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Attack intensity and effectiveness pheromone on *Oryctes rhinoceros* L. in oil palm, Seluma district, Bengkulu

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Abstract Oil palm production continues to increase as the area of oil palm plantations increases. Seluma is one of the oil palm production centers in Bengkulu, which is located in the wet tropical region directly bordering the Indian Ocean. One of the main pests on oil palm plants is *Oryctes rhinoceros*, this pest can cause attacks on immature and mature plants. The use of ferotrap can control *O. rhinoceros* beetles. However, information regarding *O. rhinoceros* attacks oil palm has not been reported in Bengkulu. The results showed that the percentage of attacks against the beetle *O. rhinoceros* was highest in oil palm plantations in Tanjung Seluai Village was 10.53% with an attack intensity was 12.33%, then in Riak Siabun Village the percentage of attacks was 3.09% with an attack intensity was 4.67 % and on oil palm plantations at PT. Sandabi Indah Lestari had no attacks. The lowest average population of *O. rhinoceros* beetles was 4.67 individuals/ha/2 months in Tanjung Seluai Village, and 7 individuals/ha/2 months in PT. Sandabi Indah Lestari and the highest was 7.67 individuals /ha/2 months in Riak Siabun Village.

Keywords: Attack, Ferotrap, Intensity, Oil palm, Pests

Introduction

Oil palm (*Elaeis guineensis* Jacq.) is one of the plantation commodities that plays an important role in Indonesia's economic activities (Ministry of Agriculture, 2020), Hendarjanti and Nawangsari (2022). Oil palm creates extensive employment opportunities and improves community welfare. In 2020 the area of plantations will reach 14 million hectares, and oil palm production continues to increase along with the increase area of oil palm plantations, in the last 5 years (2016-2020), it growth of 8.3% (Directorate General of Plantations, 2020).

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Oil palms are attacked by pests, namely bagworms (Lepidoptera: Psychidae), *O. rhinoceros* (Coleoptera: Scarabaeidae), fireworms (Lepidoptera: Limacodidae) (Fauzi *et al*. 2012). Handayani *et al.* (2014) reported that the main pest that attacks many oil palm plants is *O. rhinoceros*. This pest has long been known in Indonesia and spreads to almost all oil palm plants. *O. rhinoceros* attacks oil palm plants from immature plants to mature plants (Apriyaldi, 2015; Pujiastuti *et al*. 2022). Lukman and Alamudin (2018) reported that the *O. rhinoceros* caused damage to the Barito Putera Plantation in South Kalimantan with damage was 56%.

Muliani *et al*. (2017) reported that *O. rhinoceros* caused attacks on immature plants was 20% and mature plants was 28.45%. Ginting *et al.* (2022) reported *O. rhinoceros* attacks can cause losses to oil palm production both directly and indirectly. Losses directly affect plant photosynthesis which will reduce fruit production. Indirect losses are in the form of delays in the production period of the plant from 3-3.5 years to 5-7 years. Handoko *et al*. (2017) explained that the *O. rhinoceros* beetle damages oil palm plants by boring and eating the tissue of young leaves and making holes in the leaf midribs and stems of the oil palm. This pest attack is characterized by the presence of V-shaped palm fronds and cracked holes in the palm fronds and this pest attack can cause young leaf fronds to break.

Luhukay *et al.* (2017) reported that *O. rhinoceros* beetles can be controlled by using light traps and pheromone traps (ferotraps). The use of pheromone traps was considered more effective because it was able to catch 36 individuals/ha of *O. rhinoceros* imago, while light traps were able to catch 6 individuals/ha of *O. rhinoceros* imago a month. Pheromone traps (Ferotrap) can attract both female and male beetles, but in general, the targets captured were female beetles (Herman *et al.,* 2012). Control techniques using pheromone traps are quite efficient and widely used to control *O. rhinoceros*. Santi and Sumaryo (2008) reported that the use of pheromone traps could trap 113-177 *O. rhinoceros* adults per hectare/month. Sahetapy *et al.* (2018) pheromone traps using the active ingredient Ethyl-4-methyl octanoate were able to attract 19-35 individuals per hectare of *O. rhinoceros* imago in one week. Seluma Regency is one of the centers of palm oil production in Bengkulu, which is located in the wet tropical region directly bordering the Indian Ocean. *O rhinoceros* also attacks oil palms in Bengkulu (Gunarwan, 2022), but information about this pest attack has not been widely reported. The research finding aimed to calculate the intensity of the *O. rhinoceros* attack and to find out the effectiveness of pheromone traps in trapping *O. rhinoceros* L. on plants oil palm in Seluma Regency, Bengkulu.

Materials and methods

Study area

The research was conducted from June to December 2023 at PT. Senabi Indah Lestari in Lunjuk Village, West Seluma District, with coordinate 4°03'12.7"S 102°29'37.0" E (33 m asl), a community garden in Riak Siabun Village, Suka Raja District, Seluma Regency 3°55'02.1"S102°20'13.9" E (5 m asl), and community garden in Tanjung Seluai Village, South Seluma District, Seluma Regency (14 m asl) 4°04'39.0"S 102°31'58.3"E.

Research design

Observations were carried out on immature oil palm plants (≤ 3 years old) using a systematic method (systematic sampling) in the form of a diagonal. Sampling was carried out in an area of 1 ha at each research location. At the research location, 5 sample points were determined per hectare with a distance of 10 plant rows between sample points. Each sample point contains 5 plants so each observation location (1 ha) contains 25 sample plants. The total plants observed at the 3 research locations were 75 oil palm plants. The plantation chosen was an oil palm plantation that has a uniform plant age. One pheromone (Ethyl-4-methyloctanoate) trap was installed for each hectare. The traps needed to observe horn beetle populations were 3 traps for each research location.

Pheromone traps

The trap was made using a 15-liter plastic bucket. The lid of the bucket has a hole for the beetles to enter. Pheromone (Ethyl-4-methyloctanoate) was hung in the middle of the bucket to attract male/female beetles. The bucket used as a trap was hung at a height of 2 meters and placed in the center of the sample point. The shape of the trap can be seen in Figure 1.

Determination of sample

The sample at each observation location was determined systematically (systematic sampling) following the research design. Sample plants were marked using paint on the stems and the development of attack symptoms was observed. Symptoms of *O. rhinoceros* beetle attacks were characterized by the presence of cut marks on the leaves that form the letter V.

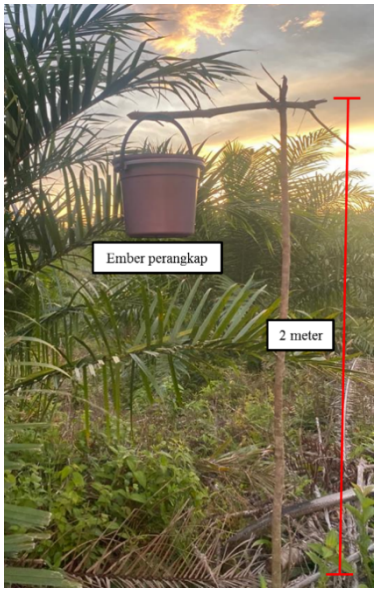

Figure 1. *O. rhinoceros* traps at the research location

Observation variables

Attack percentage was observed the percentage of attacks which carried out once a week for 2 months after trap installation. The attack percentage was calculated using the formula:

$$\text{Attack percentage} = \frac{\text{Number of plants attacked}}{\text{Total plants in 1 ha}} \times 100\%$$

Attack intensities were carried out once a week for 2 months after trap installation. The intensity of the attack was calculated using the formula (Sahetapy *et al.* 2018).

$$IS = \frac{\sum (n \times v)}{N \times V} \times 100\%$$

Information

IS : Attack Intensity
n : Number of plants on value score
v : Observed plant score value
N : Total plants observed in one area
V : Highest score value

Table 1. Oil palm damage score due to *Oryctes rhinoceros* attack

Score	Description	Criteria
0	No part of the plant was attacked	Highly resistant
1	Plant parts attacked 0-25%	Resistant
2	Plant parts attacked > 25-50%	Partially resistant
3	Plant parts attacked > 50-75%	Susceptible
4	Plant parts attacked > 75%	Highly susceptible

Population of the beetle Oryctes rhinoceros

The population of *O. rhinoceros* beetles was calculated by counting the number of beetles trapped in pheromone traps (Ferotrap). The number of beetles was counted once a week for 2 months by collecting trapped beetles and placing them in bottles containing 90% alcohol, and labeled with the date and location of observation.

Number of male and female beetles trapped

The trapped *O. rhinoceros* beetles were collected in bottles and then counted by separating the number of male and female beetles. Male beetles have longer horns than female beetles. Male beetles can be distinguished more accurately by the tip of the last abdominal segment where the female has hair. This was done to calculate the ratio of the number of male and female beetles in the field.

Number of larvae in piles of organic material

Horn beetle larvae were searched using machetes and hoes around piles of organic material located at the specified sample points (fallen trees, piles of pruned fronds, and piles of other organic material). The larvae found were then counted to determine the number at each observation location.

Data analysis

The data obtained were analyzed with ANOVA and if there were significant differences between treatments, they were further tested with DMRT at 5% level.

Results

Percentage of attacks Oryctes rhinoceros

Symptoms of *O. rhinoceros* beetle attacks can be easily seen on completely open leaves. The affected leaves were cut into V shape (Figure 2a), the newly opened (young) leaves will appear difficult to develop, and parts of the leaves begin to form V pattern due to the attack (Figure 2b). In heavy attacks, the grinding of the *O. rhinoceros* beetle can cause the fronds to break when they are completely open (Figure 2c).

Figure 2. Symptoms of attacks in the field, a. V symptoms on opened leaves, b. Symptoms of attack on newly opened leaves, and c. The front was broken due to an attack by the beetle *O. rhinoceros*

Oryctes rhinoceros beetle attacks only occurred in oil palm plantations in Tanjung Seluai Village and Riak Siabun Village, while at PT. Sandabi Indah Lestari there were no *O. rhinoceros* beetle attacks. The percentage of attacks continues to increase with each week of observation, both in Tanjung Seluai Village and in Riak Siabun Village (Table 2).

Table 2. Average percentage of *Oryctes rhinoceros* attacks (%)

Location	1	2	3	4	5	6	7	8
PT.Senabi Indah Lestari	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a
Riak Siabun	0.80a	0.80a	1.08a	1.95a	2.23a	2.49a	2.83a	3.09a
Tanjung Seluai	6.62b	6.90b	6.90b	7.18b	7.45b	8.36b	9.02b	10.53b

Description: Numbers followed by the same letter indicate the same result not significantly different at the 5% level of DMRT.

Attack intensity

The intensity of attacks that occurred in the oil palm plantations of Tanjung Seluai Village was greater than that of Riak Siabun Village, and PT. Sandabi Indah Lestari (Table 3).

Table 3. Average intensity of *Oryctes rhinoceros* attacks (%)

Location	1	2	3	4	5	6	7	8
PT. Senabi Indah Lestari	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a	0.00a
Riak Siabun	1.33a	1.33a	1.67a	3.00b	3.00b	3.33b	4.33b	4.67b
Tanjung Seluai	6.67b	8.33b	8.00b	8.00c	9.00c	8.33c	10.67c	12.33c

Description: Numbers followed by the same letter indicate the same result not significantly different at the 5% level of DMRT.

Population of the Oryctes rhinoceros

The average population of *O. rhinoceros* beetles in the three observation locations showed fluctuating data (Table 4).

Table 4. Average population of *Oryctes rhinoceros* (tail)

Location	1	2	3	4	5	6	7	8
PT. Senabi Indah Lestari	0.00a	1.67b	1.33b	0.33a	1.33b	0.67a	0.33a	1.33b
Riak Siabun	0.33a	2.33b	0.33a	0.67a	1.00b	0.67a	1.67b	0.67a
Tanjung Seluai	1.33b	0.00a	1.33b	1.00a	0.00a	1.00b	0.33a	0.00a

Description: Numbers followed by the same letter indicate the same result not significantly different at the 5% level of DMRT.

The average number of *O. rhinoceros* beetles trapped during 8 weeks of observation in Riak Siabun Village was 7.67 individuals/ha/2 months, in the plantation of PT. Sandabi Indah Lestari was 7 individuals/ha/2 months and the lowest population occurred in Tanjung Seluai Village at 5 individuals/ha/2 months (Table 5).

Table 5. Number of trapped male and female *O. rhinoceros* (tail/ha/2 months)

Location	**Male**	**Female**	**Total**	**Average/ha**
PT. Senabi Indah Lestari	3	18	21	7.00
Riak Siabun	8	15	23	7.67
Tanjung Seluai	0	14	14	4.67

More female *O. rhinoceros* beetles were trapped than males. In Table 5 it can be seen at PT. Sandabi Indah Lestari the number of male and female beetles trapped was 3:18, in Riak Siabun Village 8:15, and Tanjung Seluai Village 0:14**.**

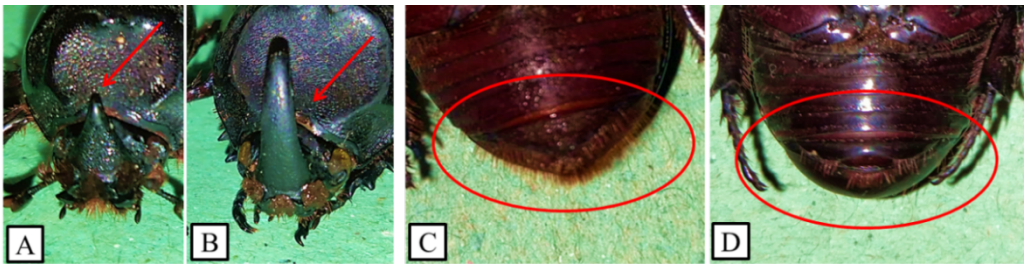

Figure 3. Male and female *Oryctes rhinoceros* beetles. A: female imago horns, B: male imago horns, C: female imago pygidium, and D: male imago pygidium.

Male and female *O. rhinoceros* beetles were quite easy to recognize morphologically. Male adults have longer horns than females, then at the tip of the abdomen (pygidium), the female has dense red-brown fur, while the male's pygidium has less (almost none) (Figure 3).

Number of larvae O. rhinoceros

There were 34 larvae of *O. rhinoceros* found in the field, and one of them looked sick (Figure 4). The cause of the sick larvae was unknown, but the larvae were dead when found. In the three locations observed, *O. rhinoceros* beetle larvae were only found in the gardens of Riak Siabun Village, Sukaraja. In the other two locations, no *O. rhinoceros* beetle larvae were found, this was thought to be because the plants were still young, and these locations had just planted oil palm.

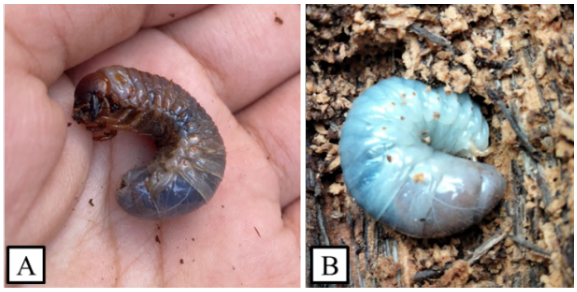

Figure 4. *Oryctes rhinoceros* larvae in the field. A: sick larvae and B: healthy/normal larvae

Discussion

The *O. rhinoceros* beetle bores (punches) the midrib to eat the leaves which were still soft, so that when the leaf fully opens will see cut marks that form the letter V. Lukman and Alamudin (2018) also explain that heavy attacks from the *O. rhinoceros* beetle can cause damage to the midrib become hollow and broken because the *O. rhinoceros* beetle attacks the coconut leaves. When it was a leaf and the frond was still soft, the *O. rhinoceros* beetle could easily eat the frond. According to (Muliani *et al*., 2017) damage to the leaves that form the letter V was caused by the *O. rhinoceros* beetle attacking. The percentage of attacks by *O. rhinoceros* beetles in Tanjung Seluai Village was 10.53% in the 8th week of observation, and the percentage of attacks was the highest compared to other locations. The percentage of attacks that occurred in Riak Siabun Village was 3.09% in the 8th week of observation and showed a lower percentage of attacks. In the oil palm plantation of PT. Sandabi Indah Lestari has no attacks *O. rhinoceros*. According to Lukman and Alamudin (2018), the threshold for the percentage of infected trees in a unit area of oil palm plantations was 5%. Therefore, the percentage of attacks that occurred in Tanjung Seluai Village has exceeded the attack threshold and needs to be controlled immediately.

The *O. rhinoceros* beetle attacks can be seen as the highest percentage of attacks occurring in community gardens located in Tanjung Seluai Village, South Seluma. The percentage of attacks was 6.62% and continued to increase until 10.53% at the end of the observation. In the community garden in Riak Siabun Village, the percentage of attacks that occurred was 0.80%, and at the end of the observation, it was only 3.09%. Oil palm plantation at PT. Sandabi Indah Lestari had no *O. rhinoceros* beetle attacks (0%).

The percentage of attacks in Tanjung Seluai Village was higher compared to the other two locations, and the percentage of attacks in the oil palm plantation of Riak Siabun Village was lower and at PT. Sandabi Indah Lestari had no attacks because there were many sources of organic material for *O. rhinoceros* beetles to breed around the oil palm plantations of the people of Tanjung Seluai Village. Around the oil palm plantation area, there were other commodities such as coconut, corn, rice, cassava, sugar cane, and vegetables. The land used to plant horticultural crops also uses manure which was applied before planting. Manure was an organic substrate that became a place for female *O. rhinoceros* beetles to lay their eggs. Fauzana and Ustadi (2020) reported that *O. rhinoceros* beetles generally lay eggs on oil palm stems that have begun to decompose. However, *O. rhinoceros* larvae can also live on other organic substrates that have begun to decompose, because *O. rhinoceros* larvae can eat and live on organic substrates that have decomposed (rotted). The availability of organic materials around oil

palm plantations such as manure and piled crop residues was thought to be a breeding ground for *O. rhinoceros* beetles and attacks surrounding oil palm plants. This was the cause of the percentage of *O. rhinoceros* beetle attacks in the coconut gardens of the people of Tanjung Seluai and Riak Siabun Villages.

The intensity of the attacks that occurred was relatively low and included light damage (<25%). In the oil palm plantations of PT Indah Sandabi Lestari, there was no intensity of attacks because in these plantations there were no *O. rhinoceros* beetle attacks. The increasing intensity of attacks in Riak Siabun Village and Tanjung Seluai Village was thought caused by *O. rhinoceros* beetles hiding in oil palm trees when it rains. Cumber (1957) explained that during high rainfall the beetle *O. rhinoceros* hides on the top of coconut plants or bushes that cover the land. Because the *O. rhinoceros* beetle was on the coconut tree when it rains, the feeding activity of this insect causes new attack symptoms when the oil palm leaves begin to fully open.

The intensity of attacks in the oil palm plantations of Tanjung Seluai Village in the first week of observation after trap installation was 6.67% and continued to rise until the 8th week to 12.33%. The oil palm plantations in Riak Siabun Village were lower, the attack intensity was 1.33%, and at the end of the observation it rose to 4.67%. The oil palm plantation owned by PT. Sandabi Indah Lestari had no attacks by *O. rhinoceros* beetles, either before trap installation or after trap installation.

The intensity of attacks on oil palm plantations in Riak Siabun and Tanjung Seluai Villages was still included in the light attack category because the intensity of attacks that occurred was ≤ 25%, while at PT. Sandabi Indah Lestari not experience any *O. rhinoceros* beetle attacks. This was influenced by the maintenance techniques in the cultivation practices carried out. The oil palm plantation owned by PT. Sandabi Indah Lestari was known to apply empty bunches as organic fertilizer. Only one layer of empty fruit bunches was applied to oil palms to prevent *O. rhinoceros* beetles from laying eggs. Handoko *et al.* (2017) explained that the application of empty fruit bunches with more than one layer was the preferred place *for O. rhinoceros* beetles to lay eggs, because the food source, humidity, and temperature were very suitable for the development of larvae. Therefore, even though PT. Sandabi Indah Lestari applied empty bunches, there was no damage caused by *O. rhinoceros*. The high intensity of attacks that occur in community gardens was thought to be because around community oil palm plantations there were many sources of organic material for laying eggs and hiding places, so the *O. rhinoceros* beetle can cause great damage to farmers' oil palm plants.

O. rhinoceros beetles trapped in PT Sandabi Indah Lestari and Riak Siabun Village fluctuated from the first week of observation to the 8th week,

while the number of *O. rhinoceros* beetles trapped in Tanjung Village always decreased from the first week to the last week of observation. The fluctuating population of *O. rhinoceros* beetles was thought to be caused by weekly rainfall (PT Sandabi Indah Lestari: high, Riak Siabun Village: normal, Tanjung Seluai Village: moderate) and the different number of rainy days in each week of observation at the locations observed. When it rains, *O. rhinoceros* beetles will hide in oil palm trees or coconut trees around oil palm plantations and in cover crop plants, so that they not enter the trap and cause the number of *O. rhinoceros* beetles trapped to decrease. A little. This causes the activity of the *O. rhinoceros* beetle to be limited and the beetle will stay in that place after the rain stops. Pujiastuti *et al*. (2010) also explained that during high rainfall the number of trapped beetles tends to be less because *O. rhinoceros* beetles will hide in remaining organic material, on trees or in bushes around the garden. This causes fluctuations in the number of trapped *O. rhinoceros* beetles.

Populations of *O. rhinoceros* beetles counted in oil palm plantations in Riak Siabun Village and PT. Sandabi Indah Lestari was quite high, but the percentage of attacks and intensity of damage in these two locations was the lowest. The fluctuating number of trapped *O. rhinoceros* beetles, apart from being caused by rainfall and the number of rainy days was thought to also come from the area around the observation location. This causes attacks on plants to be low but the population trapped was high. Sahetapy *et al.* (2018) stated that the pheromone Ethyl-4-methyl octanoate has a range of 2 ha. The recommendation for using one Ethyl-4-methyloctanoate pheromone was for a garden area of 2 ha so that the population counted in the traps also attracts *O. rhinoceros* beetles located around the observation location.

Widyanto *et al.* (2014) stated that the pheromone Ethyl-4-methyloctanoate, an aggregation pheromone, has an efficacy of 95% in capturing both male and female *O. rhinoceros* beetles. Sahetapy *et al*. (2018) reported that the pheromone Ethyl-4-methyl octanoate was able to trap 9 *O. rhinoceros* beetles/ha/2 months. Luhukay *et al.* (2017) stated that in high population densities of *O. rhinoceros*, the pheromone Ethyl-4-methyl octanoate was able to trap 36 *O. rhinoceros* beetles/ha/2 months. The high or low number of trapped *O. rhinoceros* beetles was influenced by the population density of *O. rhinoceros* beetles in a plantation area. The low population of *O. rhinoceros* beetles trapped at the three observation locations was influenced by the low population density in the field and was related to the low percentage of attacks and intensity of attacks that occurred in oil palm plantations.

Rainfall that occurs in the field does not affect the performance of the installed pheromone; rainfall only causes the number of trapped *O. rhinoceros* beetles to decrease because the beetles will take shelter in a safe place. Prok *et*

al. (2019), stated that the pheromone Ethyl-4-methyloctanoate can be used effectively for a period of 3 months in the field. Alouw (2007) also explained that the effectiveness of the pheromone Ethyl-4-methyloctanoate was influenced by the sensitivity of the insect, the amount and chemical produced (depending on concentration), the evaporation power of the chemical, and the speed and direction of the wind.

More female *O. rhinoceros* beetles were trapped than males. In Table 6 it can be seen that at PT. Sandabi Indah Lestari the number of male and female beetles trapped was 3:18, in Riak Siabun Village 8:15, and in Tanjung Seluai Village 0:14. The research results of Luhukay *et al.* (2017) also obtained a sex ratio of trapped *O. rhinoceros* beetles of 27 females and 9 males. Hadi *et al*. (2009) explained that generally, the insect sex ratio was 1:1. However, due to the use of sex pheromones there can be changes in the number of males and females trapped. The use of pheromone traps for *O. rhinoceros* beetles can attract 69-79% of females and 21-31% of males. Morin *et al*. (1996) explained that Ethyl-4-methyl octanoate was a compound released by the male beetle *O. rhinoceros.* Therefore, the use of this pheromone causes more female *O. rhinoceros* beetles to be trapped.

Male and female *O. rhinoceros* beetles were quite easy to recognize morphologically. Male adults have longer horns than females, then at the tip of the abdomen (pygidium), the female has dense red-brown fur, while the male's pygidium has less (almost none). Luhukay *et al.* (2017) explained that male and female adults of the *O. rhinoceros* beetle both have horns, but the male insect's horns are longer than those of the female. The male pygidium has no fine hairs, while the female has dense red-brown feathers.

The high number of trapped female *O. rhinoceros* beetles can affect the number of births in the next cycle. A reduced number of females in the field can disrupt the copulation (mating) process so that the birth rate or emergence of new insects will decrease. Hadi *et al.* (2009) explained that changes in the proportion of female insects in the field can cause changes in the birth rate of new insects, so installing pheromone traps can gradually reduce the population of *O. rhinoceros* beetles. *O. rhinoceros* larvae were taken from a pile of pruned oil palm fronds. The female *O. rhinoceros* beetle lays eggs in a collection of decomposed organic material as a food source for the larvae. *O. rhinoceros* larvae obtain nutrition from decomposed organic material. Moore (2015) explained that female *O. rhinoceros* beetles will lay eggs in chopped stems or palm fronds that have been decomposed. This was done because *O. rhinoceros* larvae only eat organic material that has been decomposed (rotted).

The number of sick *O. rhinoceros* larvae found at the research location was 2.94% and the number of healthy larvae was 97.06%. The cause of *O.*

rhinoceros larvae sick (dead) was not yet known, but it was thought to be due to an environment that was not suitable for their development. Siahaan (2014) stated that the optimum environmental conditions to support the development of *O. rhinoceros* larvae were humidity of 85-95% and temperature of 27-29°C. If the environmental conditions were too dry and the temperature was too hot or cold, the growth of the larvae can be hampered, and the larvae can die. In conclusion, the percentage of pest attacks and the intensity of attacks by *O. rhinoceros* beetles in oil palm plantations in Tanjung Seluai Village and Riak Siabun Village continues to increase, the highest percentage of attacks was 10.53% and the attack intensity was 12.33%, while PT. Sandabi Indah Lestari, not attack *O. rhinoceros* beetle. The intensity of the attacks that occurred was relatively low and included light damage (<25%).

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