



Biological aspects of *Myopopone castanea* on its prey *Oryctes rhinoceros* larvae

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ABSTRACT

Ants are social insects with some significant roles in the ecosystem, including acting as predators for various insect pests. *Myopopone castanea* ants is a predator for the larvae of *Oryctes rhinoceros* pest. The existence of a similar niche of life between *M. castanea* ants and *O. rhinoceros* larvae opens an excellent opportunity to utilize these ants as biological agents. The research was conducted to study some aspects biology of *M. castanea* so that later it can be applied to mass rearing of natural enemies in the laboratory. The study was conducted by maintaining 50 eggs of *M. castanea* ant. Then, the eggs placed on two pieces of decayed palm oil stem together with twenty individual worker ants and ten individual end instar larvae. It needs five replications for the experiment. The results showed that egg stadia length was 13.8 days. It found five instars within *M. castanea* ant larvae with varying lengths of each stage. It takes 17.2 days for worker ant pupae to go through stadia pupa and 17.9 days for female ant pupae. The survival rate of *M. castanea* ant life from eggs until imago is 56.4%, which means that from several groups of eggs laid by queen ants, only about half have succeeded in becoming ant imago.

1. Introduction

Ants are social insects that have an essential role in the ecosystem, one of which is as a predator for herbivorous insects (Anshary and Pasaru, 2008; Choate and Drummond, 2011; Falahudin, 2013). The ants of *M. castanea* that have been reported by Marheni (2012) are predators of the *O. rhinoceros* insect, which is an important pest in oil palm plantations. These ants attack the larval stage and pupae of *O. rhinoceros*. In the oil palm plantations, *M. castanea* ants are found alive, and nesting on fallen and decayed oil palm trunks, both uprooted due to old age or uprooted due to root rot disease of Ganoderma stem. The adult stage of *O. rhinoceros* which is the prey of *M. castanea* ants also lives in these decayed oil palm trunks, so that the similarity of niches between predators and prey opens a great opportunity to utilize *M. castanea* ants as biological agents for *O. rhinoceros*.

The *M. castanea* ant is an obligate predator that attacks Coleoptera larvae (Wilson, 1971). This ant paralyzes its prey by stinging and biting it. After the prey dies, the ants and colonies will eat the hemolymph

fluid from the prey. The ability to prey on *M. castanea* ants in the laboratory is quite good, which can reach 5–6 prey larvae instar 1 and 2 per day (Junaedi et al., 2014; Marheni, 2012; Widihastuty et al., 2018a), while the ability to prey on *M. castanea* ants in the field can reach 46.87% in immature plants plantation and 50.3% in mature plants plantations over 5 days of exposure (Widihastuty et al., 2018b).

To be able to optimize the role of *M. castanea* ants as biological agents against *O. rhinoceros* pests, it is necessary to explore various information needed to develop them as biological agents through mass rearing activities in the laboratory. Information about the biology of *M. castanea* ants is minimal and limited. Therefore this research was conducted to explore information about the biology of *M. castanea* ants, so that later it could be developed as a potential biological agent against *O. rhinoceros* pests in oil palm plantations.

2. Material and method

The ants of *M. castanea* collected from rotten oil palm stems from

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community oil palm plantations in the Tanah Merah Village, Binjai Selatan District, Binjai City. The ants of *M. castanea* obtained from the field are kept in the Plant Pest Laboratory of the Faculty of Agriculture, University of North Sumatra. The ant colony raised in a glass box with a size of 70 × 30 × 30 cm. Firstly, put the two pieces of rotten palm stems inside the glass box with a size of 20 × 20 × 3 cm, which designed symmetrically as a place where the ants make their nests. Then, prey of *O. rhinoceros* larvae placed in a little hole in the middle of the palm trunk. Every day the log is sprayed with water to maintain the moisture of the ant nest. Provision of *O. rhinoceros* larvae managed according to ant predation needs. If the prey is dead and begins to dry, provide a new *O. rhinoceros* immediately. An ant colony that has queens and male ants are observed every day to see if there are already groups of eggs placed. If there are groups of eggs placed, then the eggs are taken to examine the life cycle of *M. castanea* ants.

Research on the life cycle of *M. castanea* ants was carried out by taking fifty newly laid eggs and transferred them to a smaller glass box measuring 40 × 20 × 20 cm along with twenty worker ants and ten final instar larvae (instar 4 or instar 5). These ants are placed in a rotten palm trunk measuring 15 cm × 15 cm × 4 cm which has a small hole in the middle to place *O. rhinoceros* larvae. The *O. rhinoceros* prey provided three instar larvae of the second instar and managed according to the needs. If the prey is dead and the only one left, then immediately two replacement prey are given. The number of worker ants in each repetition is maintained at 20 ants. If some worker ants died from predation, they would be immediately replaced by other worker ants from the same colony. Moreover, this treatment would be done until the *M. castanea* ant becomes an imago and each with five replications. Modifier variables observed were the length of each phase of development of ant life from eggs to imago and body size of each stage of development of *M. castanea* ants, which is measured using a micrometer calliper.

3. Results

3.1. The life cycle of *M. castanea* ants

3.1.1. Eggs

The eggs of *M. castanea* are white and placed in group as shown in Fig. 1.

3.1.2. Larvae

The development of *M. castanea* ant larvae consists of five instars. The larva is vermiform and white. Elongate cylindrical body shape, without appendages, no eyes, and no legs, so the larvae move using peristaltic hydroskeleton body movements (Fig. 2).

3.1.3. Pupa

The colour of *M. castanea* ant pupa is orange. At the beginning of the pupa formation, the colour is light yellow and slightly transparent (Fig. 3), and after one day it will change to bright orange, and then it



Fig. 1. *M. castanea* ant eggs group.

will turn to a darker orange. In observations in the laboratory, pupae were found to be larger than most existing pupae. Pupae which is larger than the others pupae turn out to be female ant pupae (queen candidate), as shown in Fig. 4.

3.1.4. Imago

Imago ants *M. castanea* consists of two castes, namely the worker caste and the reproductive caste. Reproductive caste, female ants and male ants usually have wings, while the worker caste has no wings as shown in Fig. 5.

3.2. Survival rate of *M. castanea* ants

The observation of 50 eggs maintained from each repetition obtained that, around 28.2 individual ants can go through all stages of life development and managed to become an imago (Table 3).

4. Discussion

M. castanea ants have perfect metamorphosis that is experiencing a developmental phase of eggs, larvae, pupae and imago. The number of eggs laid by the actual queen (a populated ant) can reach a range of 350 eggs, white and oval (Fig. 1). The results of the search for ant colonies in the field, this ant egg group usually placed inside the nest and hidden place, whereas in mass rearing in the laboratory this egg group is found in small holes made by ants in logs that are used as a place to make the nest. There is a no different colour of the eggs from the beginning until they hatched. The colour of the eggs before hatching becomes a bit duller. The average egg length is 0.98 mm, and the width is 0.46 mm. The average length of the egg stage is around 13.8 days, with the percentage of eggs hatching into instar one larvae at 79.6% (Table 1).

The development of *M. castanea* ant larvae consists of five instars. Most ant larvae in *Amblyoponinae* go through four or five stages before developing into pupae (Masuko, 2003; Masuko, 2016). Wheeler and Wheeler (1952) explained that the ant larvae of the Ponerinae subfamily are generally vermiform, elongate and apodous. The larval stage is the most vulnerable in the life cycle of ant development. Worker ants raise ant larvae. Feeding on ant larvae is usually carried out by trophallaxis such as worker ants feed the larvae through the exchange of feed from mouth to mouth (Penick et al., 2012; Penick and Liebig, 2017).

Fine hairs overgrew abdomen larvae of *M. castanea*. Larvae are usually located in a somewhat closed room and avoid the light in the nest and placed in groups. In the laboratory, worker ants will immediately move to move the larvae to a more hidden place if the nest opening. The duration of the larval stage for each instar is different. The development of first instar larvae to second instar was very rapid, which averaged around 2.3 days (Table 2). Susanti (2016) also found that the duration of the first instar stage to second instar *M. castanea* ants was very fast, which was around two until three days. The duration of second instars to the third instar was around 4.9 days and third to fourth-instar around 7.3 days. The duration of the fourth instar is around 11 days, and the duration of the fifth instar is 16.4 days.

The body size of *M. castanea* ant larvae between first instar and second instar is not too different due to the short development time to the next stage. Short development time is not enough to increase the apparent change in body size (Davidowitz et al., 2003), whereas from 3rd instar, 4th instar, and 5th larvae, differences in body size and width are quite different. In observations in the laboratory, larvae that are often moved by worker ants to prey that have been paralyzed are 3rd, 4th and 5th instar larvae. It is presumably because larvae in this stage need more nutrients than the first instar larvae.

Pupae *M. castanea* ants are usually kept in a hidden and dry place in the nest. In observations in the laboratory, pupae were found to be larger than most existing pupae (Fig. 4). Pupae which is larger than the others pupae turn out to be female ant pupae (queen candidate). The

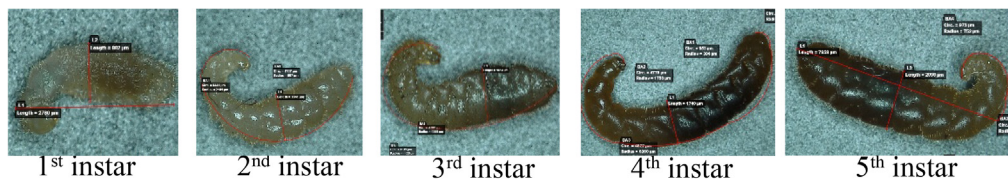


Fig. 2. Stadia larvae of *M. castanea* ants.

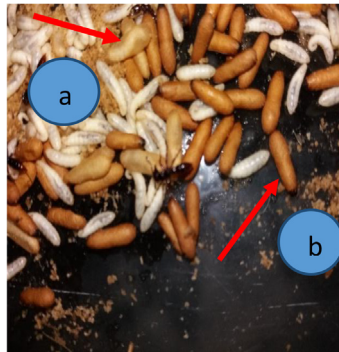


Fig. 3. *M. castanea* ant pupa; (a) new pupa, (b) old pupa.

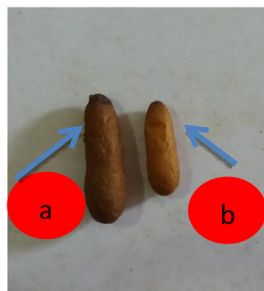


Fig. 4. Difference in workers ant pupae size and female ants of *M. Castanea*; (a) female pupae ants, (b) worker pupae ants.

difference in pupa size is quite different. The workers' ant pupa size ranges from 9.98 mm, and the width is 3.06 mm, while the female ant pupa size ranges from 14.61 mm with a width of 4.31 mm. The duration of the pupa stage for worker ants ranges from 17.2 days, and the duration of the pupa stage for female ants is around 17.9 days.

Imago ants *M. castanea* consists of two castes, namely the worker caste and the reproductive caste. Reproductive caste, female ants and male ants usually have wings, while the worker caste has no wings. Worker castes are sterile female ants (Ito, 2010). The colour of the *M. castanea* ants is reddish-brown (Zheng-hui and Qiu-ju, 2011). Ants that just come out of the pupa are lighter brownish red, after a few days later they turn reddish-brown.

Based on observations during mass rearing, *M. castanea* ants are very sensitive to light. If the nest is opened and the ant is exposed to

Table 1

Description of the eggs of *M. castanea* ants.

Description	Information
Shape	Elongated
Color	White
Average egg length	0,98 mm ± 0,063
Average width of eggs	0,46 mm ± 0,052
The average age of stadia	13,8 days ± 0,447
Average percentage of hatching	79,6%

Table 2

Duration of larval stage and larval size of *M. castanea* ants.

Larva Stadia	Length of stadia (days)	Body size (mm)	
		length	width
1st instar	2.3 ± 0.274	1.26 ± 0.052	0.45 ± 0.053
2nd instar	4.9 ± 0.458	2.04 ± 0.052	0.72 ± 0.042
3rd instar	7.3 ± 0.570	5.07 ± 0.082	1.05 ± 0.071
4th instar	11.0 ± 0.500	7.01 ± 0.074	2.06 ± 0.084
5th instar	16.4 ± 0.418	10.15 ± 0.118	0.063

light, the ants will try to avoid the light and enter the nest or seek shelter. The worker ants will also immediately lift their broods (eggs, larvae and pupa) to be immediately moved to a place that is protected from light. Ants species can be active diurnal or nocturnal (Narendra et al., 2017). Male and female of *M. castanea* ants are having activities before dusk around 18.00–20.00 WIB, while worker ants are also actively leaving the nest during these hours.

The ability of an insect to breed and survive is influenced by potential reproductive factors and environmental factors (Netherer and Schopf, 2010). Reproductive potential is the ability of insects to breed under optimum conditions, while environmental factors are all environmental factors that can inhibit the development of insect populations. These potential reproductive factors include fecundity, length of life and sex ratio, while environmental factors affecting the development of insect populations are biotic factors (competition, predators and parasites), abiotic (temperature, humidity and sunlight) and feed (quantity and quality).

M. castanea ants kept in the laboratory from eggs to imago show varying degrees of survival. The observation of 50 eggs maintained from each repetition obtained that, around 28.2 individual ants can go through all stages of life development and managed to become an

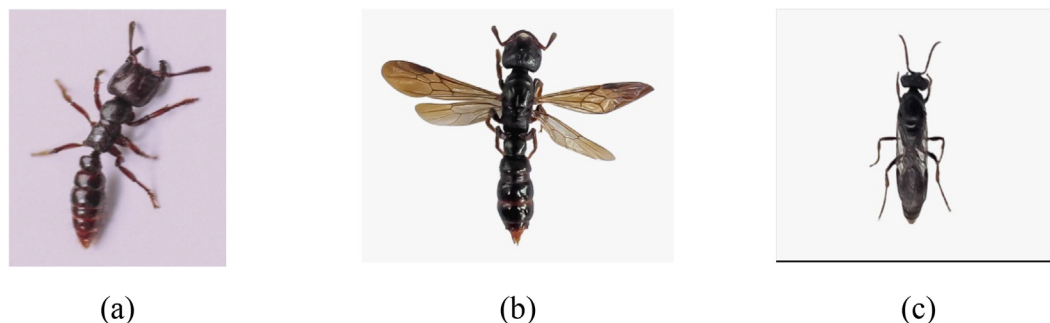


Fig. 5. Imago ants of *M. Castanea*; (a) worker ants, (b) female ants, (c) male ants.

Table 3
Survival rates of *M. castanea* ants from eggs to imago.

Deuteronomy	Number of eggs (eggs)	Become an imago (individual)	Ant caste (individual)	% Survive
1	50	30	♀ = 2 ♂ = 1, workers = 27	60
2	50	29	All workers	58
3	50	28	All workers	56
4	50	28	♀ = 2, workers = 26	56
5	50	26	All workers	52
Average		28.2		56.4

imago (Table 3). Early instar larvae (instar larvae 1 and 2) are the most vulnerable to the risk of death. Nonacs and Dill (1990) and Peterson et al. (2009) explained that the initial phases of development of an insect are phases that are very vulnerable to various risks of death. Early instar larvae have a small body size. Renault et al. (2003) stated that the body size of *Alphitobius diaperinus* (Coleoptera: Tenebrionidae) largely determines its survival rate at various ambient temperatures

Overall, the survival rate of *M. castanea* ants around 56.4%. This low survival rate is presumably because the ant nest are opened too often and are disturbed to see the stage of ant development. Ants including insects that are very sensitive to disturbances that occurs in their environment (Latumahina et al., 2015). The total imago of female and male ants that emerge from each repetition is only five individuals (3.55%), while the rest are 136 individual worker ants (96.45%). During the exploration of *M. castanea* ants in the field, the number of ants found in each colony ranged from tens to hundreds of individuals. Traniello (1982) stated that most ants from the sub-family Amblyoponinae have a small number of individuals from each colony.

5. Conclusion

The ant *M. castanea* is a perfectly metamorphosed insect. The eggs laid by the queen ants are white, oval-shaped, and the length of the egg is about 13.8 days. The larvae develop in five instar stages, white colour with varying lengths of instars. *M. castanea* ant pupa has an orange colour. The size of the female ant pupa (± 14.61 mm) is higher than the worker ant pupa (± 9.98 mm). The duration of worker ant pupa stage is around 17.2 days, and the length of the female ant stage is around 17.9 days. The survival rate of *M. castanea* ants from eggs to become imago is by 56.4%, which means that from several groups of eggs laid by the queen, only about half of them will succeed in becoming imago.

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