Simple method for mass-trapping of *Chalcosoma atlas* (Coleoptera: Scarabaeidae) in oil palm plantation

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Abstract. Atlas beetle is identified as one of minor pest in oil palm plantation. It feeds on oil palm fronds and some cases on the fruits. The beetle mass trapping has been conducted at an immature oil palm plantation in the peatland area located in Indragiri Hulu Region, Riau Province, Indonesia. In a total 2,963.89 ha area, the 10 dm³ dimension trap installed in the block boundaries every 100 m. The trap developed by 100 g of pineapple pieces which placed into a hanging container. The result showed from daily observation for 6 mo (June-Nov 2017), the trap caught 650,691 individuals. The highest catch number in the July-September period with total 39.96 individu/trap/day then decreased until the end of November with a total of 6.30 individu/trap/day. The result showed that the sex ratio trapped beetle is 1:1. The damage rate of atlas beetle decreased from 23.08% to 10.14% during trap application.

1. Introduction

The beetles are the most significant order of animal in the world. There are approximately 10 times more species of beetles than of vertebrates. The diversity in their life history is just as broad. There are carnivores, herbivores, carrion feeders, aquatic dwellers, desert dwellers, fossorial species, and arboreal species [1]. Genus Chalcosoma is the most prominent species of beetle in the family Scarabaeidae, subfamily of Dinastinae, and subtribe of Chalcosomina [2, 3]. Genus Chalcosoma characterized by the presence of pronotum with 1 pair of dorsolateral horns and basomedial horn directed horizontally over the base of the cephalic horn [4, 5].

The 2 species from genus Chalcosoma (*Chalcosoma caucanus* and *C. atlas*) are widely distributed in tropical Asia and Australia region confirmed by morphological and molecular character [4, 6]. *C. caucanus* distributed from Java to East Thailand and seen in the medium elevation forests (mainly 800-1,500 m asl) [2]. *C. atlas* is on average smaller (by some 16% in body length in overall location mean) than *C. caucanus*. It is found in the low to medium-elevation forests (mainly 0-1,200 m a.s.l.) throughout Southeast Asia except for Java [7]. The Chalcosoma beetle has been reported cause damage in various estate commodities, i.e., a forest plantation, rattan, and some Palmaceae [8, 9].

The rapid growth of oil palm in Indonesia approximately up to more than 16 million ha has resulted in the emergence of pest attacks, including *C. atlas*. Moreover, the plantation area is bordered by forest areas or peat areas that have the potential to provide a variety of organic materials as a breeding site for the beetle [1]. *C. atlas* larvae characterized by the hairless body, there are 3 pairs of legs that
develop, bodies can expand and are large (> 4 cm) consuming decaying plant material [8, 10]. Nonetheless, C. atlas includes minor pests in oil palm plants [11, 12].

Beetles bore or cut the stems, bud and flower stalks of rattan plants. The existing stem borer also occurs due to the secondary symptom of rat or squirrel pests [13]. Some researchers have reported stadia larvae that attack rattan plants [14] and stem of various palm plants [15], although oil palm plants have not been reported in these pest stages.

The control is often done by using insecticides as done in the palm [9]. The control with this system requires a high financial cost and applications that depend on the season. Pineapple utilization (Ananas comosus) is often reported to attract beetles nowadays. However, studies of beetle catch and the impact on the level of damage to oil palm plantations have not been published. This paper is a case study of the mass trapping of C. atlas in peatland oil palm plantations using pineapple traps.

2. Methods

2.1. Estate condition

These oil palm plantations are in Indragiri Hulu, Riau which is a type of Hemik peatlands with a depth of 1-3 m. The application of pineapple traps was carried out in 4 divisions in the oil palm plantation with a total area of 2,963.89 ha including Division II (750.89 ha), Division III (714.30 ha), Division IV (758.60 ha), and Division V (940.10 ha). Several locations around the site of mass trapping is an area of replanting conducted in July 2015 until December 2017. The method of replanting is a compacting system with old palm trees or stumps buried, and the soil is compacted by heavy equipment up to the surface of the flat area.

2.2. Pineapple traps

One pineapple was cut into pieces then a total of 100-200 g pieces was put into a perforated bottle. The bottle which contains pieces of pineapple is placed in a trap made from a container by placing 2 pieces of aluminum inserted (Fig. 1). Pineapple traps are hung on a pole with a height of about 2.5 m. The pieces of pineapple were replaced once a week.

![Figure 1. Container filled with fresh pineapple (left) and the installation designed for atlas beetle mass trapping (right).](image)

The traps were installed at each edge of the block with a distance of about 100-200 m. This is conducted so the beetle pest in the middle of the block can be pulled out of the block, and the beetle pest that is outside the block (other blocks or other estates) cannot enter the block to facilitate observation because it is located at the side of the road. The layout of the trap installation is shown in Figure 2 located in Division II, III, IV, and V, oil palm plantations in Indragiri Hulu, Riau.
2.3. Observation of beetle catches
The period of installation and observation is continuously carried out every day, starting from June 1 to November 30, 2017. Observations that made include the types of insects that enter the trap, the number and sex of insects.

![Figure 2](image.png)

**Figure 2.** The layout of pineapple traps on the side of Division II, III, IV, and V block of oil palm plantation in Indragiri Hulu (circled in blue).

2.4. Observation of attack intensity of Chalcosoma atlas
The attack intensity of *C. atlas* beetle was carried out before and after mass trapping. The visible attack of the *C. atlas* beetle is symptoms of damage that caused the fracture of the young frond, in the middle part of the frond (Fig. 3). At the base of the frond, there were no symptoms of damage which indicate that the beetle was not found eating the growing point of oil palm plants. The plant produces in the other block also seen the damage symptom of ripe palm fruit bunches. Determination of the intensity of attacks using the scoring method, namely:

- Score 0 : Healthy plant
- Score 1 : 1-2 frond truncated / damaged
- Score 2 : 3-4 frond truncated / damaged
- Score 3 : 5-6 frond truncated / damaged
- Score 4 : > 7 frond truncated / damaged

The attack intensity of *C. atlas* is calculated based on the formula:

\[
AI = \frac{\sum(n \times v)}{N \times V} \times 100\%
\]
\( \text{AI} = \text{Attack intensity of } C. \text{ atlas} \)
\( n = \text{The number of plants at each score of damage/attack levels} \)
\( v = \text{Score of the damage levels} \)
\( N = \text{Total number of plants observed} \)
\( V = \text{Value score of the level of damage/highest attack} \)

**Figure 3.** *C. atlas* beetle attack symptoms on the leaves of palm fronds (top pictures) and a ripe palm fruit bunches (bottom pictures).

3. **Results and discussion**

The replanting program increases the population of *C. atlas*. Pest attacks in the field seem to increase. For more than 1 yr, larval population growth is thought to increase due to a large number of new organic material sources for the breeding of *C. atlas*. At the beginning (1-11 June 2017), pineapple traps were installed in Division II by 95 fruit traps and then increased in Division III and IV to a total of 238 fruit traps. The replanting area expansion was carried out so that the number of fruit traps was increased to 375 fruit traps by installing up to Division V starting on Oct 21, 2017.

3.1. **The catch of the *C. atlas* beetle**

In general, there are various insects found in the pineapple traps most were *C. atlas*, earwig, various insects of Dipteran and Hymenopteran. The type of insect that acts as oil palm pest is only the *C. atlas* beetle. The source of *C. atlas* beetle comes from local estates and tertiary forest areas outside the estates. A study showed that in general, the abundance value of *C. atlas* in the area around the coast is quite significant as much as 2 individuals/m\(^2\) [16].

The result of atlas beetle caught can be seen in Fig. 4. In early July 2017, the number of *C. atlas* beetle caught increased significantly, and the peak occurred during the period of mid-July to early September 2017. This was related to the increasing population of *C. atlas* in the field. The number of caught of *C. atlas* beetle then tends to decrease until the end of October 2017 observations. It means that the effort of mass-trapping using pineapple was quite effective in reducing the beetle population.
in the field while breaking the life cycle of pests. During the 6 mo installation period, about 650,691 beetles were caught with an average catch of 1.79 - 39.96 beetles/traps/day.

![Graph showing the number of C. atlas beetle catches in pineapple traps every day for 6 mo.](image)

**Figure 4.** The number of *C. atlas* beetle catches in pineapple traps every day for 6 mo.

The sex ratio of *C. atlas* was 116:112 or 1:1. It means that the population of male and female beetles is quite balanced. The male beetles have horns on the head and thorax, whereas female beetles do not [5, 17]. The observation results of *C. atlas* found that male beetles have short horns (minor) and longhorns (major) (Fig. 5). The longer the body size, the more long-sized horns [2]. Morphological dimorphism and horn size are thought to be related to differences in behavior between minor and major male beetles although it is still little understood as mating strategies such as locating and securing female beetles in most species of horn beetles [2, 18]. Besides being useful for mating the female of *C. atlas*, the male beetle horn also functions to fight the enemy and defend its territorial [19].

![Images of C. atlas beetles: (a) female, (b) minor males (short horns), and (c) major males (long horns).](image)

**Figure 5.** (a) *C. atlas* female, (b) minor males (short horns), and (c) major males (long horns).

Generally, all Scarabaeidae larvae eat the remains of decaying plants, while adult will eat fruit, leaves or plant exudates. Beetles live on branches or frond or any surface above the ground at a temperature of 23-26 °C. The study at the screen house proves that the beetle can live and breed in small spaces measuring 30x15x20 cm³ which contains a mixture of manure and rotting hardwood
(moist). Metamorphosis can occur after 4 mo to 3 yr with a beetle phase life span of 3-6 mo [1].

3.2. The attractiveness of pineapple traps to the C. atlas
The sugar which contained in pineapple is glucose 2.32%, fructose 1.42%, and sucrose 7.89%. The acids contained in pineapple are citric acid, malic acid, and oxalic acid. The most dominant type of acid is citric acid. It is 78% of the total acid [20]. This sugar content is thought to be a food attractant for C. atlas, or maybe other compounds that need further research. Various fruits have also been used as a method to trap various kinds of butterflies because the alcohol content of fermented fruit compounds is often even added with sugar [21].

From the analysis of the number of catches of C. atlas in pineapple traps that replaced every 7 d for 6 mo, the average number of catches of beetles per fruit trap can be seen in Fig. 6. The number of catches of C. atlas increased significantly on the 2nd day after installation and then tended to decrease until the 7th day. It is related to the level of freshness of the fruit. On the 7th day, the pineapple slices had dried.

![Figure 6. The average total of Chalcosoma atlas beetle catches per trap fruit in every period installation of pineapple for 7 d.](image)

3.3. Decreased intensity of C. atlas attacks
Trapping beetles are quite effective in breaking the life cycle of C. atlas. It can be seen through the decreased intensity of pest attacks from 23.08% to 10.14% within 6 mo. The decreased intensity of attack is likely to be even higher if an increase in the number of fruit traps is carried out and the fruit trapping period is continued until the pest population is below the economic threshold. It is calculated mathematically with a total of 357 pineapple traps in an area of 2,963.89 ha, then 1 trap is estimated for an area of 8.53 ha. This amount was still less than the use of pheromone traps to control O. rhinoceros pests in the field, which is 1 ferotrap/2 ha [22]. In several locations, O. rhinoceros attack was also found, so an application of the combination of pineapple and pheromone ethyl 4 methyl octanoate is needed to control both C. atlas and O. rhinoceros as well.

4. Conclusion
Pineapple traps are quite effective in attracting male and female C. atlas. The application of 238-375 traps in an area of 2,963.89 ha for 6 mo was able to catch C. atlas as much as 650,691 beetles with an average catch of 1.79 - 39.96 beetles/traps/day. The number of catches of C. atlas tended to decrease and correlated with the decrease intensity of pest attacks from 23.08% to 10.14% within 6 mo. This mass trapping needs to be continued by increasing the number of pineapple traps to 1 trap/ 2 ha.
References

[1] Mason T and Cobaugh A M 2013 *Zookeeping: An Introduction to the Science and Technology* ed M D Irwin, J B Stoner and A M Cobaugh (London: The University of Chicago Press, Ltd.) pp 362-374

[2] Kawano K 2002 *Am. Nat.* 159 255–71

[3] Gupta D Studies on Rhinoceros Beetles (Coleoptera—Scarabaeidae—Dynastinae) from Madhya Pradesh, central India *Colemania* 34 pp 1-9

[4] Rowland J M and Miller K B 2012 *Insecta mundi* 0263 1–15

[5] Ichishii W, Shimada S, Motobayashi T and Abe H 2019 *Zokeys* 2019 89–110

[6] Bousquet Y and Bouchard P 2017 *Bull. Zool. Nomencl.* 74 17

[7] Kohiyama K 2014 *Rhinoceros Beetles: Micro Presence* (Japan: Shuppan-Gejutsu-sha Co., Inc.)

[8] Kalshoven, Louis George Edmund and Laan, P. A. van der and Rothschild G H L 1981 *Pests of crops in Indonesia* (Jakarta: P. T. Ichtia Baru, Van Hoeve)

[9] Winotai A 2014 *Cord* 30 18–36

[10] Harianto B 2009 *Kajian macam spesies uret dan musuh alaminya pada tanaman stroberi di desa Kalisoro Tawangmangu Karanganyar* (UNS (Sebelas Maret University))

[11] Bedford G O 1980 *Annu. Rev. Entomol.* 25 309–39

[12] Susanto A, Prasetyo A E, Priwiratama H, Rozziansha T A P, Simanjuntak D, Sudharto, Chenon R D de, Sipayung A and Purba R Y 2015 *Kunci Sukses Pengendalian Hama dan Penyakit Kelapa Sawit* (Medan: Pusat Penelitian Kelapa Sawit)

[13] Chung A Y C 1995 Insect Pests of Rattans in Sabah *Plant.* 71 55–6

[14] Dransfield J and Manokaran N 1993 *Plant Resources of South-East Asia, No 6: Rattans* (Wageningen: Pudoc Scientific Publishers)

[15] Marshall G A 1916 *Review of Applied Entomology* (London: Imperial Bureau of Entomology)

[16] Yulianti S 2017 *Keanekaragaman Dan Kelimpahan Coleoptera Di Pantai Sindangkerta Cipatujah Kabupaten Tasikmalaya* (Bandung: University of Pasundan)

[17] Kaltenbach C, Kaltenbach C, Kaltenbach and C 2018 *Insecte: interdisciplinary engagements in an emergent entomological design practice* (Australia: RMIT University)

[18] McCullough E L, Ledger K J, O’Brien D M and Emlen D J 2015 *Anim. Behav.* 109 133–40

[19] Oberbillig D R 2009 *Res. View, Innov. Scholarsh. Univ. Mont.* 11 1–2

[20] Irfandi 2005 *Karacterisasi Morfologi Lima Populasi Nanas* (Ananas Comosus (L.) Merr.) (Bogor: IPB University)

[21] Purwanto A, Harsanto F A, Marchant N C, Houlihan P R, Ross K, Tremlett C and Harrison M E 2015 *Good Practice Guidelines: Butterfly Canopy Trapping* (Palangkaraya: Orangutan Tropical Peatland Project)

[22] Susanto A, Prasetyo A E, Sudharto, Priwiratama H and Rozziansha T A P 2012 *Pengendalian Terpadu Oryctes rhinoceros di Perkebunan Kelapa Sawit* (Medan: Pusat Penelitian Kelapa Sawit)