Formulation Of Artificial Diet To Increase Population Distribuion And Aggressive Behavior Of Weaver Ant (Oecophylla Smaragdina F.) For Controlling Cocoa Pod Borer (Conopomorpha Cranerella Sn.)

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Formulation of Artificial Diet to Increase Population Distribution and Aggressive Behavior of Weaver Ant (*Oecophylla Smaragdina* F.) For Controling Cocoa Pod Borer (*Conopomorpha Cramerella* Sn.)

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ABSTRACT

This study aims to determine the effect of artificial diet formulation on the increase of population and aggressive predation of weaver ants (Rangrang). This research was conducted in several regions and districts in South Sulawesi in March to December 2013. This study was conducted were randomized group design which consists of 4 treatments with 5 replicates. The treatments consisted of 1 g brown sugar pellet, 1 g shrimp pellet, 1g chicken intestine pellet, and control (without pellet). Each treatment (pellet) was tied and 2 m above ground to pod with a distance of 4 m from natural nests. In this study, 10 cocoa trees with ants and 10 trees without ants were used as samples.

The results of this study showed that ant population and distribution were still low during the initial stage of this study. However, as the time elapsed, the population increased tremendously and it distributed widely. The intensity of pod damage due to cocoa pod borer was generally low on trees with artificial diet treatment and moderately to high intensities on trees without the artificial diet.

Keywords: Formulation, distribution and aggressive behavior, oecophylla smaragdina, conopomorpha cramerella

INTRODUCTION

Farmers in a large numbers in South Sulawesi heavily rely on cocoa trees; roughly 70% of agricultural sector is from cocoa farms. Yetcocoa pod borer known as CPB has attacked, the numbers of yields decreased resulting in reduction of cocoa communities' revenue. This has also significantly affected the reduction of local and national government incomes.

The actions to tackle wide-spread CPB infestation in cocoa ecosystem vary such as chemical usage. There is, however, not significant result in reduction of pod damage and CPB infestation seems to become excessive in the large number of cocoa plantation because they migrate to cocoa surrounding (Wardoyo, 1996). CPB has natural enemy such as group of predator and parasitoid in the environment which can press the population.

A predator, one of general natural enemies, is promisingly to develop in the cocoa plantation. A number of species might associate with CPB but certain group of natural enemies could be easily to find in cocoa trees is ant species. One of them is rangrang (O. smaragdina). Rangrang is strongly believed to reduce noticeably the large numbers of larvae, pupa, and adults of CPB. As Holy *in* Metcalf, (1994) argues, rangrang could collect their prey that includes larvae and adults and bring them to their nest for feeding the generation. The ant could hunt various insect pests and all stages of insect development in the estate crops (Schmutterer, 1978). Likewise, Lim *et al*. (1982) and La Daha *et al*. (2003) point out that Rangrang, is one of ant species on the cocoa farming, has been generally found to prey larvae

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and pupa of CPB. The ant diet obviously varies and could be classified into two main groups namely sugar and protein. As opposed to other ants, rangrang prefers the protein to sugar. Finding this, protein can be found in red and white meats, shrimp, mice, and insect. Furthermore, rangrang behavior has aggressiveness in for aging and delivering back food to their nest in order to feed their colonies. A group of lepidopteran is an example, nocturnal insects and general crop pests, is preyed indeed even though they could camouflage to avoid rangrang when night and daylight (Van Mele et al., 2004).

The previous study related to ant behavior conducted by Ahdin in 2002recorded that 7 species are predominantly found in cocoa farms, three species are identified to build their colonies and have aggressiveness throughout 24 hours. Rangrang (Oecophylla smaragdina Sn.) is one of ants observed which their role is vital for pressing CPB population. Similarly, finding the preliminary study carried out by Ahdin *et al.* (2009) and Fatahuddin *et al*. (2009) recorded that there are positive correlation cocoa trees occupied by ant as less severity pod damage results. Regardingseverity pod damage led by CPB, trees occupied by both rangrang (O. smaragdina) and black ant (Dolichoderus sp) appears to have healthy pods. In contrast, the trees unoccupied tend to increase severity pod damage, suffering from moderate to heavy pod damage. Similarly, the study of rangrang conducted by Tamrin *et al.* (2010) showed that there is significant difference between the trees with and without rangrang population. Establishment of rangrang population in the trees tends to have slight pod damage while another suffers from pod damage from moderate to heavily.

This significance leads to being proposed in this study regarding development of rangrang population combined with artificial diet stimulation made of organic matter in pellet formulation. Therefore, both distribution of population and ability of predation in reducing pod damage in the field would be understood and arised.

METHOD

The purposes of study are to see the attractiveness of artificial diet made of organic matter, consisting of steamed shrimp and chicken intestine of pellet formulation, to understand the distribution pattern and aggressiveness of rangrang. The research is carried out in three main regions in South Sulawesi namely Sidrap, Soppeng and Luwu.

Preparation

Artificial diet is tested in forming pellet made of organic matter. Every type of organic ingredients is prepared in the powder and all are mixed together to become paste. The composition is steamed shrimp and chicken intestine, sugar, and flour; 1: 0.5: 0.25 respectively. Afterwards, the paste is designed to shape pellet which is 1 g weight per pellet before they are heated for 5 menits.

Research Action

Attractiveness of Artificial Diet with Pellet Formation in the Field

The trial is designed based on randomized block design, consisting of 4 treatments in 10 times-replication. The treatment consists of each 1 g of palm sugar; shrimp pellet chicken intestine pellet and control (without artificial diet). Every pod trial is wrinkled and hanged by artificial diet on the petioles and pods (see: white arrow) with choosing size of 9 to 10 cm in the same tree.

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Figure 1. An example of establishing artificial diet in the pod

Particularly, this term is not released the ant to spread on the trees because prior to choosing the cocoa trees as the samplings, the trees are taken consideration to nearby shade trees which are occupied by colony of rangrang. This would be hoped that the rangrang could attract to artificial diet given. Then, the tree samplings are regularly observed to every 8 hours a day during 10 days. The observation determines and calculates the number of rangrang colony which attract to each trial.

Development and Distribution on the Rangrang by Stimulated Artificial Diet

Artificial Diet Stimulation

Development of ant species aims to increase population and therefore their population could give services for cocoa pod protection, reducing the number of pod damage caused by CPB infestation. Development and distribution, as a result, are vital for commencing and conducting the study in the trees which are nearby to their nests, followed by provision of artificial diet stimulation in order that they could sustain, spread, settle in, and build up their nests on the cocoa tree and others.

The Ability of Predation

The ability of rangrang in predating larvae and pupa of CPB is conducted by collecting as many larvae and pupae as possible and putting them in the trees occupied by the colony. The percentage of predation is measured as following;

$$P = (n/N) \times 100\ \%$$

P = the percentage of ant predation to either larvae or pupa of CPB

n = the number of larvae and or pupa predated by the rangrang

N=Total number of larvae and pupa of CPB given in the tree-samplings

Severity Pod Damage Caused By CPB

The observation is purposed to understand the relationship between the significant role of rangrang on the trees and severity pod damage led by CPB. The observation of severity pod damage is conducted when the pods are ready for harvest, collection all pod mature in both trials. The severity damage is calculated by following Lee *et al.* (1995);

$$IS = \frac{(Ri \times 0.093) + (Se \times 0.2970) + Be}{JB} \times 100\%$$

IS: severity damage (%)

So: healthy pod

Ri: slight damage (1 % to < 10 % of pod damage), easy pod segregation

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Se: moderate damage (10 % to < 50 % of pod damage), difficult pod segregation

Be: heavy damage (up to 50 % of pod damage), heavy pod aggregate

JB: the number of pods

RESULT AND DISCUSSION

Attractiveness of Artificial Diet

The ant attractiveness to the artificial diet in pellet formulation is provided in Table 1. This shows that the average number of rangrang attracted in artificial diet is the most significant in the shrimp pellet, followed by sugar pellet, chicken intestine pellet and the control.

Figure 2. The attractiveness of shrimp pellet and chicken intestine pellet on the field

The treatment of shrimp pellet shows significant difference among treatments (sugar, chicken intestine, and control). Meanwhile, sugar pellet and chicken intestine pellet are not significant difference but both treatments have significant difference in the control.

Tabel 1. The average of the number of rangrang (*O. Smaragdina* F.) preferring the artificial diet in the treesduring10 day observation.

Treatment	*Observation (day)*										*The No of Ant Colony*
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	
K0	0.0	0.1	0.1	1.2	0.2	0.0	1.0	0.3	0.6	1.1	4.60 **c**
PG	1.8	4.6	5.1	9.0	11.2	12.4	16.1	17.8	16.2	17.3	111.50 **b**
Pud	3.4	6.4	5.5	11.4	13.5	15.1	14.7	19.8	15.6	21.0	126.40 **a**
Pus	2.8	2.8	3.7	9.2	13.9	15.2	14.4	17.5	16.3	15.2	111.00 **b**

Note: A number in the same row followed by the same word meaning non significant difference in the test of DMRT 5%.

K0: Control (without artificial diet)

PG: Sugar pellet

Pud: Shrimp pellet

Pus: Chicken intestine pellet

The Table indicates that the treatment of shrimp pellet is significantly more preferable than both chicken intestine pellet and sugar. It is led to typical flavor resulted by shrimp, attracting the colony to visit. The rangrang as a powerful decomposer, scavenger, and predator in the environment would significantly attract to typical odor which shrimp pellet results.

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The rangrang mainly obligates in foraging food in order to sustain their colony and generation and therefore provision of healthy new generation in their nest in particular their larvae is vital for the ant workers and the colony as well as feeding their larvae ina mount of sufficient nutrient. As Suud (1978) states the rangrang could prey any other living organism when they are foraging, collecting and delivering to their nest as food for the new generation. Similarly, previous research finding by Tamrin *et al.* (2010) recorded that provision of shrimp-decoy food for the colony of rangrang tends their population to significantly arise because this type of food is more suitable and preferable.

In the control, without artificial diet, the trees seem to not be visited because the ant colony prefers other attractive trees given artificial diet. In the foraging, ant workers choose to stay at the nest protecting their generation more than foraging. They also tend to feed the insect bodies of what they preyed and kept in the nests more than their colony attract to a mount of honey dew.

Development and Ant Distribution of Rangrang Population by Artificial Diet Stimulation

The distribution of rangrang population in the cocoa plantation can be seen in the Table 2. The table shows that on the initial study the movement of population tends to become short range but a number of small and big nests built are found in particular 6^{th} and 7^{th} trees. The next observation found that their population distributed equally in all trees. This means that development of nest occurred and tended to increase from time to time observation.

Figure 3. The set of artificial diet in the tree

The most significant advantage of the number of rangrang nests in the study is mainly led by shrimp pellet sufficiently given and therefore allows them to establish in the trees(attachment4).The shrimp pellet has rich-nutrients such protein and mineral (consisting of 299 kcal energy) which are adequate energy supply for the population when expanding their foraging and nest development (Anonim, 2009). The number of nest development in the colony observed is mostly affected by food availability and any interference. One colony of rangrang, for instance, could reach to 100 nests, spreading over 15 trees of habitat, and their range of foraging is roughly 1000 meter squire (Van Mele *et al*, 2004).

Another benefit of rangrang colony for crops in order to provide services for cocoa pods is by provision of sufficient artificial diet in their niche along with giving a mounth of sugar liquid. The colony could be stimulated to settle in the trees and thus gives services for pod protection. By spraying adequately amount of attracted sugar liquid is carried out to each their trace which are frequently travelled, their service by protecting cocoa pods against CPB would be durable. The previous research finding by Subiady (2001) has been reported the provision of artificial diet implicating the ant colony to optimize their development without any interference. Likewise, as Untung (1993) points out an organism could develop

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significantly on their generation if sufficient food and optimum environmental capacity and therefore the organism allow building the large number of generation by its self-ability.

Table 2. The measurement of rangrang distribution (*O. smaragdina*) and development of nest on the trees given artificial diet

Observation	*Distribution of rangrang population on the trees given artificial diet*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
I	0 m 0 S	0 m 0 S	0 m 0 S	0 m 0 S	0 m 0 S	0 m 1 Sb	0 m 6 Sk 1 Sb	0 m 3 Sk	0 m 0 S	0 m 0 S
II	0 m 0 S	0 m 0 S	0 m 0 S	12.1m 0 S	7.1m 0 S	4.6m 1 Sb	7.3m 7 Sk 1 Sb	10.0m 5 Sk	6.5m 2 Sk	7.8m 2 Sk
III	0 m 0 S	0 m 0 S	0 m 0 S	12.1m 0 S	7.1m 1 Sk	4.6m 1 Sb	7.3m 7 Sk 1 Sb	10.0m 5 Sk	6.5m 2 Sk	7.8m 2 Sk
IV	0 m 0 S	0 m 0 S	0 m 0 S	12.1m 0 S	7.1m 1 Sk	4.6m 1 Sk 1 Sb	7.3m 7 Sk 1 Sb	10.0m 5 Sk	6.5m 3 Sk	7.8m 3 Sk
V	0m 0 S	0 m 0 S	0 m 0 S	12.1m 2 Sk	7.1m 1 Sk	12.6m 2 Sk 1 Sb	13.3m 7 Sk 1 Sb	10.0m 5 Sk	13.5m 4 Sk	13.8m 6 Sk
VI	4.5m 1 Sk	4.5m 1 Sk	6.0m 2 Sk	17.1m 3 Sk	15.1m 3 Sk	18.6m 4 Sk 1 Sb	18.8m 8 Sk 1 Sb	18.0m 6 Sk	19.5m 6 Sk	18.8m 7 Sk
VII	9.5m 3 Sk	9.5m 2 Sk	11.0m 2 Sk	17.1m 4 Sk	15.1m 4 Sk	22.6m 7 Sk 1 Sb	23.8m 9 Sk 1 Sb	24.0m 9 Sk	25.5m 10 Sk	25.8m 11 Sk
VIII	13.5m 4 Sk	13.5m 3 Sk	15.0m 4 Sk	17.1m 4 Sk	15.1m 5 Sk	28.0m 8 Sk 1 Sb	28.8m 9 Sk 1 Sb	29.0m 11 Sk	30.5m 11 Sk	31.0m 12 Sk
IX	14.5m 5 Sk	14.5m 3 Sk	15.0m 5 Sk	17.1m 5 Sk	19.1m 5 Sk	34.5m 9 Sk 1 Sb	35.0m 9 Sk 1 Sb	36.4m 12 Sk	36.5m 12 Sk	38.0m 15 Sk
X	21.0m 6 Sk	18.0m 5 Sk	19.0m 6 Sk	22.1m 7 Sk	23.0m 7 Sk	39.6m 10 Sk 1 Sb	42.0m 11 Sk 1 Sb	43.4m 12 Sk	44.5m 12 Sk	45.0m 16 Sk
Total of length movement	*21 m* *6 Sk*	*18.0m* *5 Sk*	*19.0m* *6 Sk*	*22.1m* *7 Sk*	*23.0m* *7 Sk*	*39.0m* *10 Sk* *1 Sb*	*42.0m* *11 Sb* *1 Sk*	*43.4m* *12 Sk*	*44.5m* *12 Sk*	*45.0m* *16 Sk*

Notes:

m= length movement of rangrang from the site of tree equipped with artificial diet (meter)

Sk= small size of nest built

Sb= big size of nest built

Severity Damage of CPB

The severity pod damage led by CPB on the trial can be seen in the Table 3. Table 3 shows that the large number of pods harvested is healthy condition but some are slight pod damage. Neither moderate nor heavy pod damage is found. The trees unoccupied by rangrang, almost pods harvested are not healthy, suffering from moderated to heavy severity pod damage.

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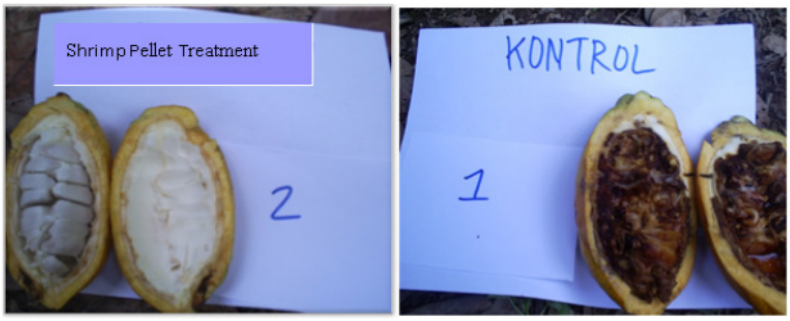

Figure 4. The difference in performance between pods given shrimp pellet treatment (right) and without treatment (left)

This closely relates to the large numbers of rangrang population that occupy the trees. In the observation of population, the ant population seems to develop rapidly and colonize the trees as well as cocoa pods. The study of Van Mele *et al*, (2004) reports that Rangrang could disturb, protect, and prey many kinds of insect pests such as a group of bug, leaf caterfillar, and any other pod insects. The population of rangrang could also reduce mirid and citrus leaf borer. Most of crop pests can be predated by the rangrang and protect the crops such as citrus, cashew, coconut, and cacao, implicating for the increase of quality and quantity yield. Rangrang could also repel the rats in cacao trees.

Rangrang (*Oecophylla smaragdina*) is not only one of powerful insect predators in environment but also successful colony in social behavior. Rangrang would prey any other larvae, pupa, and adult of insect pests. Their colony hunts both larvae and adults, collect them and bring to their nest before feeding their generation (Hoy *in* Metcalf, 1994). Similarly, Schmutterer (1978) argues that rangrang plays a vital role in preventing effectively yield damage caused by pests in particular annual crops due to attacking larvae, pupa and adult of pests. Another argument about successful rangrang in cocoa plantation is from Lim *et al.* (1982) and La Daha *et al.* (2003) that rangrang (*O. smaragdina)* is one of ant species in predating larvae and pupa of CPB. In addition, as Snelling (1999) supports rangrang is a remarkable aggressive predator, building their arboreal nest and occupying the number of plant species. Rangrang is often defined as eater of insect bodies and scavenger because they frequently hunt active insect pests, collects insect bodies, and brings them into their nest. In short, rangrang provides valuable services for plantation due to pressing crop pests' especially group of lepidopteron.

Table 3. Severety pod damage caused by CPB in the trees occupied by rangrang (*O. smaragdina*) in Soppeng Regency

Observation	*Damage Categories (%)*				*No of Pods*	*Severity Damage (%)*
	Healthy	*Slight*	*Moderate*	*Heavy*		
I	40	1	7	0	48	0.71 (So)
II	47	1	0	0	48	0.20 (So)
III	17	8	0	0	25	3.10 (Ri)
IV	7	6	1	0	14	3.70 (Ri)
V	12	2	1	0	15	2.47 (Ri)

Table 4. Severity damage of cocoa pod borer on the trees unoccupied by rangrang (*O. smaragdina*) in Soppeng Regency

Observation	Damage Categories (%)				No of Pods	Severity Damage (%)
	Healthy	Slight	Moderate	Heavy		
I	0	0	24	26	50	51.88 (Be)
II	0	1	0	48	49	55.83 (Be)
III	0	0	1	26	27	52.33 (Be)
IV	1	1	7	7	16	35.80 (Se)
V	1	1	1	11	14	37.05 (Se)

Snelling (1999) argues that rangrang is the greatest aggressive predator and build their arboreal nest and occupy many kinds of trees. Rangrang also can be compared with other predators and scavengers because they forage and collect organic matter and insect bodies and prey active insects. As a consequence, the trees occupied by rangrang are protected from insect pests in particular lepidopteran.

The Predation Ability of Rangrang

The study related to preying larva and pupa of CPB is carried out through collecting as many possible as egg, larvae, and pupa and then are placed to the trees occupied by rangrang. The percentage of predation is calculated by how many eggs, larvae, and pupa predated as following Table 5.

Table 5. Persentage of egg, prepupa and pupa of CPB predated

Trees	A number of egg laid, prepupa, pupa of CPB			A number of predation (%)		
	Egg	Prepupa	Pupa	Egg	Prepupa	Pupa
I	1	2	3	0	50.0	33.3
II	0	11	3	0	90.9	33.3
III	1	3	0	0	66.6	0
IV	1	1	3	0	100	66.6
V	1	2	3	0	50.0	66.6
VI	1	3	0	0	66.6	0
The average of predation (%)				0	70.7	33.3

The Table shows that the rangrang tends not to predate egg of CPB laid on the pods but the level of rangrang predation for pupa is high (33.3%) and 70.7 % for prepupa. Rangrang is, one of insect arthropode that can play as a prodator, from Hymenopteran known as *Oecophylla smaragdina* Fabricius (Hymenoptera: Formicidae). Rangrang aggressively prey all stage of insect pests' development such as larvae, pupa, and adult. They collect insect

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pests, bring to the nest and feed their generation (Hoy *dalam* Metcalf, 1994). Similarly, as Lim (1992) states the number of ant species have been found and preyed the larvae and pupa of CPB. One of them was *O. smaragdina.*

CONCLUSION

The distribution of rangrang population (*O. smaragdina*) in the initial study tends to be low rate in the cocoa trees. However, the range of distribution and a number of nests established seem to increase on the treatment.

The range distribution of rangrang and the number of nests built have positively correlated between pod damage on the trees occupied and unoccupied by rangrang. The proportion of pod damage in the trees with rangrang is from slight to moderate severity damage while the trees unoccupied is from moderate to heavy pod damage.

The aggressiveness of rangrang to predate pupa of CPB is high (33.3%) and prapupa appears higher (70.7%).

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