The potential of *Myopopone castanea* (Hymenoptera: Formicidae) as a predator for *Oryctes rhinoceros* Linn. larvae (Coleoptera: Scarabaeidae)

To cite this article: Widihastuty et al 2018 J. Phys.: Conf. Ser. 1116 052074
The potential of *Myopopone castanea* (Hymenoptera: Formicidae) as a predator for *Oryctes rhinoceros* Linn. larvae (Coleoptera: Scarabaeidae)

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Abstract. *Myopopone castanea* (Hymenoptera: Formicidae) is predators for larvae horn beetle *Oryctes rhinoceros* (Coleoptera: Scarabaeidae) which is pest on oil palm plantations. These ants able to prey on all stadia of larvae *O. rhinoceros*. This study was conducted to determine the potential of *M. castanea* ants in prey on *O. rhinoceros* larvae. This research have been done from April 2017 to January 2018 in Plant Pests Laboratory of Agriculture Faculty Universitas Sumatera Utara Medan, PTPN IV Adolina Oil Palm Plantation-Perbaungan and public-owned in Binjai Area. The research done in the laboratory was using a completely randomized non-factorial design with five replications whereas the application on the field, predation test had been done at ten points that are distributed in the location. The result test predation in the laboratory showed that 100% mortality of 1³ and 2³ instar larvae of *O. rhinoceros* by *M. castanea* achieved on the five day while the 3³ instar larvae prey reached mortality on the seven day after application. The predation on the field for the young plants (immature plant) in PTPN IV Adolina showed that *M. castanea* can preying $X = 2.8$ individuals larvae (46.87%) in a four day exposure and for productive plants (plants aged between 15-20 years) at Binjai area, *M. castanea* can preying $X = 3.0$ individuals larvae (50.3%). The results showed that *M. castanea* have great opportunities to developed as agents to control *O. rhinoceros* pests.

1. Introduction
Palm oil plantation is considered as the prime plantations in Indonesia. According to the data reported from Directorate General of Estate Crops Indonesia, the oil palm plantation in 2016 covered 11.9 million hectares of land with 33.2 million tonnes of total production [6]. Horn beetle *Oryctes rhinoceros* Linn (Coleoptera: Scarabaeidae) is one of pest in oil palm plant. The pest usually attacks young plants...
(immature plant = IM). The offence can reduce the production of fresh fruit bunches (FFB) by up to 60% in the first year. Moreover, it causes death to young plants by 25% [4].

Many techniques have been applied to controlled population of *O. rhinoceros* such as usage of pheromone, handpicking and use insecticides. Usage of pheromone is excellent to calculate and reduce the population. However, the cost of such control is expensive. While the application of carbofuran and cypermethrin insecticide is demanding towards palm oil plants aged over one year, and they have a negative impact on the environment as well. Therefore, the control of *O. rhinoceros* is being focused on preventive technique that is controlling pra-adult phase in anyways by removing and minimizing breeding site, handpicking larvae and pupa, using natural enemies of *O. rhinoceros* and also taking beetles out of the holes [5], [16].

Ants have been known as predator and have been widely used as biological agents for plant pest control, such as weaver ant (*Oecophylla smaragdina*) can prey on caterpillars (*Setora nitens*) with 83% high predation rate [8], *Dolichoderus thoracicus*, is able of suppressing *Helopeltis* sp. attacks on cocoa plantations in Sulawesi [1]. In general, ants and crickets are often found attacking caterpillar pests in oil palm plantation in Indonesia [13], [17]. [12] found that *Myopopone Castanea* ant (Hymenoptera: Formicidae) is predator to *O. rhinoceros* larvae. These ants are able to prey on all stadia of *O. rhinoceros* larvae. The ants are known as obligate predators to arthropods. *M. castaneae* ant attacks its prey alive by biting and stinging it to death then eating its hemolymph liquid. The initial symptoms that were indicated on the larvae of *O. rhinoceros* were the larval cuticle which turns into brownish and gradually darkened. The body of the larvae will be blackened and damaged due to the bite and sting of *M. castaneae* ants so that remaining only the cuticle part. This ant is also able to eat the first instar larvae of *O. rhinoceros* until it runs out [11].

There is only a little information available about the predator ants. Therefore this research is conducted to learn the potential of *M. castanea* as agents to controlled population of *O. rhinoceros* in oil palm so that more environmental-friendly control measures and supporting sustainable management of oil palm plantations.

2. Materials and Methodology
The study was conducted from April 2017 to January 2018 in Plant Pests Laboratory of Agriculture Faculty USU Medan, PTPN IV Adolina Oil Palm Plantation-Perbaungan, Serdang Berdagai Regency - North Sumatra Province and public-owned palm oil plantation in Tanah Merah District, South Binjai Regency - Binjai City, North Sumatra Province.

2.1. Insects Test Collected
The study was started by collecting predator *M. castanea* ants from decaying palm oil tree trunks in Tanah Merah District, South Binjai Regency - Binjai City. *M. castanea* ants obtained were kept in Plant Pests Laboratory of Agriculture Faculty, Universitas Sumatera Utara. The colony is maintained in a 70x30x30 cm glass box. There are two decaying palm oil trunks in the size of 20x20x3 cm and a symmetrical place for the colony to build the nest. There is a small hole (2x3x1 cm) in the middle of the trunks where *O. rhinoceros* larvae were put. Every day, the log was sprayed with water to maintain the humidity in the nest. Prey is given according to the predation needs of the ants. The new batch of larvae is delivered immediately when the existing one is drying and dying.
2.2 Laboratory Predation Test
The predation test of \textit{M. castanea} ants in the laboratory was conducted by using a completely randomized design with five replications. The testing was done in a 40x20x20 cm glass box. There were two logs of palm oil decaying trunks put into with the size of 15x15x4 cm in each of the box. They are made symmetrical with the mid-part dredged to put \textit{O. rhinoceros} larvae. In each box of glass inserted 50 worker ants \textit{M. castanea} and 20 ants larvae which have been starved for 24 hours. Five boxes were given six individuals first-instar larvae prey \textit{O. rhinoceros}, the next five boxes provided six individuals second-instar larvae prey \textit{O. rhinoceros} and the last five boxes provided six individuals third-instar larvae. The observation was done each day by calculating the number of dead prey larvae.

2.3 Field Predation Test
The predation test on the field was done in PTPN IV Adolina palm oil plantation at Perbaungan District, Serdang Bedagai Regency, North Sumatra Province. The palm oil plants in the farm are around one year old (Immature Plant 1) while the test conducted in Binjai Area was carried out to the public-owned plantation which is 15 - 20 years old (Productive Plant). The predation test on the field was performed by putting palm oil decaying log trees in the size of 85x30x5cm in a symmetrical shape. The mid-part was dredged to put \textit{O. rhinoceros} larvae. The log was set systematically at ten observation points in the plantation, with a 70m distance between each point. Fifty individuals \textit{M. castanea} worker ants, twenty brood larvae were placed inside the log together with six individuals 2nd instar larvae of \textit{O. rhinoceros} as prey. Then the trunk was wrapped using gauze to prevent ants going out of the log. The observation was done four days after aplications by calculating the number of death \textit{O. rhinoceros} due to the predation did by \textit{M. castanea} ants. The data obtained can be analyzed statistically and followed by t-test at 5% level.

3. Result and Discussion
3.1 Signs of Predation and Prey Behaviour
Based on the observation in the laboratory, \textit{O. rhinoceros} larvae preyed on \textit{M. castanea} ants showed changes of colours in the cuticle. It becomes brownish and gradually changes its colour to black (Figure 2A). Ants attack their prey by stinging and biting them to death. Next, they eat and suck the hemolymph liquid from the larvae until cuticle alone is left. The prey had its body torn apart due to the ant's bites. Ants
are even able to finish up the whole of first and second-instar of larvae which only left mandible out of the prey larvae (Figure 2B). The third-instar is more significant in size, and the cuticle was getting darker and wrinkled as the hemolymph had been suck out by the ants.

![Figure 2](image2.png)

**Figure 2.** Signs of *M. Castanea* ants preying on *O. rhinoceros* larvae.

Ants from Amblyopone family are usually predators who eat and suck hemolymph from their prey. In general, these ants always bring the pieces of their prey back to the nest for their brood or colony. But, this is different for *M. castanea* which prey on *O. rhinoceros*. After the prey has died, *M. castanea* ants bring their larvae to the corpse, and they have hemolymph from the prey together (Figure 3). This is the same as what [18] explained. However, it differs from what Ito [9] elaborated that *M. castanea* ants that prey on *Tenebrio Molitor* larvae, bring the pieces of the prey to the nest to their larvae or colony.

![Figure 3](image3.png)

**Figure 3.** The preying behaviour of *M. castanea* ants on *O. rhinoceros* larvae.

### 3.2. Predation Potential

#### 3.2.1. Laboratory. The result of predation test by *M. castanea* in the laboratory showed 100% of mortality for first and second-instar *O. rhinoceros* larvae on the fifth day after the application and the third-instar reached 100% mortality at seven day after application (Figure 4). This is aligned with the result obtained by [11] and [12]; first and second-instar of *O. rhinoceros* larvae have higher mortality than the third-instar larvae due to the smaller body size and thinner cuticle of prey which make them easier to be eaten. Usually, predators consider the predation efficiency by choosing the prey for their food. [3] stated that predators are using energy in searching and then consuming their prey. Therefore, they have to choose
their preys to maximize the ratio of energy and nutrition consumption to predation process they had done [15].

Figure 4. Mortality percentage of each instar of *O. rhinoceros* larvae with predation by *M. castanea* ants.

3.2.2. On Field. The observation of predation test between productive plants and immature plants plantations gave two significantly different data (Figure 5). In the immature plant plantation, *M. castanea* ants can consume 46.87% of 2nd instar *O. rhinoceros* larvae within four days of exposure; however, 50.3% was reached in productive plants plantations. The abiotic environment causes the differences in each of the two locations. The oil palm plants in productive plants plantations averagely aged between 15-20 years which the canopy of the plants has closed and the environment at the surface or under the soil to be shadier have caused the temperature is lower, and humidity level is higher, whereas, in the immature plants plantation, the plants are young and yet fruitful. They are just around one year old where the abiotic environment in the farm is much more exposed with higher temperature and lower humidity level. Abiotic environment affects ants abundance and performance as predators [7, 14].

Ants are considered as the organism sensitive to changes in the abiotic environment. [2] stated that factors such as climate, temperature and rain are affecting the way ants respond to the surroundings. *M. castanea* ants are included in the group of insects that love high humidity level. Productive plants plantation with taller plants and closed canopy have more wet soil surface, creating microenvironment loved by ants. The temperature of *M. castanea* ants nests during the exploration of their existence is around 27 - 29°C.
4. Conclusion

*M. castanea* ants can prey 100% on first and second-instar of *O. rhinoceros* larvae in the laboratory after five days of application and seven days for third-instar larvae. While the predation on the field, *M. castanea* ants can prey on 2.8 larvae (46.87%) after four days of exposure in immature plants and 3.0 larvae (50.3%) in productive plants plantation. The predation ability from the data recorder shows that *M. castanea* ants have the potential to be developed as biological agents in controlling *O. rhinoceros* larvae.

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