



Research Article

The Coexistence of *Oryctes rhinoceros* L. and *Xylotrupes gideon* L. (Coleoptera: Scarabaeidae) on Immature Plant in Oil Palm Plantation

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ABSTRACT

Oryctes rhinoceros L. and *Xylotrupes gideon* L. (Coleoptera: Scarabaeidae) are known to attack palms. *O. rhinoceros* is a major pest in oil palm while *X. gideon* is a minor pest found in certain areas with a relatively few numbers. Collecting these beetles by hand picking and trapping are intended to reduce their population. Objectives of this study were to describe an intimacy of shared existence of *O. rhinoceros* and *X. gideon* in the oil palm plantation, and to determine the effect of manual collection of the beetles from the decomposing trunks to that collected using attractant traps. The study was conducted in Asahan Regency, North Sumatera, in Sei Silau PTPN III oil palm plantation. Five traps (2 Ha/trap) containing the pheromone ethyl-4-methyloctanoate were installed randomly at a replanting area of immature palm. Beetle collection was performed daily for 30 consecutive days using two methods, i.e. (a) hand-picking of beetles on the decomposed trunks at surrounding the trap for 2 hour per day, and (b) using pheromone traps. Simple regression and correlation model was used for data analysis. Results showed that coexistence of *O. rhinoceros* and *X. gideon* was observed at the breeding sites of decomposing trunks, but not in the traps, and their coexistence showed a weak relationship ($r = 0.12$). Number of collected *O. rhinoceros* (221 beetles) was much more than *X. gideon* (82 beetles). Natural sex ratio (male: female) was approximately 0.5 for *O. rhinoceros* and 0.4 for *X. gideon*. Collection of the beetles in the decomposed trunks showed a moderately positive relationship ($r = 0.43$) with and significantly influenced (18.73%) to the collection of beetles using pheromone traps.

Keywords: coexistence; oil palm; *Oryctes rhinoceros*; *Xylotrupes gideon*

INTRODUCTION

The rhinoceros beetle, *Oryctes rhinoceros* L. (Coleoptera: Scarabaeidae) is a major pest of oil palms. Manjeri *et al.* (2014) has reviewed the biological and ecological characteristics of *O. rhinoceros* as an oil palm pest in Malaysia. This noxious pest damages the immature and mature plants there by affecting the oil palm production (Chung *et al.*, 1991; Mariau, 2000; Abidin, *et al.*, 2014; Bedford, 2014). Adult male and female beetles can cause significant damage to the plants but not to the larvae because they feed on the dead plant materials. One attack increases of further attacks and certain trees could be more frequently attacked than would be expected by chance. More than one beetle may infest a tree at the same time, while a neighboring tree may remain un-infested. A study in India found five to six beetles feeding in the same crown (Bedford, 1980). On both oil palms and coconuts, the adult beetles bore through the petiole bases into the central unopened leaves.

This causes tissue maceration and the presence of a fibrous frass inside the feeding hole. These pests can reduce 69% of the yield of fresh fruit bunches in the first year; causing the death of 25% of the young plants (Widayanto *et al.*, 2014). On an oil palm estate, decaying palm trunks serve as common breeding grounds, furthermore while empty bunches or other organic waste used as mulch may also become breeding sites (Wan *et al.*, 2009; Corley and Tinker, 2016). Eggs, larvae, pupae as well as adults can be collected by digging into or breaking open its possible breeding sites such as in the heaps of empty fruit bunches and decomposing trunks.

Another rhinoceros beetle is *Xylotrupes gideon* L. (Coleoptera: Scarabaeidae), that is widespread throughout South East Asia. This species is not recorded in the list of oil palm pests of Indonesia (Kalshoven, 1981), however, the adults of *X. beckeri* Schauf. adults were found to feed on oil palms in Malaysia (Wood, 1968 *cit.* Bedford, 1975). Furthermore, Kalshoven (1981) explain that the

female beetles bore into the central leaf in the crown of coconut palms in a way similar to *O. rhinoceros*; consequently part of the frond may break off where the crown leaves unfold. The males are often observed on the newly-opened inflorescences. The larvae live in the soil rich in organic matter, in the heaps of compost and manure, in dead banana stems, and in decaying wood.

The pest, *X. gideon*, has never been noticed as a significant pest of oil palm in Indonesia. Some adult beetles, mainly the females, are often attracted to light at night. In-depth research on *X. gideon* as a palm pest is required. A preliminary study on the existence of *X. gideon* was hence carried out in the oil palm plantation. Breeding sites of *X. gideon* are similar to *O. rhinoceros* (Bedford, 1975; Kalshoven, 1981), hence, the study intended to describe the coexistence of *O. rhinoceros* and *X. gideon* in the oil palm plantation.

Collection of rhinoceros beetles at their breeding sites by trapping adult beetles is often carried out to monitor and control the pests. A pheromone is used in the traps to effectively capture the beetles. The aggregation pheromone, ethyl-4-methyloctanoate, is produced by the males of *O. rhinoceros* (Bedford, 2014). The synthetic version of this pheromone has been developed to control 21%–31% male and 67%–79% female beetles in the field (Sudharto *et al.*, 2000). Pheromone traps are useful as monitoring tools, which can be an economical control method particularly in young oil palm replant areas when placed at one trap per 2 ha (Norman & Basri, 2014). Mechanical control by picking up larvae at the breeding sites is an alternative control measure. Labour costs to manually collect the beetles was approximately 71,500 USD annually (Agus, 2018; personal communication). Mechanical control may have significant impact to the population of the adult beetles. Therefore, the second objective of this study was to determine the influence and correlation of adult beetles collected manually from the breeding sites against collected in the pheromone traps.

MATERIALS AND METHODS

Study Site

The study site was an immature oil palm plantation, three years after replanting, approximately 10 ha wide and 2 km away from the border, at which the dead

old trees were scattered relatively and evenly on plantation. The study was conducted during January to February 2019, in Afdeling II Sei Silau PTPN III, Asahan Regency, North Sumatera Province, Indonesia. An attractant trap containing ethyl-4-methyloctanoate (Bedford, 2014) was erected at the plantation site, approximately 300 cm above the soil surface and as high as the oil palm canopy (Figure 1). The trap was designed as a double vane bucket trap (Lestari, 2018) installed at one trap per 2 ha (Norman and Basri, 2014). Therefore, in this study five traps were installed approximately 400 m apart. The adult beetles at every trap were collected, identified, and recorded daily during 30 consecutive days.

Determining the Breeding Site for Collecting Adult Beetles

The decomposing oil palm trunks are the ideal breeding sites of the rhinoceros beetles (Wan *et al.*, 2009; Corley & Tinker, 2016). At the study site, one trap was set in the middle of the plot where decomposing oil palm trunks (Figure 2) surrounding the young plants that were relatively regular in position; most of them on the ground while some were still upright. Adult beetles were inspected for



Figure 1. A double vane bucket trap with aggregation pheromone to catch adult rhinoceros beetles for catching adult rhinoceros beetles



Figure 2. A decomposed trunk of oil palm as a breeding site of rhinoceros beetles

2 h per day during 30 consecutive days at the study site, by breaking open the decomposing trunks. The collected beetles were identified and recorded. Purposive sampling was applied to get the intended samples (i.e. the decomposing trunks). Due to uncertain size of the decomposing trunks at the beetle breeding site, the sampling unit was set as individuals/2 h.

Data Analyses

In this study, the term “coexistence” is defined as the state or fact of living or existing at the same time or in the same place between the rhinoceros beetles *O. rhinoceros* and *X. gideon* at the oil palm plantation, especially in the breeding sites and traps. The strength of their relationship was determined by interpreting the correlation coefficient (r), resulting from the analysis of simple linear regression and correlation of $Y = a + bX$, where Y is the population of *X. gideon* and X is the population of *O. rhinoceros*, while a is the intercept and b is the coefficient of regression. Analysis tools available in the Microsoft Office Excel program were used for data analysis. Guidelines of Ratner (2009) was used for interpreting the correlation coefficient. Similar analysis was used to determine the influence of beetle collection in the decomposing trunks vs those in the attractant traps.

RESULTS AND DISCUSSION

Pest Status of X. gideon on Oil Palm

This current study is one of the first reports on *X. gideon* found at an oil palm plantation in the region of North Sumatera Province, Indonesia. Figure 3 shows a pair of the *X. gideon* found mating on an oil palm frond, likewise, males and females were also found in the decomposing trunks. The male and female adult of *X. gideon* is not similar to *O. rhinoceros* (Figure 3 and 4). The *X. gideon* affects oil palm plants and has the potential to become a pest (Wood, 1968 *cit.* Bedford, 1975), however, there has not been any reports on the economic impact of *X. gideon*. Therefore, existence of *X. gideon* in the oil palm plantation is not a threat at the moment and its current status is stated as an incidental or minor pest.

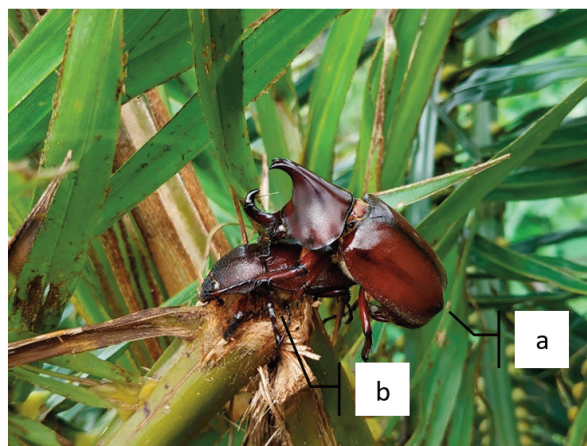


Figure 3. The adult male (a) and female (b) of *Xylotrupes gideon* on frond of oil palm

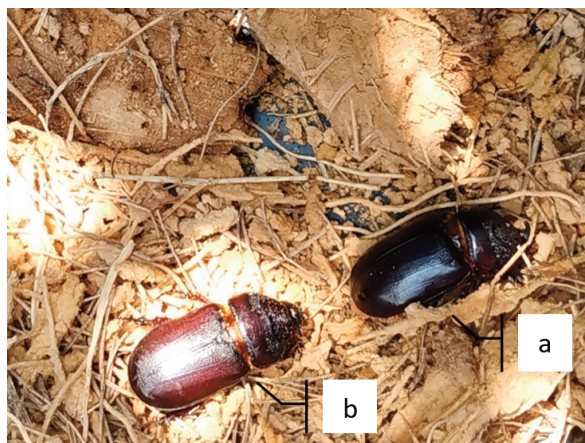


Figure 4. The adult male (a) and female (b) of *Oryctes rhinoceros* on trunk decomposing area

Coexistence of the Rhinoceros Beetles, *O. rhinoceros* and *X. gideon*

We found both species of the beetles in the decomposing trunks. Population density of *O. rhinoceros* adults was approximately 2.7 times greater than that of *X. gideon* (Table 1). The *O. rhinoceros* females dominated ($p < 0.05$) at the breeding sites (148 females vs 73 males) while the males dominated in the pheromone traps (55 females vs 102 males).

The existence of *O. rhinoceros* did not influence the existence of *X. gideon* such as indicated by the non-significant coefficient of regression ($p > 0.05$). Relationship between the two beetle species was weak, meaning that they freely coexisted with other macrofauna.

The aggregation pheromone has been reported to attract more than one species of rhinoceros beetles, however, in this study *O. rhinoceros* was the only species collected in the attractant traps (Table 1). Existence of *X. gideon* was noticed on frond of the oil palm (Figure 3) and it was also found in the decomposing trunks. Female beetles were also attracted to the light at night (Syaiful, 2019; personal communication).

The Influence of Manual Collection vs Attractant Traps

Destruction of breeding sites and manual collection of adult beetles are the traditional methods used to control rhinoceros beetles (Corley & Tinker, 2016). Trapping using pheromones is becoming a popular method to monitor the beetle populations (Norman *et al.*, 1999). We found that the population densities of *O. rhinoceros* that were collected by trapping

(7.37 ± 5.03) and hand picking (5.23 ± 3.52 beetles/30 days) were relatively equal (p -value = 0.0627). Fluctuation pattern of the population (Figure 5) shows that the population measurement using trapping follows that of hand picking. This indicates a dependency relationship between hand picking and attractant trapping, and it proved that the breeding sites are an infestation source of the adult beetles.

Statistical analysis showed that the correlation coefficient ($r = 0.4328$) between the hand picking to trapping indicates a moderately positive linear relationship (Ratner, 2009). The significant (p value = 0.0169) coefficient of regression (Figure 6) indicates that hand picking significantly influenced the collection of the beetles by attractant trapping. The collection of beetles using attractant traps was approximately 18.73% influenced by hand picking. In Malaysian oil palm plantations, *X. gideon beckeri* Schauf. adults feed mainly under the surface of rachides, newly emerged fronds, causing them to break. The distal portion of the frond then hangs loose and dies (Wood, 1968 *cit.* Bedford, 1975). The differences in the infestation characteristics of *X. gideon* vs *O. rhinoceros* require further investigation.

Dominance of females in the beetle population in this current study is in accordance with that of Fauzana *et al.* (2018) which reported 97 females vs 22 males using a similar pheromone trap. Although aggregate pheromones can invite both male and female beetles, there are actually more female trapped (Witjaksono *et al.*, 2015). The population of *X. gideon* was also dominated by females (58

Table 1. The statistical comparison between *Oryctes rhinoceros* and *Xylotrupes gideon* and their coexistence relationship in oil palm plantation

Existence places:	<i>O. rhinoceros</i>	<i>X. gideon</i>	p value
Decomposed trunks			
Total number of adult beetle collected (Individuals) during 30 days, 2h/day	221	82	1.1383E-10
Male number (individuals)	73	24	5.43E-06
Female number (individuals)	148	58	4.86E-09
Sex ratio (♂/♀)	0.49	0.41	~
Coefficient of regression	0.07935		0.15556
Coefficient of correlation (r)	0.11654, very weak		
Attractant traps			
Total number of beetle caught (Individuals/30 days)	157	0	
Male number (individuals)	55	0	
Female number (individuals)	102	0	
Sex ratio (♂/♀)	0.54	-	

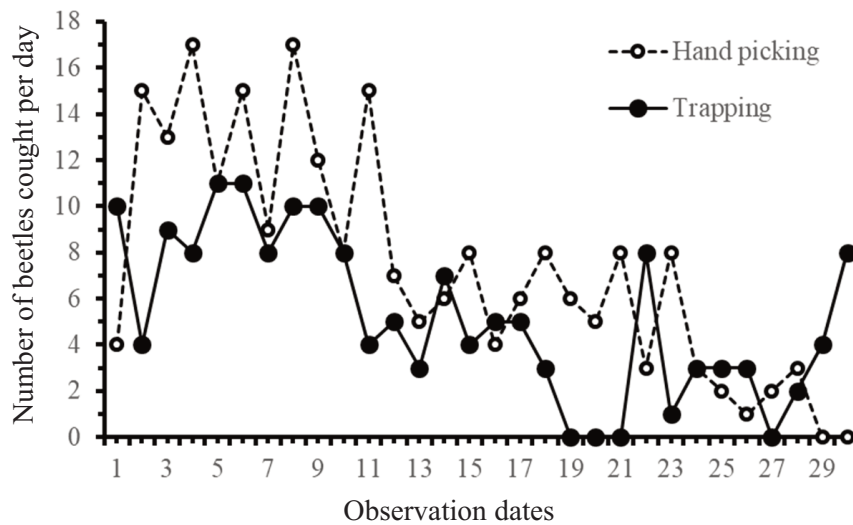


Figure 5. The fluctuation of daily collection of adult beetles by hand picking and pheromone traps

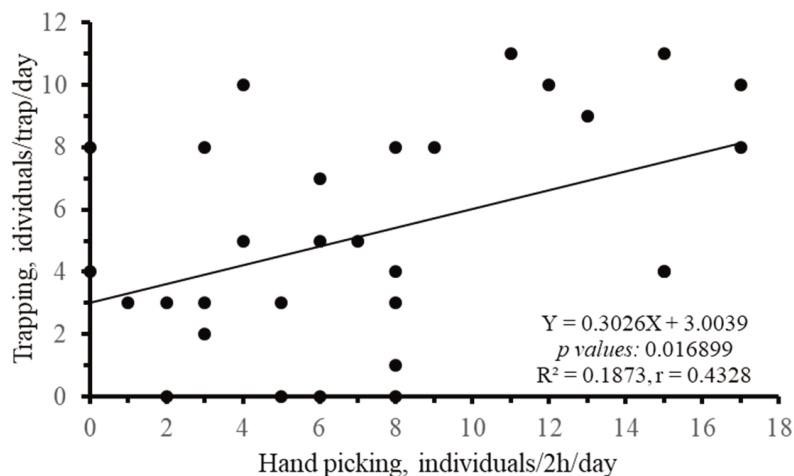


Figure 6. The influence and relationship of hand picking to attractant trapping of adult beetles

individuals) compared to males (24 individuals). Control methods such as hand picking and trapping effectively reduce the number of fertilized females, and hence, it is more effective in reducing the progeny for the following generations.

Pheromone trapping is mainly used in monitoring the beetle populations (Norman *et al.*, 1999). During 12 weeks of monitoring using aggregation pheromone traps at a coconut plantation in Jepara Regency, Indonesia, Indriyanti *et al.* (2018) found that the traps captured a total of 101 beetles that consisted of 90.1% *O. rhinoceros* and 9.9% other insect species namely *Rhynchophorus ferrugineus* and *X. gideon*. The red palm weevil, *R. ferrugineus*, is presumed to

be one of the most aggressive pests that may threaten the oil palm survival in Malaysia, however, currently there is no evidence of the oil palm trees being significantly affected (Azmi *et al.*, 2017).

This current study reveals that the two control measures, hand picking and pheromone trapping, are well integrated in the management and control of the rhinoceros beetles. Next step is to intensify the mechanical control by hand picking in a sustainable manner. Further studies should focus on the economic utilization of the rhinoceros beetles. If the rhinoceros beetle has economic value, the people will be motivated to massively, intensively and continuously collect this pest insect. The pest population will gradually

reduce and eventually be under control in a sustainable manner.

CONCLUSIONS

Males and females of *X. gideon* were found at a palm oil plantation at the study location, and coexisted with *O. rhinoceros* in the decomposing trunks. There was no evidence of *X. gideon* infestation in oil palm significantly, lead them to be categorized as an incidental pest. The integration of hand picking with pheromone trap can be a good strategy in the management of the rhinoceros beetles.

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LITERATURE CITED

- Abidin, C.M.R.Z., A.H. Ahmad, H. Salim., & N.H. Hamid. 2014. Population Dynamics of *Oryctes rhinoceros* in Decomposing Oil Palm Trunks in Areas Practising Zero Burning and Partial Burning. *Journal of Oil Palm Research* 26: 140–145.
- Azmi, W.A., C.J. Lian., H.A. Zakeri, N. Yusuf, W. B.W. Omar, Y.K. Wai, A.N. Zulkefli, & M.H. Hussain. 2017. The Red Palm Weevil, *Rhynchophorus ferrugineus*: Current Issues and Challenges in Malaysia. *Oil Palm Bulletin* 74: 17–24.
- Bedford, G.O. 1975. Observations on the Biology of *Xylotrupes gideon* (Coleoptera: Scarabaeidae: Dynastinae) in Melanesia. *Australian Journal of Entomology*, 14: 213–216.
- Bedford, G.O. 1980. Biology, Ecology, and Control of Palm Rhinoceros Beetles. *Annual Review of Entomology* 25: 309–339.
- Bedford, G.O. 2014. Advances in the Control of Rhinoceros Beetle, *Oryctes rhinoceros* on Oil Palm. *Journal of Oil Palm Research* 26: 183–194.
- Chung, G.F., S.C. Sim, & M.W. Tan. 1991. Chemical Control of RBs in the Nursery and Immature Oil Palms, p. 380–395. In *Proceeding of the 1991 PORIM International Palm Oil Congress - Agriculture Conference*. Kuala Lumpur.
- Corley, R. H.V. & P.B. Tinker. 2016. *The Oil Palm*. 5th edition. Wiley-Blackwell, West Sussex. 687 p.
- Fauzana H., A. Sutikno, & D. Salbiah. 2018. Population Fluctuations of *Oryctes rhinoceros* L. Beetle in Plant Oil Palm (*Elaeis guineensis* Jacq.) Given Mulching Oil Palm Empty Bunch. *Jurnal Cropsaver* 1: 42–47.
- Indriyanti, D.R., J.E. Lutfiana, P. Widiyaningrum, E. Susilowati, & M. Slamet. 2018. Aggregation Pheromones for Monitoring the Coconut Rhinoceros Beetle (*Oryctes rhinoceros*) in Jerukwangi Village, Jepara, Indonesia. IOP Conf. Series: *Journal of Physics: Conf. Series* 983. 012177. International Conference on Mathematics, Science and Education 2017 (ICMSE2017), Semarang, September 18–19, 2017.
- Kalshoven, L.G.E. 1981. *Pests of Crops in Indonesia*. Revised and Translated by P.A. Van Der Laan. P.T. Ichtiar Baru. Van Hoeve, Jakarta. 701 p.
- Lestari, F.F. 2018. *Development of Pheromone Trap for Rhinoceros Beetles (Oryctes rhinoceros Linn.) Pest Control on Oil Palm Plantation in Minamas Research Centre, Minamas Plantation, Riau*. <http://repository.ipb.ac.id/handle/123456789/92986>. modified 06/11/2019.
- Manjeri, G., R. Muhamad, & S.G. Tan. 2014. *Oryctes rhinoceros* Beetles, an Oil Palm Pest in Malaysia. *Annual Research & Review in Biology* 4: 3429–3439.
- Mariau, D. 2000. *Oryctes rhinoceros* Linn. in Oil Palm and Coconut Pests, p. 197–203. In J.C. Jacquemard,, S. Edayana, H. Asmady, D.D.C. Roch (eds.), *Oil Palm (Elaeis guineensis Jacq.) and Oryctes rhinoceros L. Planting Material Effect. International Palm Oil Conferences*. Nusa Dua, Bali. July 8–12, 2002.
- Norman, K. & B.M. Wahid. 2004. Immigration and Activity of *Oryctes rhinoceros* within a Small Oil Palm Replanting Area. *Journal of Oil Palm Research* 16: 64–77.
- Norman, K., B.M. Wahid, M.Z. Isa, & M. Abdullah. 1999. Population Studies of *Oryctes rhinoceros* in an Oil Palm Replant Using Pheromone Traps, p. 477–496. In *Preprints, 1999 PORIM. International Palm Oil Conferences*. Palm Oil Research Institute of Malaysia, Kuala Lumpur.
- Ratner, B. 2009. The Correlation Coefficient: Its Values Range between +1/–1, or do They? *Journal of Targeting, Measurement and Analysis for Marketing* 17: 139–142.
- Sudharto, P.S., Susanto, Z.A. Harahap, & E. Purnomo. 2000. Pengendalian Kumbang Tanduk *Oryctes rhinoceros* pada Tumpukan Tandan Kosong Kelapa Sawit. *Pertemuan Teknis Kelapa Sawit*. Medan, Oktober 2000.

- Wan, Z.W.M., M.R.C. Salmah, A.A. Hassan, & A. Ali. 2009. Composition of Various Stages of *Oryctes rhinoceros* (Linn) (Coleptera: Scarabaeidae) in Mulch of Oil Palm Empty Fruit Bunches. *Planter* 85: 215–220.
- Widyanto, H., S. Saputra, & Suryati. 2014. Pengendalian Hama Kumbang Tanduk (*Oryctes rhinoceros* Linn) Menggunakan Perangkap Feromon pada Tanaman Kelapa Sawit (*Elaeis guineensis* Jacq) di Lahan Gambut Provinsi Riau. Prosiding Seminar Nasional Pengelolaan Berkelanjutan Lahan Gambut Terdegradasi Untuk Mitigasi Emisi GRK dan Peningkatan Nilai Ekonomi. Jakarta, Indonesia, August 18-19, 2014.
- Witjaksono, A. Wijonarko, T. Harjaka, I. Harahap, & W. B. Sampurno. 2015. Tekanan *Metarhizium anisopliae* dan Feromon terhadap Populasi dan Tingkat Kerusakan oleh *Oryctes rhinoceros*. *Jurnal Perlindungan Tanaman Indonesia* 19: 73–79.