are several compelling reasons to use the weaver ant (*O. smaragdina*) as one of the biological controls on oil palm plantations. The weaver ant (*O. smaragdina*) is an aggressive and, with numerous individuals in one colony, and community life is eusocial, mostly nesting in oil palm, making it easier to search for prey such as caterpillars (*S. nitens*) or other types of caterpillars Oil palm trees. The use of the weaver ant as the control of natural enemies in oil palm plantations makes it a novel way to explore more of the behavior of these ants in the ecology of oil palm plantations (Falahudin, 2012; Parr & Gibb, 2010).

Fire caterpillars are a type of caterpillars that eaters of palm leave most often cause losses. The most common types of caterpillars are *Setothosea asigna, Setora nitens, Darna trima, Darna diducta*, and *Darna bradleyi*. The rare species are *Theya vestusa, Theya bisura, Susica pallida*, and *Birthamula chara* (Wahid & Kamarudin, 2000). The most damaging types of caterpillars in Indonesia are *S. asigna, S. nitens*, and *D. trima*. From the results of the feeding preference, test conducted it was *weaver ant* (Oechopylla) able to eat caterpillars and other caterpillars. For insect pest control, a colony of *O. smaragdina* with some queens may be very useful because it can be divided into several subcolonies depending on the number of queens, and then can be transferred to plantations without destroying the original colonies (Isingrini & Lenoir, 1988).

Therefore, this natural control technique is more effective and environmentally friendly and sustainability need to be applied (Figure 2.a), one of them maximize the role of predators or predators. Similar results were also obtained from Nirdev et al (2011), that Oecophylla ant ability can be used as a bio-indicator to prey *Lupropstristis* beetle (Coleoptera: Tenebrionidae) on rubber plantation (Nirdev et al., 2011). The same opinion is also seen in Kluge (2000), Sabu & Vinod (2009) studies that the absence of arboreal ants on rubber leaves causes the emergence of pests. This means that there is the role of arboreal ants in this case *O. smaragdina* as a biological control agent on oil palm plantations.

a b c

Figure 2. The ant preference test on the fire worm (a) the attack on smaragdina on *S. Nitens* (b) dead *S. nitens* is attacked and (c) the feeding preference test box.

There are ways induced experiences of target species can be reduced. The most difficult effect to avoid is an enhanced response to the reinforcing host (which is usually a target pest) as a result of experience resulting from enclosing or shortly after the environment. For crucial tests, methods such as dissecting larvae out of different time hosts. This study can be continued by looking at the effectiveness of *weaver ants* for caterpillars in oil palm plantations. Other studies can also be recommended to see the *weaver ant* aggression. Another problem to be aware of is the *weaver ant* which also carries the parasitoid so it is suspected of bringing new pests to the oil palm plantations. The presence of grass ants in oil palm is also a problem, as farmers harvest for their larvae and are sold as bird food. Therefore, it needs to be studied more deeply, at least from 2015 to 2016 this study focused to see the ability to eat weaver ants until the caterpillar is quite successful as a natural control of caterpillar pests. The weaver ant testing method discussed in this paper has proven to be different, ideally there is no choice and preferred method to use in combination. In an unusual case where predicted outcomes by no choice and selection tests differ significantly, further research will be required. Natural enemy biologists involved need to be examined and ideally, the behavioral mechanisms responsible for another aggressiveness should be explained. The research more gives information to our understanding of how to effective with different types of tests will increase in biological control tests on weaver ants (*O. smaragdina* F.).

Conclusion

The *weaver ant* (*O. smaragdina*) is able to prey on some caterpillar, (the average equality test is 87,50%) with the nonchoice technique the result is very different. In the equation test, the average of choice technique is significantly different (83.33%). The *weaver ant* (*O. smaragdina*) is preference to prey *S. nitens* 41,67% with choice methods dan 87,50% with non-choice methods. It can be recommended that the *weaver ant* (*O. smaragdina*) can be utilized as the natural enemy controller of fire caterpillar (*S. nitens)* pests on oil palm plants. Effectiveness and efficiency will be studied more about ants' aggressiveness to various types of pests in oil palm crops.

Acknowledgment

This research can be continued by seeing the effectiveness of *weaver ants* to caterpillars on oil palm crops. Other studies can also be recommended to see the aggression of *weaver ants*. Yet another obstacle to be observed is the *weaver ant* which also carries the parasitoid so it is suspected to bring new pests to oil palm plantations. In addition, the availability of *weaver ants* is also a problem because of the harvesting by farmers to take larvae sold as bird food. Therefore needs a more in-depth study, least from 2015 to 2016 this study focused to see the ability to eat *weaver ants* on caterpillars quite successfully as a controller Natural fire pest caterpillar. The results of this study at least provide an illustration of the potential of the *weaver ant* that can be utilized in integrated pest management and can be recommended for the control of caterpillar pests on oil palm crops.

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