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Research Article

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The Use of Colored Pan Traps to Study Ant Community at Rehabilitated Coal Mining Area in Sawahlunto City, West Sumatera, Indonesia

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A B S T R A C T

Pan trapping is a popular technique for exploring the diversity of insects (i.e. pollinators) in different settings. The use of traps in the field is effective to produce sample data for its operability as well as needs specific equipment the least. Despite, the pan-trapping is a non-selective catching method with significant possibility of entrapping non-targeted taxa. In this study, coloured pan-trapping was applied to survey ant species diversity at three different habitat types, rice-field, Acacia agroforestry and secondary forest in the site of reclaimed coal mining in Sawahlunto City, West Sumatra, Indonesia. A total of nineteen ant individuals were collected in this study, identified into 11 species, 9 genera, 8 tribes and 3 subfamilies. The most common species was *Camponotus arrogans* recorded from all surveyed habitats. Blue pans collected the most ant species (14 individuals, 9 species), while the yellow ones only recorded one individual of a single species. There might be connection between pan coloration with survey result, with probable affecting factors from habitats and inhabitant species.

INTRODUCTION

A popular technique for sampling insect species is pan-trapping (Krauss *et al*., 2018; Naqvi *et al*., 2022). As a passive sampling method, it is useful for determining insect diversity and independent to specific equipment (Vrdoljak and Samways, 2012; Krahner *et al*., 2021; Hutchinson *et al*., 2022). The trap consists of a 20 cm in diameter x 10 cm tall plastic container, filled with propylene glycol, salt, soap water, or a mix of these materials (Buffington *et al*., 2021). Three distinct colours (white, blue, and yellow) are in use to attract insects based on preference and visual perception (O'Connor *et al*., 2019; Mendes *et al*., 2021).

With over 16,000 species recognized globally, ants (Formicidae) are among the most varied insect species (AntWiki, 2024). Depend on its environment, they differ greatly in population and distribution. Ants are ecologically important to recycle nutrients and to disseminate seeds in forest. However, they may also be found at urban environments, inhibiting cracks and fissures among building, depend mostly on food remnants for foraging. Recent observation confirmed that ants also inhibit reclaimed ex mining area in Sawahlunto City, West Sumatra.

Ants are known to gather nectar from various flowers without risking high cross-pollination incident, differed to the other members of Hymenoptera which considered as effective pollinators. Due to natural antibiotics existing on the surface of ants' body, pollens tend to be impotent when come into contact (US Department of Agriculture, 2024). Studying ant diversity, their interactions to the surrounding habitat along with intrinsic and extrinsic influencing factors to their biology and ecology, offers important insights into the health, function, management, and conservation efforts of ecosystems. Ant population monitoring is an important way to evaluate habitat quality and biodiversity as it is useful in signalling possible disturbances and impending changes in the environment.

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MATERIALS AND METHODS

Study site and methodology

The study had been conducted in October 2022, taken place at Emil Salim Biodiversity Park (ESBP) in Sawahlunto City, West Sumatra, Indonesia (0°37’32.0” S, 100°44’55.3” E and 272-323 m elevation). The site was divided into three types of habitats. The first was a secondary forest within the rehabilitated ex-mining land covered with various of woody plants, shrubs, and bushes. The second was acacia agroforestry dominated by the standings of *Acacia* spp. and shrubs. The last habitat was a rice field in adjacent to the two habitats within the ESBP site.

Figure 1. Snippet on surveyed habitats in Emil Salim Biodiversity Park: (A) Secondary Forest; (B) *Acacia* agroforestry; (C) Rice field

A set of pan traps with blue, yellow, and white-coloured containers were deployed. These containers were attached to forked wooden stick; each of this arrangement was positioned every 15 m of sixty transect lines erected in each surveyed habitat. A combination of formaldehyde, water, and detergent solution was poured into to containers. Traps were checked daily in which the trapped insects collected and stored into tubes with alcohol. After three days of survey, the collected samples were taken to the Invertebrate Taxonomy Laboratory in Universitas Andalas. In the laboratory, samples were sorted, identified, and labelled accordingly. Identification process was guided with proper references for Formicidae (Bolton, 1994) in addition to the consultation made with experts for the taxa, while taxa distribution was confirmed using online sources such as AntWiki (www.antwiki.org) and AntWeb (www.antweb.org). Ant diversity was calculated using Shannon-Weiner (H’) formula, while the evenness of ant distribution across habitats was with Pielou index (J) formula (Magurran, 2004).

RESULT AND DISCUSSION

A total of 11 species, 9 genera that belonging to 8 tribes, 3 subfamilies and 19 ant individuals of ants were collected using coloured pan traps from the three habitats surveyed in ESBP site. These specimens were scrutinized into (Table 1). Pan traps at *Acacia* agroforestry collected 9 ant individuals, while the ones set at secondary forest resulted in 8 ant individuals and at paddy field only yielded 2 ant individuals. Identification put that two species were recorded at paddy field and three species at *Acacia* agroforestry habitats, on the other hand seven species booked at secondary forest habitat. It seemed that the vegetation diversity and density of canopy coverage increase resource availability (e.g. foods) for ants, which in turn affects ant population in that given environment. Previous study at forest ecosystem using quadra protocol confirmed that ants were more abundance and more diverse in this compared to other types of habitats surveyed in the same study (Herwina *et al*., 2024).

Table 1. The taxonomy and composition of ants collected from Emil Salim Biodiversity Park, Sawahlunto City, West Sumatra, Indonesia. (B: blue pan trap; W: white pan trap; Y: yellow pan trap)

No	Sub family / Tribe / *Species*	Forest			∑	Acacia agroforestry			∑	Paddy field			∑	TOTAL
		B	W	Y		B	W	Y		B	W	Y		
	Dolichoderinae													
	Dolichoderini													
1	*Dolichoderus thoracicus* (F. Smith, 1860)	0	1	0	1	0	0	0	0	0	0	0	0	1
	Tapinomini													
2	*Tapinoma melanocephalum* (Fabricius, 1793)	2	0	0	2	0	0	0	0	0	0	0	0	2
	Formicinae													
	Campotini													
3	*Camponotus arrogans* (F. Smith, 1858)	0	0	0	0	2	1	1	4	0	0	0	0	4
4	*Camponotus bedoti* Emery, 1893	0	1	0	1	0	0	0	0	0	0	0	0	1
	Lasiini													
5	*Nylanderia* sp.	0	0	0	0	0	0	0	0	1	0	0	1	1
	Plagiolepidini													
6	*Anoplolepis gracilipes* (F. Smith, 1857)	0	0	0	0	2	0	0	2	0	0	0	0	2
	Myrmicinae													
	Attini													
7	*Pheidole* sp.	1	0	0	1	0	0	0	0	0	0	0	0	1
	Crematogastrini													
8	*Crematogaster fraxatrix* Forel, 1911	0	0	0	0	2	1	0	3	0	0	0	0	3
9	*Crematogaster quadriruga* Forel, 1911	1	0	0	1	0	0	0	0	0	0	0	0	1
10	*Tetramorium indicum* Forel, 1913	1	0	0	1	0	0	0	0	0	0	0	0	1
	Solenopsidini													
11	*Monomorium floricola* (Jerdon, 1851)	1	0	0	1	0	0	0	0	1	0	0	1	2
	∑ individual	**6**	**2**	0	**8**	**6**	**2**	**1**	**9**	**2**	0	0	**2**	**19**
	∑ species	**5**	**2**	0	**7**	**3**	**2**	**1**	**3**	**2**	0	0	**2**	**11**

Numerous variables, including temporal and geographical distribution of foods, food quality, level of competition, and impact of parasitisation or predation, affect ant foraging behaviour (Traniello, 1989). The general state of nutrition in a colony, in addition the presence of foragers from other colonies intensifies foraging activity of ants. Worker ants often tend to choose the best food sources from the surroundings, they then use pheromone markings to direct other workers to the food source (Hölldobler and Wilson, 2009; Jeanson *et al*., 2012).

In general, the ESBP site had moderate ant diversity (Table 2). The secondary forest habitat, however, possessed the highest ant diversity among other (H' = 1.09) and rice field as the lowest one (H' = 0.69). The variation of vegetation among habitat, was again thought to be the reason for this situation. Ants are commonly omnivores that opportunistically feed on a wide range of food hence put them at various trophic level in the ecosystem; therefore, ants can take advantage of a variety of nutritional resources (Hunter, 2009; Jaques *et al*., 2023). Certain ant species, however, display specific eating habits, including nectarivorous, fungivorour, granivorous, direct herbivorous and predator; they can also be indirectly herbivory by consuming hemipteran honeydew (Beattie, 1985; Hölldobler and Wilson, 1990). Environmental circumstances that apply in ants' habitats also affect the nutritional levels of food resources (Blüthgen *et al*., 2003; Davidson *et al*., 2003; Fiedler *et al*., 2007; Csata and Dussutour, 2019). This study help contributing in addressing how habitat typicality affects ant composition, and in the long run provide useful information for managing and conserving ecosystems.

Table 2. Diversity Indices of Ant Community at Three Habitats in Emil Salim Biodiversity Park, Sawahlunto City, West Sumatra, Indonesia

Habitat	Number of species	H' index	Category
Forest	7	1.09	Moderate
Acacia agroforestry	3	1.06	Moderate
Paddy field	2	0.69	Moderate

Sampling Rate Based on Pan Trap Color

In this study, pan traps with blue containers were more frequently visited by ants than the white or yellow ones (Table 3). Blue pan traps captured the highest diversity and abundance of ants, while yellow ones showed the least effectivity. Previous study examined the efficiency of Malaise and blue pan traps in capturing pollinators in forested environments (Campbell and Hanula, 2007; Westerberg *et al*., 2021). It was concluded that pan traps with blue coloration worked the most efficient for sampling insects. Additionally, it was discovered that putting Malaise traps with certain coloration had helped captured more pollinator insects; emphasized that certain distinct pollinator groups exhibited preferences for particular colour (Das and Das, 2023). Pan traps generally yielded more captures of pollinators than the Malaise traps.

Using a wide array of coloured pan-traps helps to efficiently sample a vast diversity of flower-visiting insect species. Despite this research indicated the blue pan-trap gained the most sampling, many previous studies indicated that the yellow ones had higher successful rate in capturing pollinator insects rather than the blue ones. Saunders and Luck (2013), for instance, found that albeit the capture varied by environments, the yellow pan traps collected the most insects above other colours ones used. It was also effectively applied to sample native Hymenoptera in natural or semi-natural habitats (e.g. gardens), while the blue pan-traps were more successful at mallee environments such as almond gardens. While the debate on which more effective between blue- or yellow coloured pan-traps, the data from previous studies, the yellow and white pan traps are suitable for surveying pollinating insects, while blue ones are for estimating the abundance and diversity of insects in general (Kočíková *et al*., 2012; Kočíková *et al*., 2014; Csanády *et al*., 2021).

Table 3. Trapping yield based on trap colour at Emil Salim Biodiversity Park, Sawahlunto City, West Sumatra, Indonesia (B: blue, W: white; Y: yellow)

No	Species	B	W	Y	TOTAL
1	*Dolichoderus thoracicus* (F. Smith, 1860)	0	1	0	1
2	*Tapinoma melanocephalum* (Fabricius, 1793)	2	0	0	2
3	*Camponotus arrogans* (F. Smith, 1858)	2	1	1	4
4	*Camponotus bedoti* Emery, 1893	0	1	0	1
5	*Nylanderia* sp.	1	0	0	1
6	*Anoplolepis gracilipes* (F. Smith, 1857)	2	0	0	2
7	*Pheidole* sp.	1	0	0	1
8	*Crematogaster fraxatrix* Forel, 1911	2	1	0	3
9	*Crematogaster quadriruga* Forel, 1911	1	0	0	1
10	*Tetramorium indicum* Forel, 1913	1	0	0	1
11	*Monomorium floricola* (Jerdon, 1851)	2	0	0	2
Total number of ant individual		**14**	**4**	**1**	**19**
Total number of ant species		**9**	**4**	**1**	**11**

It is hardly to specify a single colour assigned to trap all targeted insects in various types of habitats, it is emphasized the significance of taking habitat variables into account while conducting trap surveys (Saunders and Luck, 2013). Aside from further exploring the effectivity of yellow and blue pan trap for sampling non-Formicid Hymenopterans, paying more attention to canopy cover and light conditions could provide essential insights (Abrahamczyk *et al.*, 2010). It is also recommended to compare the use of pan traps at forest with various structural configurations to justify the effectiveness of trap colour. While ants are generally not considered as common pollinators, they play role in pollinating some succulent and other low-growing plants, particularly in hard, dry soils where other pollinators may be scarce. In addition, ants tend to collect nectar without performing effective cross-pollination. Ants exude natural substances from its body surface that act as antibiotics that protect them from infections which in most case also kill pollens that come into contact with them, render their ineffectiveness as pollinators.

CONCLUSION

The diversity of vegetation in a certain habitat influences ants' diversity in ESBP. Secondary forest habitat was found to harbor more ant species than the *Acacia* agroforestry or rice field, as dense vegetation is deemed to be rich with resources needed by ants. Majority of ant inventory found at ESBP showed preference for blue pan traps as resulted in more sampling yielded than what observed in traps with other color used in this study. More researches are needed to reveal the effectiveness of using certain color for traps that capture insect specimens.

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