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CONSERVATION OF PREDATORY ANTS *Myopopone castanea* SMITH (HYMENOPTERA: FORMICIDAE) IN AN OIL PALM PLANTATION IN NORTH SUMATERA

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ABSTRACT

The predatory ant, Myopopone castanea *Smith, F. (Hymenoptera: Formicidae) has been reported as a natural enemy for the oil palm pest,* Oryctes rhinoceros *Linnaeus (Coleoptera: Scarabaeidae). This study aims to determine the distribution of the predatory ants among selected oil palm* Elaeis guineensis *Jacq. (Arecales: Arecaceae) plantations of North Sumatra Province, Indonesia. The presence of* M. castanea *colonies was conducted by checking several fallen and rotting oil palm trunks. Conservation efforts to ensure a sustainable ant population were made by inserting* M. castanea *colonies into each of the two deteriorating palm trunks, which were identified as sustainable habitats for the ants. The palm trunks were placed at the frond stacks and trunk heaps and kept in the open field for five days. It was discovered that* M. castanea *colonies, with variable ant counts in each colony, are present on several oil palm plantations. The results indicated that the frond stacks contained more dead prey and ants than the trunk heaps. Since ants do not have a preferred habitat for nest-building, rearing the ant colonies in the frond stacks should provide a higher population of ants compared to the trunk heaps.*

Keywords: conservation, *Myopopone castanea*, oil palm plantation, *Oryctes rhinoceros*.

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INTRODUCTION

The African oil palm *Elaeis guineensis* Jacq. (Arecales: Arecaceae) is planted in the tropics of Southeast Asia, the African continent, and the Americas (Brazil, Columbia, Costa Rica) (Cheng et al., 2019; Danylo et al., 2021; Tan et al., 2009). Oil palm plantations are mainly found in Indonesia, with an area reaching 16.883 million hectares in 2021 and crude palm oil (CPO) production at 45.10 million tonnes (Badan Pusat Statistik, 2022). Currently, Indonesia is the largest CPO producer in the world. It is imperative to manage oil palm cultivation in compliance with the principles set forth by the Roundtable on Sustainable Palm Oil (RSPO) to attain maximum yields in oil palm production (Köhne, 2014; Webber & Atchanah, 2015). This comprehensive management approach includes addressing various factors such as reducing the use of chemical fertilisers and pesticides (Wood & Norman, 2019a, 2019b) utilising empty oil palm fruit bunches to improve soil structure, and incorporating flowering plant cultivation to increase arthropod diversity; practices that exemplify a sound agroecosystem management in oil palm plantations (Bessou et al., 2017).

The management of ecosystems within the oil palm plantations includes a variety of conservation initiatives, with a focus on preserving

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the natural enemies which are native to these environments. According to Nurdiansyah et al. (2016), conservation of natural enemies is a critical biological control technique used to regulate pests in oil palm plantations. According to Rizali et al. (2019), effective habitat management practices are critical for ensuring the viability and persistence of these natural enemies. One notable habitat management strategy involves the strategic planting of diverse flowering plants alongside oil palm plantation thoroughfares. This intentional inclusion of flowering plants serves the dual purpose of providing nectar as a sustenance source for natural enemies, particularly parasitoids, as demonstrated by Dislich et al. (2017) and Tawakkal et al. (2019), and also as refugia plants (Mokoginta & Mohamad, 2022).

Biological control is the best and most environmental friendly alternative method to control pests and plant diseases. Many biological control agents that are being widely carried out for *Oryctes rhinoceros* pest, include the use of entomopathogens, such as *Metarhizium anisopliae* (Fauzana et al., 2020; Indriyanti et al., 2017; Suryanto, 2020), *Bacillus thuringiensis* (Pujiastuti et al., 2022), *Beauveria bassiana* (Indriyanti et al., 2021; Nasution et al., 2018), and *Baculovirus oryctes* (Rahayuwati et al., 2020).

Ants have long been recognised as one of the predators of many plant pests. *Oecophylla smaragdina* Smith. (Hymenoptera: Formicidae) is also a potential predator in controlling oil palm leaf-eating pests (Exélis et al., 2024). Falahudin (2013) stated that this ant can prey on the nettle caterpillar pest (*Setora nitens*) while Pierre and Idris (2013) explained that this ant is also a predator of the bagworm pest *Pteroma pendula*. In addition, other ant species that can be predators in oil palm plantations are *M. castanea* ants. This ant is a predator of *O. rhinoceros* larvae (Widihastuty, 2020). While these ant colonies are commonly observed in the smallholder plantations in the Binjai region, their prevalence in various private or state-owned plantations (PTPN) has not been thoroughly investigated (Susanti et al., 2017; Widihastuty et al., 2019). *M. castanea* ants typically establish colonies in decaying logs or fallen oil palm trunks infected with *Ganoderma*. The larvae and pupae of *O. rhinoceros* also live in piles of rotting organic material including fallen rotting oil palm trunks. The goal of this study is to look into the presence of the predatory ant *M. castanea* in oil palm plantations, towards implementing conservation measures to protect its presence within the plantation areas.

MATERIALS AND METHODS

Study Sampling Site

This investigation was carried out across various oil palm plantations located in various districts and cities throughout the Indonesian province of North Sumatra. The study focused on rotting oil palm trunks as the ants' nest within these plantations (*Figure 1*), and the exploratory method to detect the presence of *M. castanea* ants involved chopping, sectioning and dismantling the oil palm trunks. The validity of the *M. castanea* species was confirmed and identified at the Biological Research Center LIPI Bogor.

Figure 1. (a) The palm trunk stump as a nest, (b) colonies M. castanea *in the nest and (c) ants feeding hemolymph of* O. rhinoceros *larvae.*

When an ant colony was identified within the oil palm trunk, a specialised measuring device was used to assess the abiotic conditions within the ant nest, which included the temperature, humidity and pH levels. The abiotic environment data were described and analysed using the descriptive statistical analysis method. Following the discovery of existing ant colonies, specimens were carefully transferred to plastic containers and were transported and kept together in the laboratory.

Experimental Study Design

The study of *M. castanea* ants was conducted at the Bandar Khalifah PTPN 2 plantation in Deli Serdang Regency, North Sumatra (3°39'14.9" N 98°48'14.0" E). As part of the conservation efforts, a colony of *M. castanea* ants was introduced into two decaying oil palm trunks, each measuring 35 cm in diameter and 25 cm in thickness. In one of the palm trunks, a hole with a diameter of 15 cm and a depth of 5 cm was created to house 50 *M. castanea* ants and five *O. rhinoceros* second instar larvae (*Figure 2*). The experiment was repeated five times. The hole was then filled with another trunk. The trunk was strategically placed in two locations: One at the frond stack, and another in the trunk heap. These trunks were exposed in the field for five days. The trunks were then unsealed to assess the presence of *M. castanea* ants, with subsequent quantification and recording of the remaining ant population and prey mortality. The data observed was analysed statistically using t-test.

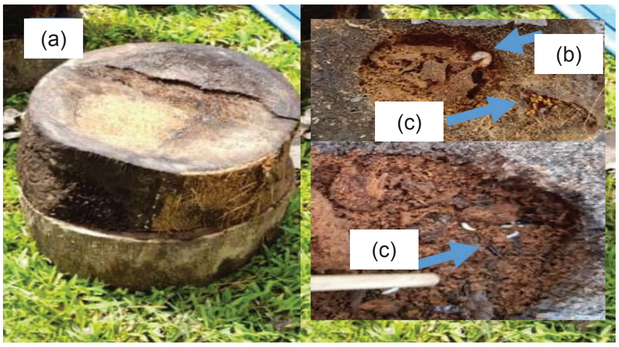

Figure 2. (a) Palm trunks conservation, (b) O. rhinoceros *larvae as a prey and (c) colonies* M. castanea.

The Exploration to Detect the Presence of *M. castanea*

The presence of *M. castanea* colonies (*Figure 3*) in various oil palm plantations in several districts and cities of North Sumatra is shown in *Figure 4*. *M. castanea* belongs to the primitive ant group of the Amblyoponinae family, which is usually found in the forest and commonly lives on rotting logs (Wilson, 1971). *M. castanea* ant nests were rarely found in plantations with young palms because rotting trunks are rare.

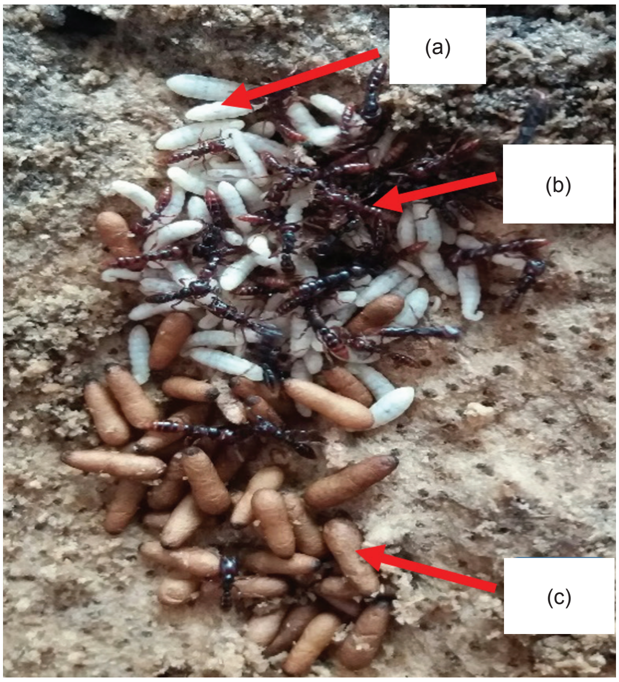

Figure 3. M. castanea *colonies; (a) larvae; (b) ant worker and (c) pupae.*

Environmental factors strongly influence the presence of ants in an ecosystem. The abiotic environment within the colony of *M. castanea* ants in this exploratory study is shown in *Table 1*. The mean temperature obtained ranged from 28.77°C–30.44°C, while the mean humidity was 69.75%–76.33%. The mean pH found was 6.05–6.20. The abiotic environment factors such as temperature, humidity and light conditions affect the foraging patterns, distribution and activity of the ant species (Philip et al., 2018).

Land use changes affect the availability of suitable habitats for ants, leading to shifts in ant species composition and a decrease in ant diversity (Johari et al., 2021; Philip et al., 2018). The ecological roles of plants in oil palm plantations, which provide ground cover to regulate soil moisture and producing litter for nutrient formation, can impact the availability of resources for ant species that nest in decaying logs (Nahlunnisa & Kwatrina, 2023; Syarif et al., 2025). According to Widihastuty et al. (2019), the average temperature within *M. castanea* nests was around 29°C, while the average ground surface temperature in immature plantations was generally higher than in mature plantations. This is because the palm crowns in the mature plantations have overlapped with each other, hence lowering the temperature of the ground surface.

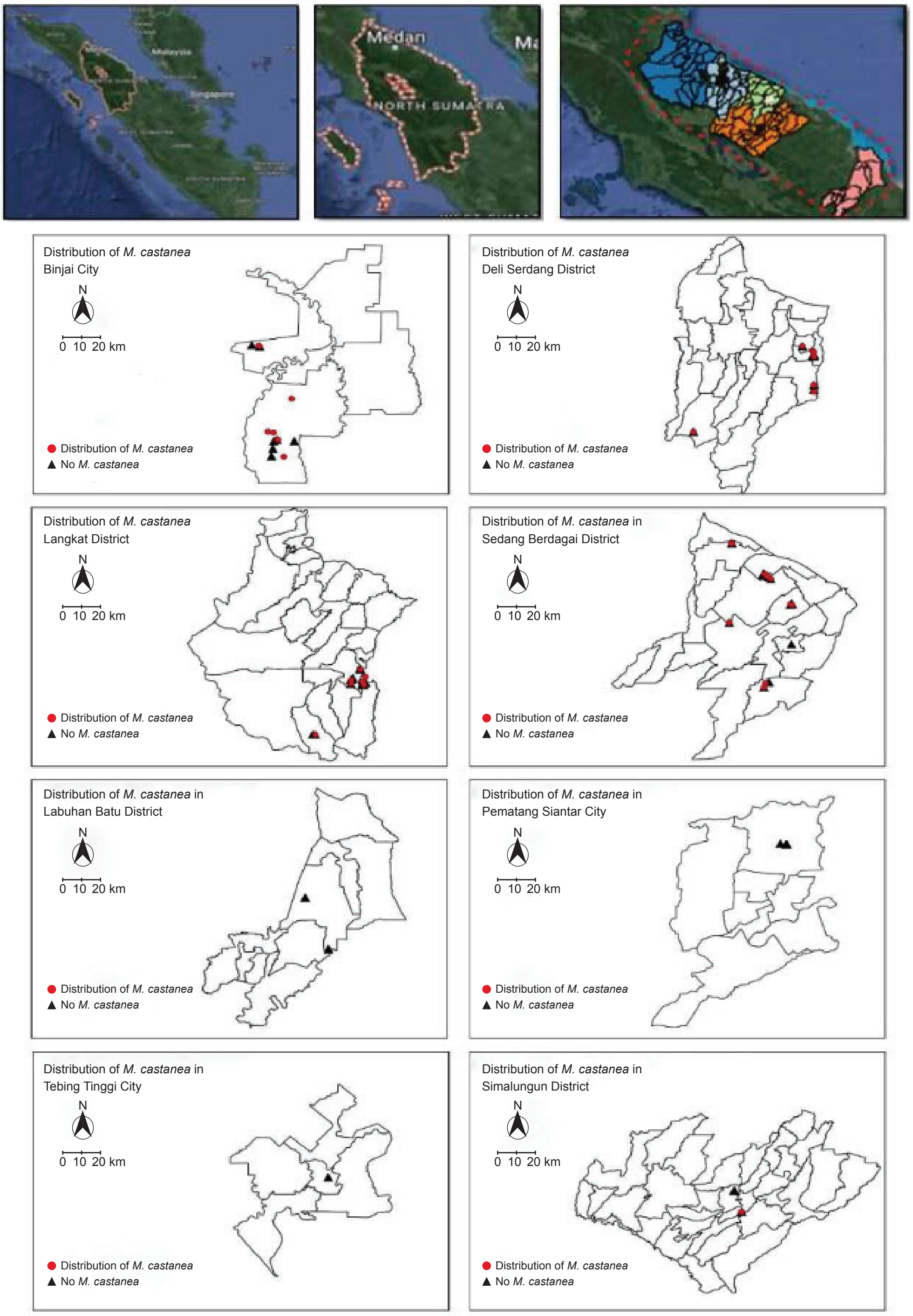

Figure 4. Distribution of M. castanea *ants in several oil palm plantations in several districts/cities in North Sumatra Province.*

TABLE 1. THE AVERAGE ABIOTIC ENVIRONMENTAL CONDITIONS OF *Myopopone castanea* NEST IN SEVERAL OIL PALM PLANTATIONS

Regency	Temperature (°C)	Humidity (%)	pH
Binjai	29.55 ± 0.63	74.75 ± 2.38	6.05 ± 0.21
Langkat	30.16 ± 0.47	70.20 ± 3.53	6.12 ± 0.18
Deli Serdang	30.44 ± 0.45	69.75 ± 0.88	6.08 ± 0.20
Serdang Bedagai	29.81 ± 0.63	70.06 ± 0.97	6.20 ± 0.23
Simalungun	28.77 ± 0.36	76.33 ± 1.78	6.07 ± 0.09

There are very few fallen oil palm trunks in private plantations, particularly in the Labuhan Batu Regency, causing fewer chances for the *M. castanea* to build their nests. Private plantations are typically very strict in keeping their plantations free of decaying oil palm trunks, as it is feared that they will become breeding sites for *O. rhinoceros* beetles (Egonyu et al., 2022). The oil palm plantations in the Labuhan Batu district were planted on peat soil, with an average pH of 4.28. The presence of organisms and microorganism activity is also determined by acidic soil pH conditions. Many microorganisms, including fungi and bacteria, are involved in the weathering of wood. These microorganisms have less activity in decomposing cellulose compounds in acidic soil than in neutral soil pH conditions (Hafif et al., 2022). Furthermore, not every oil palm trunk site investigated will have the *M. castanea* ant colony. There are many abiotic factors which influence ants to build nests or colonies in the decaying trunks. Temperature, humidity and the degree of weathering in the wood will all influence the nesting of the ants. Widihastuty et al. (2019) discovered that the C/N ratio of oil palm trunks that have weathered between 66%–69% can become conducive for *M. castanea* ants to build their nest.

The larvae of *O. rhinoceros* are not always found in every rotting oil palm trunk. If no *O. rhinoceros* larvae were discovered in the fallen trunk, most likely, there would be no *M. castanea* ant colony defected. The absence of the prey in an ecosystem will undoubtedly affect the higher trophic level (natural enemies), hence reducing the chances of finding their population in the ecosystem (Suman et al., 2023). *M. castanea* ants are predatory ants with a narrow prey range, as opposed to other predators in general, which typically have a broad prey range. *M. castanea* is a predator that feeds on the hemolymph fluid of Coleoptera larvae (Ito, 2010).

Myopopone castanea Ant Colonies

The *M. castanea* ant colonies which are mainly found in several oil palm plantations are mostly occurring without the alate queen. As shown in *Table 2*, only a small number of colonies have a comprehensive caste system. *M. castanea* ants only have two castes in their colony, namely the worker caste and the reproductive caste, which consist of winged male and female ants. If the female ant has mated with a male ant, they will shed their wings and function as a queen in the colony (Widihastuty et al., 2020).

Most ant colonies found in exploratory research were colonies that did not have an alate queen. This phenomenon is called gamergate. The gamergate phenomenon, which is characterised by the absence of reproductive castes but with the presence of groups of eggs, was observed in several ant colonies. The gamergate phenomenon describes a scenario in which the worker ants gain the ability to reproduce sexually after mating. Most ant species have sterile female worker ants; however, the gamergate phenomenon has been observed in taxa where the worker ants have sperm reservoirs that function similarly to a spermatheca (Peeters & Fisher, 2016; Schmidt & Shattuck, 2014).

According to Ito (2010), the *M. castanea* worker ants have ovarioles that are similar to those of the queen ants. This factor strengthens the suggestion that these ants may also exhibit the gamergate phenomenon, although there was no previous study to explain why and how the gamergate phenomenon occurs in *M. castanea* ants.

Conservation of the Ant *M. castanea*

The conservation efforts for the *M. castanea* ant were carried out in two distinct locations: The frond stack and sites where there were abundant decomposing oil palm trunks heaps resulting from the previous replanting activities. During the five day field experiment, the predation rate of *M. castanea* ants had reached up to 80% in frond stack, and 68% in trunk heap areas. Notably, the number of individual ants remaining after the exposure period was higher in the frond stack than in trunk heap locations (*Figure 5*). The t-test analysis for the number of remaining ants revealed a significant correlation effect ($R = 0.3202$, $p = 0.00125$), however, the t-test analysis for predation on the frond stack and the trunk heap showed no significant effect ($R = -0.1648$, $p = 0.52913$).

The increased predation rate in the frond stack was likely attributed to a large number of ant colonies that remained in the conservation trunks, sustaining the predation process for as long as the colonies remained. In contrast, fewer individual ants were observed in the trunk heaps locations, raising the possibility that *M. castanea* ants may have emigrated to other decomposing oil palm trunks. Widihastuty et al. (2021) discovered that when given the choice of odour between rotting palm oil trunks and *O. rhinoceros* prey, *M. castanea* ants prefer the odour of decomposing palm oil trunks over that of their prey. This preference can be explained by the idea that ants prioritise habitat or niche selection to protect their colony. Eventually, they would engage in predation to meet the nutritional needs of their colony. Foraging requirements, resource availability, the presence of similar species, and physiological considerations are all factors that influence their habitat selection (Stahlschmidt & Johnson, 2018).

TABLE 2. *Myopopone castanea* ANT COLONIES FOUND IN SEVERAL OIL PALM PLANTATIONS

Regency/city	Point sample	Number of ants	Ants colonies			
			Eggs	Larva	Pupa	Reproductive castes
Binjai	1	87	0	65	0	
	2	263	123	144	86	Female = 3 Male = 6
	3	135	0	82	0	
	4	87	0	66	54	
	5	112	0	80	24	
	6	76	0	0	77	
	7	134	0	88	65	
	8	65	0	77	54	
Langkat	1	98	67	53	34	-
	2	156	0	78	30	
	3	185	0	88	57	
	4	68	0	45	23	
	5	72	0	0	69	
Deli Serdang	1	238	147	98	113	Female = 4 Male = 6
	2	146	0	75	10	
	3	62	0	43	65	
	4	167	0	78	49	
	5	138	87	98	43	-
	6	96	0	42	38	
	7	120	0	65	45	
	8	97	0	0	64	
Serdang Bedagai	1	190	0	95	86	
	2	95	0	89	38	
	3	178	0	60	49	
	4	243	110	147	124	Female = 4 Male = 8
	5	124	0	152	0	-
	6	112	0	78	97	
	7	90	78	65	0	
	8	92	0	77	60	
	9	256	167	190	178	Female = 5 Male = 10
	10	88	0	89	77	
	11	102	0	75	64	
	12	99	0	57	66	
	13	198	87	102	48	
	14	77	0	68	54	
	15	89	0	69	77	
	16	105	0	79	65	
Simalungun	1	245	118	238	174	Female = 8 Male = 18
	2	176	0	189	123	-
	3	104	0	97	62	-

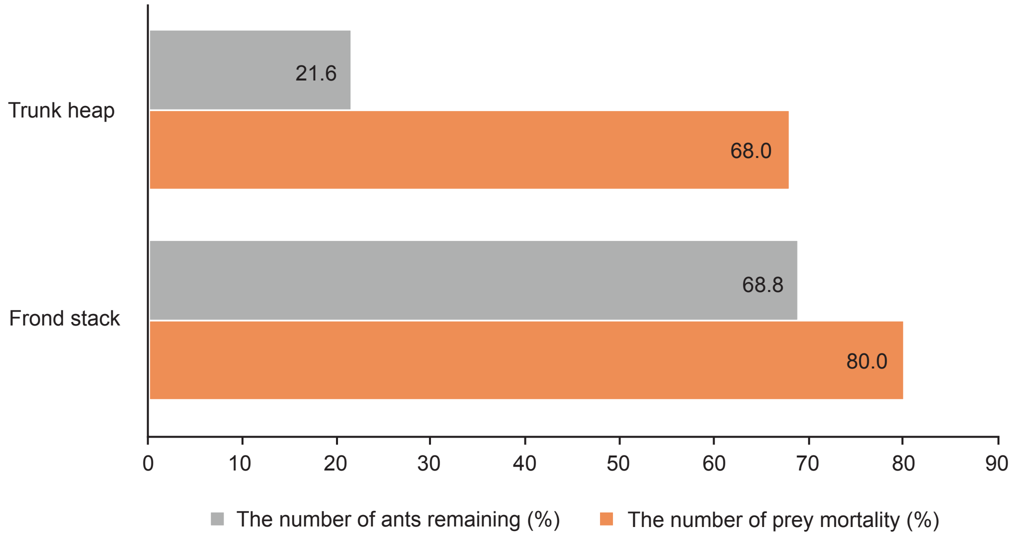

Figure 4. Percentage of the number of dead prey and the number of ants remaining in the conservation log.

The number of ants left in the conservation trunk heaps was found to be lower than at the frond stacks. This disparity was attributed to the possibility that the ant colonies in the trunk heaps may have shifted to the other decomposing heaps of oil palm trunks, as the volatile odour emanating from the rotting palm oil trunks is especially appealing to the ants.

Decomposing oil palm trunks emit a wide range of volatile compounds, the majority of which are hydrocarbons. The results of GC-MS analysis conducted by Widihastuty et al. (2021) on weathered oil palm trunks found that the dominant volatile compound was naphthalene, 2-methyl-(CAS)2-methylnaphthalene. Ants frequently communicate using hydrocarbon compounds (Chomicki & Renner, 2017; Sprenger & Menzel, 2020). Wooden logs that have decayed extensively emit a strong odour of volatile hydrocarbons, making them more appealing to ants (Hailini et al., 2020). Huber and Knaden (2018) also discovered that ants, such as *Cataglyphis fortis*, are adept at distinguishing the odour of their nest from the smell of the food provided to them.

CONCLUSION

The presence of *M. castanea* ants in oil palm plantations can still be found, but requires many explorations as their colonies are rare. As a result, immediate conservation measures are required to ensure the continued existence of these ants as effective biological agents, especially for *O. rhinoceros*. Ant conservation can be accomplished by strategically placing oil palm trunks in the frond stack areas and other locations that do not interfere with plantation operations. This proactive approach aims to provide suitable habitats for *M. castanea* ants, fostering their colonies and contributing to their role as important contributors to the ecological balance of the oil palm ecosystem.

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