



The Potency of Collecting Larvae of *Oryctes rhinoceros* L. (Coleoptera: Scarabaeidae) in the Oil Palm Plantation

Anugerah Pustakawan Pradipta¹⁾, F. X. Wagiman^{2*)} and Witjaksono²⁾

¹⁾ Post Graduate Program, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia

²⁾ Department of Plant Protection, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia

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^{*)} Corresponding author:

E-mail: wagimanfx@ugm.ac.id

ABSTRACT

The intensive and continuous collection of rhinoceros beetles, *Oryctes rhinoceros* L. (Coleoptera: Scarabaeidae), is an extraordinary strategy in IPM (Integrated Pest Management). This study was intended to evaluate the potency of people in collecting larvae and to determine the age structure of the beetle population. The study was conducted in Asahan Regency, North Sumatera Province. Adult men, adult women, adolescent girls, and adolescent boys collected beetles for 2 hours in each breeding site. Results showed that the beetle was more significant abundant in decomposed trunks at plots of immature and mature palms than at heaps of the empty fruit bunches namely 236, 221 and 93 individuals/2 hours. The population age-structure showed significantly predominant of 2nd and 3rd instars in all breeding sites, i.e. eggs, 1st instars, 2nd instars, and 3rd instars, pupae, adult males, and adult females were 2.02, 23.29, 21.39, 47.06, 3.17, 0.86, and 2.21%, respectively. Adult men, adult women, and adolescent boys had similar potency in collecting 3rd instar larvae while the least amount was collected by the adolescent girls viz. 70, 85, 60, and 38 larvae/2 hours, respectively. It is suggested that the study results support future efforts in the sustainable control of rhinoceros beetle through collecting larvae for commercial utilization.

INTRODUCTION

The rhinoceros beetle, *Oryctes rhinoceros* (L.) (Coleoptera: Scarabaeidae), is well known as an important insect pest in Palmae including oil palms. Adult beetle attacks and destroys the developing fronds and spears of oil palms. Severe damage due to the feeding galleries can retard the development or even kill the younger palms (Chalapathi Rao, Snehatharani, Nischala, Ramanandam, & Maheswarappa, 2018). Attacks by adult beetles in mature palms may reduce the yield by 20% to 25% (Abidin, Ahmad, Salim, & Hamid, 2014). This rhinoceros beetle attack sometimes coincides with an attack by a bagworm that eats leaves (Sudarsono, Purnomo, & Hariri, 2011). On the other hand, larvae of the rhinoceros beetle live in decaying materials. Farmers can take an advantage to the beetle larvae due to

their capability to accelerate the decomposition process of stems of coconut, oil palm, and other palms. A study on important role of Collembola as a decomposer of soil organic matter by Rahardjo, Rachmawati, & Soetjipto (2019) inspiring to study the role of rhinoceros beetle larvae as a decomposer in the oil palm plantations. Shelomi, Lin, & Liu, (2019) reported that the gut microbiota of *O. rhinoceros* larvae is quite similar to that of the termite gut, as both species feed on decaying wood. Moreover, the beetle larvae are suggested to be used as feed and food (Okaraonye & Ikewuchi, 2009; Omotoso, 2018). Therefore, usefulness of the larvae shall motivate ones to collect them.

Efforts in management and sustainable control of the rhinoceros beetle intend to reduce the population density of the pest in such a way so that the crop will be normally growing and developing to produce optimal yield. The pest insect exists all

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times of the years with overlapping generations which threatens palm production. Therefore, sustainable control to regulate and to keep population densities of the pest at under tolerable levels is urgent to be developed. Advances in the control of rhinoceros beetle have been developed; for example, the aggregation pheromones for trapping, the *Metarhizium anisopliae* used as a biopesticide, and *Oryctes Nudivir* (OrNV) (Bedford, 2014). The OrNV infectivity on neonates of rhinoceros beetle was reported by Khudri, Azmi, Kamarudin, Ali, & Moslim (2016). Integration of *M. anisopliae* and pheromone to control *O. rhinoceros* was reported by Witjaksono, Wijonarko, Harjaka, Harahap, & Sampurno (2015). An inoculation trap for the auto dissemination of spores of *Metarhizium anisopliae* for the management of *O. rhinoceros* in the field was studied by Moslim, Kamarudin, & Wahid (2011).

Predators play an important role in sustainable control of the pests as their prey. The predators exhibit potency to hunt prey at any habitats where the pests exist, feeding rates at certain levels, and working all the time during their life. Widiastuty, Tobing, Marheni, & Kuswardani (2018) reported that *Myopopone castanea* (Hymenoptera: Formicidae) is the larval predator of a rhinoceros beetle. This ant preys on all larval instars of rhinoceros beetle at which the 1st and 2nd instars were more preferable. Collecting larvae of rhinoceros beetle by handpicking is almost carried out monthly. The labour cost of collecting rhinoceros beetles is approximately 71,291.59 USD per year.

The rhinoceros beetles are considered as important pests. The wide utilization of rhinoceros beetle larvae for human consumption is important to be developed as an alternative strategy of pest management. One effort to anticipate this pest problem is the larvae utilization approach. Hunting larvae intensively and continuously is a strategic step for sustainable control of these pests. Utilization of rhinoceros beetle larvae is promising such as supported by Okaraonye & Ikewuchi (2009) and Omotoso (2018) that the larva is highly nutritious. This study treats hunters of this larvae are likely as a predator. The hunters exhibit potency to collect larvae during the prescribed time period – it is like feeding rate – and the hunt continues since the larvae still be needed. Therefore, the objectives of this study were to evaluate the abundance

potential of rhinoceros beetle at various breeding sites, to describe age structure of the rhinoceros beetle, and to evaluate the potency of collecting larvae at the oil palm plantation.

MATERIALS AND METHODS

Study Site

This study was conducted from October 2018 to January 2019, at the oil palm plantation of Afdeling II Sei Silau PTPN III, Asahan Regency, North Sumatera Province, Indonesia. The preliminary observation was carried out to determine habitats of the rhinoceros beetles as their breeding sites for further studies. In this oil palm plantation, there are three areas of breeding sites viz. immature oil palms, mature oil palms, and heaps of empty fruit bunches.

Rhinoceros-Beetle Abundance at Breeding Sites

Single-factor RCBD experimental design was applied in the field study with three treatments and six replicates. The treatments were breeding sites namely areas of immature oil-palm, mature oil-palm, and heaps of empty fruit bunch. The replicates were six collecting days, from Monday to Saturday. Three adult persons were employed to collect the rhinoceros beetle. In order to minimize bias, their similarity performance to collect rhinoceros beetle was tested. They exhibited collecting potential relatively similar to the rhinoceros beetle, such as indicated with low coefficient of variance (CV-value < 10) from their collecting results within 2 hours i.e. $n = 6$, average \pm SD = 167.94 ± 13.52 beetles/2 hours, CV-value = 8.05%, and p-value = 0.9488. Every day, the three people each hunt rhinoceros beetles in the three types of breeding sites for 2 hours, from 07.00 - 09.00 in the morning or 13.00 - 15.00 in the afternoon. Hunting on the first day through the sixth day at each breeding site was carried out at different plantation plots and at different heaps of empty fruit-bunches. A purposive sampling method was applied in the hunting rhinoceros beetle at places that were suspected as the breeding sites. All stages of the rhinoceros beetle found were picked up, collected, counted, and recorded.

The Age Structure of the Rhinoceros Beetle

Age structure is useful in understanding and predicting population growth. In this study, the term age structure is defined as a summary of the number of individuals of each age in the population

of rhinoceros beetle. The age of rhinoceros beetle is expressed with its stages namely egg, larval instars, pupa, and adult. Rhinoceros beetles were collected in 18 sites at the immature oil palms, 14 sites at the mature oil palms, and six sites at the empty fruit bunches. The age structure was expressed in a proportion of the stages.

Evaluation of the Potency in Collecting Larvae

The RCBD 2 x 2 factorial studies with five replications was applied to determine the effect of gender and age against their potency to collect larvae. The first factor was gender namely males and females, while the second one was age namely adults and adolescent, therefore there were combinations of adult men, adult women, adolescent boys, and adolescent girls. The replications were five breeding sites; three sites at the immature oil palms and two sites at the mature oil palms. Four people seeking and collecting the rhinoceros beetle at those breeding sites for 2 hours at 07.00 – 09.00 in the morning or at 13.00 – 15.00 in the afternoon. The rotted trunks of oil palms were opened up and 3rd instar larvae were collected and recorded.

Data Analysis

PCSTAT software developed in 1985 by Mohan Rao and Kathleen Blane from Department of Food Science, University of Georgia, was used to variance analysis. The analysis of variance (ANOVA) was applied to determine the significant influence of treatments namely (1) rhinoceros-beetle abundance at breeding sites, (2) proportion of stages of the rhinoceros beetle, (3) gender and people age in collecting the rhinoceros beetles.

RESULTS AND DISCUSSION

The oil palm plantation is an ideal habitat for rhinoceros beetle to breed and develop. Damage to plants by rhinoceros beetle is caused by adults (especially young adults) and not the larvae. The larvae feed on already rotting materials. Abidin, Ahmad, Salim, & Hamid (2014) stated that the moist condition of the rotting trunks was preferred by the second and third instar larvae. High moisture (34.6 - 74.6%) is most conducive to rhinoceros-beetle breeding and larval development (Indriyanti, Anggraeni, & Slamet, 2017). Wan Zaki, Salmah, Hassan, & Ali (2009) suggested that the empty fruit bunches may serve as potential breeding sites for *O. rhinoceros* if not managed properly.

Rhinoceros-Beetle Abundance in the Breeding Sites

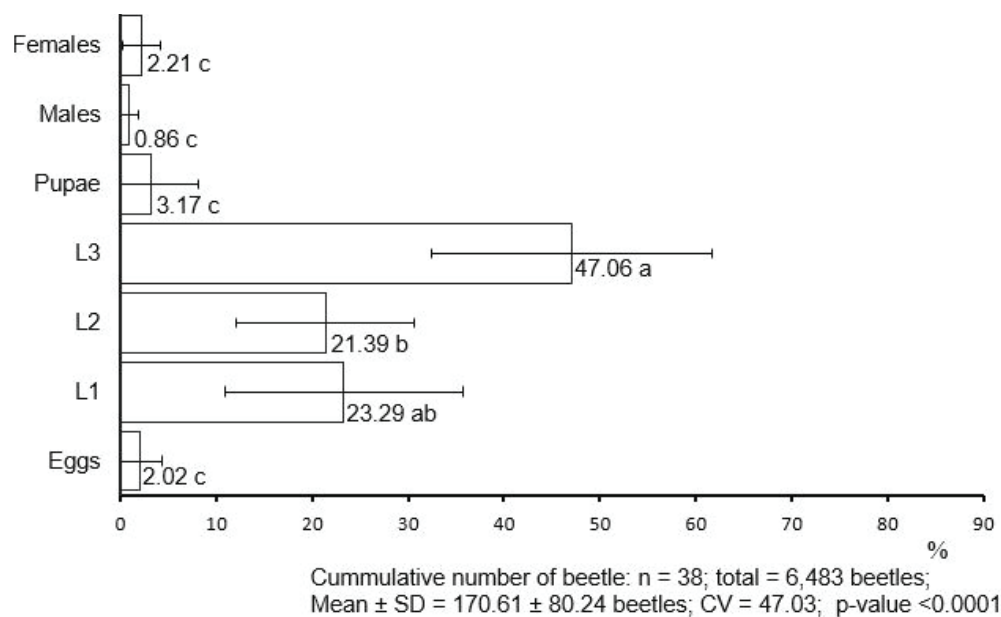
The study revealed that oil palm plantations are a suitable habitat for rhinoceros beetle to breed and develop such as shown by the number of collected beetles (Table 1). The average number of all stages of the rhinoceros beetle was significantly different amongst breeding sites. The number of collected rhinoceros-beetle from rotted trunks at areas of immature and mature oil palms was relatively similar and both were significantly more than - approximately twice in number - at heaps of the empty fruit bunches. Tens to hundreds of larvae could be collected in the oil palm plantation. This finding is in line with previous reports. Kamarudin & Wahid (2004) stated that the mature oil palm areas may harbour *Oryctes* in rotting trunks. Extensive oil palm replanting is always followed by the infestation of rhinoceros beetle and this thing becoming a renewed problem for the industry. During 6 – 10 months of oil-palm trunk degradation, at untreated plots with white-rot SK7/5 and *Trichoderma reesei*, the number of rhinoceros-beetle larvae per m² area increased approximately more than 50% as compared to at treated plots (Ali, Tajudin, Bakari, & Wahid, 2010). Frond and leaflet residues from pruning of oil palm which are applied as mulch on oil palm plantation will decompose (Pulunggono, Anwar, Mulyanto, & Sabiham, 2019). So far, there is no report on the decomposed frond and leaflet residues as a breeding site of the rhinoceros beetle.

Sustainable effective-control is an ideal approach to manage the insect pests of oil palm and other commercial crops. Intensive and continuous hunting of rhinoceros-beetle larvae resembles predatory characteristics. The advantage of predators is searching and finding prey, where the targets are then eaten up. This activity continues and stops for a moment when the predators getting full. Likewise, for larvae collectors, insofar as rhinoceros beetle larvae have promising economic value, they are motivated to hunt larvae and sell them. Among the various stages of rhinoceros beetle, 3rd instar larvae are the most selected stage to be processed into bagworm foods, feeds, or others (Okaraonye & Ikewuchi, 2009). Table 1 shows that the 3rd instar larvae can be obtained in the three breeding sites. Within 2 hours, ones are able to collect at the number of approximately 70 – 120 larvae; there is no significant difference in number amongst the breeding sites.

Table 1. The abundance of rhinoceros beetle at breeding sites in oil palm plantation in Sei Silau, Asahan Regency, North Sumatera Province, Indonesia

Statistics of rhinoceros beetle abundance	Breeding sites		
	Immature oil palm	Mature oil palm	Empty fruit bunches
All stages of rhinoceros beetle			
n	6	6	6
Total (individuals/12 hours)	1,413	1,324	560
Average (individuals/2 hours) *)	235.50 a	220.67 a	93.33 b
Standard Deviation (SD)	60.56	98.23	61.32
Coefficient of Variance (CV)	25.72	44.52	65.70
<i>P-value</i>	0.0096		
3 rd instar larva			
n	6	6	6
Total (individuals/2 hours)	592	714	418
Average (individuals/2 hours)	98.67	119.00	69.67
Standard Deviation (SD)	30.82	67.45	55.35
Coefficient of Variance (CV)	31.24	56.68	79.45
<i>P-value</i>	0.3036		

Remarks: *) Values in row with similar letters are not significantly different with one-way ANOVA and DMRT $\alpha_{0.05}$.

**Fig 1.** Age structure of rhinoceros beetle populations at breeding sites in oil palm plantation at Sei Silau, Asahan Regency, North Sumatera Province, Indonesia

The Age Structure of the Rhinoceros Beetle

The rhinoceros beetle could be obtained in all stages at the oil palm plantation. Larva seems to dominate the population (Fig. 1) i.e. eggs, 1st instars, 2nd instars, and 3rd instars, pupae, adult males, and adult females viz. 2.02, 23.29, 21.39, 47.06, 3.17, 0.86, and 2.21%, respectively. It is in line with Indriyanti, Anggraeni, & Slamet (2017), they reported that the 3rd instar larvae was predominant (72.39%) as compared to egg (5.43%), 1st instar (4.78%), 2nd instar (14.13%), pupa (1.73%), and adult (1.52%). The domination of the larva mainly 2nd and 3rd instars throughout the years was reported by Abidin, Ahmad, Salim, & Hamid (2014). Meanwhile, Wan Zaki, Salmah, Hassan, & Ali (2009) reported that throughout the trial period of 20 weeks all life stages (except for eggs) were continuously encountered; 1st instar, 2nd instar, and 3rd instar, pre-pupa, pupa, and adult viz. 12.0, 40.0, 35.5, 0.3, 4.1, 8.2%, respectively. The complete forms of developmental stages of the population of rhinoceros beetle indicate overlapping generation. Manjeri, Muhamad, Faridah, & Tan (2013) reported that the rhinoceros-beetle population consists of

overlapping generations. Multiple overlapping generations are common under favorable conditions such as in tropical countries. The beetles can be active and reproductive throughout the year (Dornberg, 2015). In terms of commercial utilization of the larvae, the 2nd and 3rd instar are more preferable because besides big in size also predominant in population. Phenomena at which the population is dominated by 2nd and 3rd instars and it exhibits overlapping generations are an advantage because the preferable stage namely 3rd instar can be obtained at all the time.

The Collecting Potential of 3rd Instar Larvae

Gender did not significantly ($p = 0.6162$) influence the collecting potential, but the age significantly ($p = 0.0017$) influenced the collecting potential of 3rd instar larvae. There was a significant ($p = 0.0275$) interaction between gender and age so that the effect of age is only experienced in adolescents namely girls and not experienced in adolescent boys, adult men and women (Fig. 2). Adult people are suggested to be more employed to collect larvae than adolescent ones.

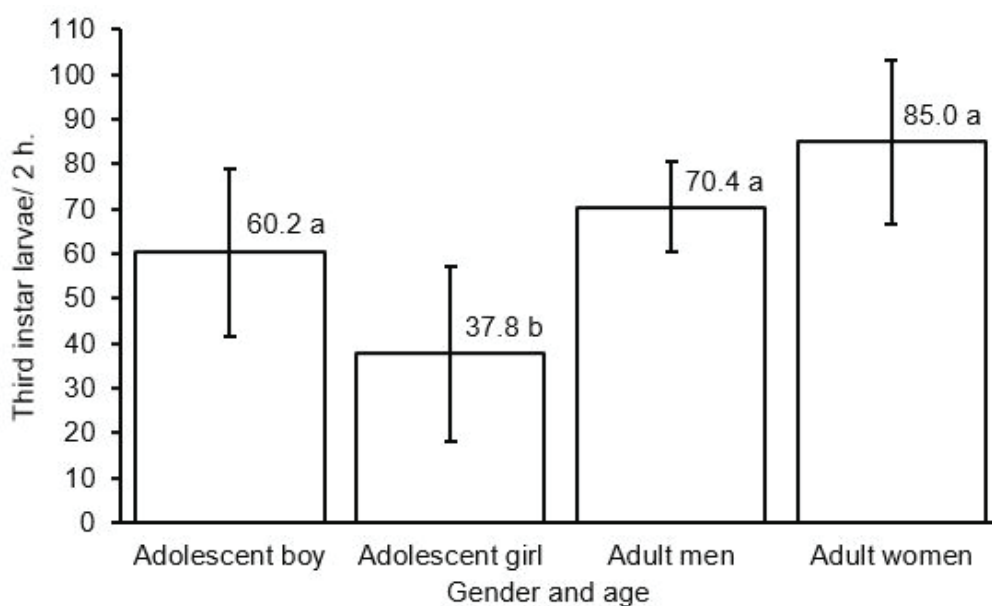


Fig 2. Influence of gender and age against potency of collecting 3rd instar larvae of rhinoceros beetle per 2 hours at the oil palm plantation in Sei Silau, Asahan Regency, North Sumatera Province, Indonesia

Edible insects are already reported in many countries. A literature survey conducted by Yde Jongema from WUR in April 2012 for an inventory of edible insect species worldwide including from Western countries and temperate regions, recorded as many as 1,900 species. Edible species - including the rhinoceros beetle - are actually considered as important pests at agro-ecosystems, they could be controlled through an alternative management-strategy namely widely utilization for human consumption (van Huis *et al.*, 2013). Rhinoceros beetle larvae have the potential to be made into food because they are highly nutritious; protein (42.29% wet weight), unsaturated fatty acids (60.34%), and ash (12.70% wet weight) including manganese, iron, calcium, magnesium, potassium, sodium, copper and phosphorus. The larvae are boiled, smoked, or fried and consumed as a snack or side dish (Okaraonye & Ikewuchi, 2009). Therefore, it is possible to develop the utilization of the larva toward commercial propose. The economic advantage will motivate the continuous and intensive hunt of the larvae. On the other hand, the population of rhinoceros beetle will slowly decrease and in the long run, the problem of these pests will be overcome. When the larvae in the oil palm plantations getting scarcity, larvae hunts switch in coconut plantations. Wagiman (2019) reported that the 3rd instars could be collected from decomposed coconut-trunks ranged between 15 – 32 larvae/trunk. Another alternative is the mass rearing of the rhinoceros beetles. Further study is suggested on the mass-rearing method of rhinoceros beetle.

CONCLUSION

Decomposed trunks and empty fruit bunches of oil palms are suitable breeding sites of a rhinoceros beetle. All developmental stages of the beetle were found at the time of observation. The 3rd instars dominated the populations in all breeding sites. High potency to collect larvae was shown by men, women, boys, and moderate potency was shown by girls, viz. 85.0, 70.4, 60.2, and 37.8 larvae/2 hours, respectively. This finding supports future efforts in sustainable control of the pest through collecting and utilizing the larvae.

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Anugerah Pustakawan Pradipta *et al.*: *The Potency of Collecting Larvae*.....

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