AN ELEVATIONAL SURVEY OF HONEYBEE SPECIES IN MARAI PARAI, MOUNT KINABALU

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ABSTRACT

The honeybees (*Apis* spp.) constitute a monophyletic genus with ten recognised species exhibiting notable geographic variations. Sabah hosts five honeybee species, spanning the *Micrapis, Megapis*, and *Apis* clades. This study aims to establish the baseline data on the altitudinal distribution of honeybee species in Marai Parai, the northwestern side of Kinabalu Park. Samples were collected over a five-day period using opportunistic netting techniques. Species were identified based on morphological characters using published identification keys. The honeybees were collected on three elevations, including Nunuk Subcamp (1177m a.s.l), Nabalu Sambau (1400m a.s.l.) and Marai Parai Subcamp (1696 m a.s.l.) consisting of three different forest types of lowland dipterocarp forest, oak-chestnut montane forest and ultramafic forest respectively. The majority of the collection was carried out at 1177m a.s.l. (58.73%), followed by 1696m a.s.l. (34.92%) and 1400m a.s.l. (6.35%), reflecting the variability in sampling effort. Four out of five honeybee species known in Sabah were collected: dwarf honeybee *A. andreniformis*, giant honeybee *A. dorsata*, and two cavity-nesting honeybees *A. cerana* and *A. nuluensis*. Six different foraging sites were recorded in this study, including cut banana trees, herbaceous plants, wet ultramafic rocks, wet cut wood logs, food waste, and cut wood logs. More research should be conducted on honeybee species, diversity, and elevational distribution in Kinabalu Park to gain a deeper understanding of their foraging behaviour and ecological roles.

Keywords: *honeybees, altitudinal distribution, Kinabalu Park, morphological characters, foraging sites*

INTRODUCTION

The honeybees (*Apis* spp.) comprise a small, monophyletic genus. There are currently ten recognised species in *Apis*, each exhibiting considerable geographic variabilities. Today's honeybees constitute three clades: *Micrapis* (the dwarf honeybees), *Megapis* (the giant honeybees) and *Apis* (the cavity-nesting honeybees) (Seeley, 2014). Of the ten recognised honeybee species, Borneo has six species spanning all three clades. The distribution and ecology of honeybees have been studied extensively due to their importance as pollinators and apiculture products (Oldroyd & Wongsiri, 2009). Situated in the northern expanse of Borneo, Sabah, Marai Parai is the primary habitat for a diverse array of honeybee species, with five recorded here (Smith et al., 2020). Marai Parai offers diverse elevations and forest types that make it ideal for studying the honeybee distribution. These include cavity-nesting honeybees *Apis cerana, A. koschevnikovi, A. nuluensis,* dwarf honeybee *A. andreniformis,* and giant honeybee *A. dorsata* (Koeniger et al., 2006; Ingel, 2012; Jones & Wang, 2018). An elevation-wide distribution of the honeybee species in Sabah has yet to be studied. This study addresses a critical research gap by providing the first baseline survey of honeybee distribution across elevations in Sabah. The baseline studies are crucial for understanding species distribution, informing conservation strategies, and monitoring ecological changes over time.

MATERIAL AND METHOD

Study site

Honeybee specimens were collected from 9 to 13 October 2023 during the Marai Parai - Gurkha Hut Scientific Expedition 2023 at Kinabalu Park (6.08186N, 116.52095E) (Figure 1). Marai Parai - Gurkha Hut was gazetted as a World Heritage Site by UNESCO in December 2000, situated on the northwestern side of Mount Kinabalu. In this study, three different sampling locations were covered, including two subcamps out of four subcamps available during the expedition, which are the Nunuk Subcamp (1177m a.s.l.) and Marai Parai Subcamp (1696m a.s.l.). Nabalu Sambau (1400m a.s.l) is along the way from Nunuk Subcamp to Marai Parai Subcamp. In Nunuk Subcamp, the lowland rainforest has dipterocarp trees and dense understorey vegetation (Martin et al., 2002). Along the way up to Marai Parai Subcamp, in Nabalu Sambau, the forest type is the Lower Montane Oak-Chestnut Forest that is dominated by conifers and oaks with thick ground cover and a presence of epiphytes (Sabah Parks, 2023). At the highest elevation of Marai Parai Subcamp, a Local Ultramafic Forest occurred, covered with ultramafic rocks, dominated by pitcher plants, slipper orchids and graminoid (Antony et al., 2016) (Figure 2).

Sample collection

The honeybee samples were collected using opportunistic netting over a five-day period. After consulting with Kiau Nuluh, Kota Belud and Sabah Park rangers for honeybee ('Pomosuon') information, opportunistic honeybee netting was decided as the sampling strategy. The forager honeybees were collected using a standard butterfly net. The sampling effort for Nunuk Camp (1177m a.s.l.) is two hours, Nabalu Sanbau (1400m a.s.l.) is one and a half hours, and Marai Parai (1696m a.s.l.) is two hours. The coordinates where the foragers were captured were recorded using the Garmin GPSMAP® 64sWW. Honeybee samples were stored in an Eppendorf Tube with 99% Ethanol and identified at the Institute for Tropical Biology and

Conservation, Universiti Malaysia Sabah. Curated specimens were deposited at the BORNEENSIS and a duplicate set with Sabah Parks Entomology section.

Morphological identification

All specimens were identified using honeybee morphological keys (Koeniger et al., 2006; Ingel, 2012; Burrows et al., 2021). A representative sample for each species was cleaned using 99% ethanol before being placed on the pinning block for pinning. The pinning process was done by holding the specimen between the thumb and forefinger in one hand, and the pin was inserted through the scutum on the thorax using a size two pin. The pinned sample is then dried in the 65°C oven overnight. The dried pinned samples were labelled and stored in an insect collection box at the BORNEENSIS Insect Collection Room.

RESULTS

During the five-day sampling period in the Marai Parai - Gurkha Hut Expedition, covering the sampling area from the Nunuk subcamp to the Marai Parai subcamp, 63 specimens of honeybees were collected. All the specimens were then identified into four species: giant honeybee *Apis dorsata*, dwarf honeybee *Apis andreniformis*, and two cavity-nesting honeybees, *Apis cerana* and *Apis nuluensis*. We did not manage to collect the lowland cavity-nesting honeybee *Apis koschevnikovi*. We collected 23 *Apis nuluensis*, 10 *A. cerana*, 17 *A. andreniformis*, and 11 *A. dorsata* foragers. The two unidentified insects are likely fly-mimicking honeybees as it does not key into any honeybee species (Table 1). The most honeybee foragers collected were in Nunuk subcamp, 1177m a.s.l. (58.73%), followed by the Marai Parai subcamp, 1696m a.s.l. (34.92%) and Nabalu Sanbau area, 1400m a.s.l. (6.35%) (Table 1). This study recorded six different foraging sites: cut banana trees, herbaceous plants, wet ultramafic rocks, wet-cut wood logs, food waste, and cut wood logs (Figure 3).

DISCUSSION

In this survey, four out of five honeybee species known to exist in Sabah were collected. The species include the giant honeybee (*Apis dorsata*), dwarf honeybee (*Apis andreniformis*), cavity-nesting honeybee (*Apis cerana*), and the highland endemic cavity-nesting honeybee (*Apis nuluensis*). The collection of these species indicates the preliminary observation of the ecological diversity and adaptability of honeybee species in the Marai Parai region. This diversity is crucial for understanding the resilience of honeybee populations in varying environmental conditions and provides a baseline for future research focused on conservation and biodiversity assessment in this ecologically significant area.

The presence of *Apis dorsata* up to 1177m a.s.l. but not at higher elevations aligns with previous observations that this species prefers nesting in lowland forests on exposed tree branches (Sihag, 2017; Jones & Wang, 2018). *Apis andreniformis*, typically found in lowland areas, was recorded at 1177m a.s.l. and 1400m a.s.l., suggesting some elevation movement, possibly due to seasonal changes (Wongsiri et al., 1996). *Apis cerana*, known for its adaptability, was found at both 1177m a.s.l. and 1400m a.s.l., indicating its capacity to thrive in diverse environments (Radloff et al., 2010; Koetz, 2013; Li et al., 2019). The highland endemic *Apis nuluensis* was observed at elevations from 1400m a.s.l. to 1696m a.s.l., consistent with its known distribution range (Tingek et al., 1996; Koeniger et al., 2006). However, the

abundance of the honeybee species collected across the different elevations in this study does not reflect the true species distribution pattern because of the uneven sampling effort. Additionally, honeybees can disperse over considerable distances and altitudes, which further complicates the interpretation of their apparent abundance at specific sites.

The observation of honeybees foraging on a variety of substrates, including cut banana trees, herbaceous plants, wet ultramafic rocks, and food waste, highlights their diverse foraging behaviour. These findings suggest that honeybees utilise a range of resources for essential nutrients, which is vital for colony survival (Botch & Judd, 2011; Mishra et al., 2013; Lau & Nieh, 2016; Chakrabarti et al., 2020; Hakami et al., 2020). However, these observations are based on a limited number of samples and should be interpreted as initial insights rather than definitive patterns.

The intriguing observation of honeybees foraging on cut wild banana trees presents an engaging information to be explored. The presence of honeybees on wet ultramafic rocks might suggest mineral foraging, a behaviour observed in other floral-diet insects that seek soil and water sources for essential salts and minerals (Chakrabarti et al., 2020; Hakami et al., 2020). Foragers are also collected on cut wild banana trees. The sap produced once the banana tree was cut may contain carbohydrates rich in potassium, calcium and magnesium (Barhanpurkar et al., 2015; Islam et al., 2023). Interestingly, banana trees also contain isoamyl acetate, a compound that is the very same as that which is in honeybees' alarm pheromone (Ndiege et al., 1991; Schwarcz, 2022). The sap's composition and the presence of isoamyl acetate in the banana tree are promising candidates for creating baits that attract honeybee foragers. While these observations provide interesting insights, they remain speculative and require further investigation.

The significance of this study lies in its contribution to the baseline understanding of honeybee species, diversity and distribution in Kinabalu Park. The documentation of the presence of five honeybee species across different elevations shows that this study provides valuable preliminary data that can inform future research efforts. The identification of these species highlights the ecological richness of the Marai Parai region and underscores the need for more comprehensive and systematic surveys.

Future studies should aim to standardise sampling efforts and incorporate statistical analyses to better understand the ecological dynamics of honeybee populations in this area. Detailed longitudinal studies with replicated sampling across multiple seasons and years will be crucial to uncover the true patterns of honeybee distribution and foraging behaviour (Turley et al., 2022). Investigating the impact of environmental factors, such as climate change and habitat disturbance, on honeybee populations will also provide deeper insights into their ecological roles and conservation needs.

While this study still provides the valuable preliminary data on the honeybee species present in the Marai Parai region, more systematic and replicated studies are necessary to draw clear and robust conclusions about the elevational distribution and foraging behaviour of honeybees in Kinabalu Park.

CONCLUSION

This elevational survey of honeybees captures four out of five honeybee species found in Sabah. A more systematic and standardised bee sampling effort and nest location will provide a more thorough understanding of Kinabalu Park's elevational distribution of honeybee species.

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APPENDIX

Table 1. Incidence of *Apis* foragers collected across sampling elevations during the Marai Parai Expedition. The two unidentified specimens are likely flies mimicking honeybee species as they do not match honeybee identification keys.

Species	Total abundance	1177m a.s.l.	1400m a.s.l.	1696m a.s.l.
Apis nuluensis	**23**	0	1	22
Apis cerana	**10**	8	2	0
Apis dorsata	**11**	11	0	0
Apis andreniformis	**17**	16	1	0
Unidentified sp.	**2**	2	0	0

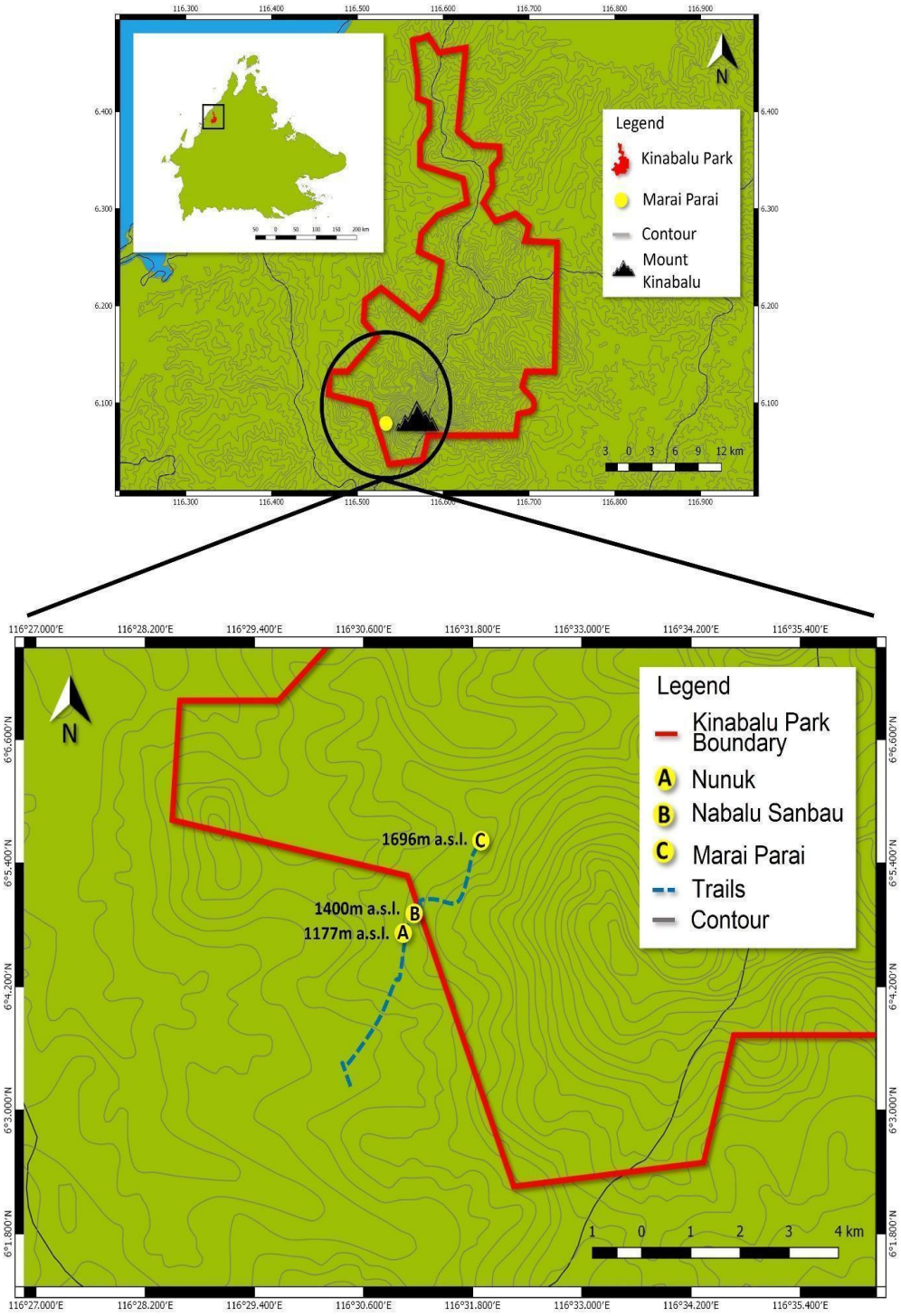

Figure 1. Map of Marai Parai Subcamp, Kinabalu Park, Sabah. Collections were carried out at all three subcamps.

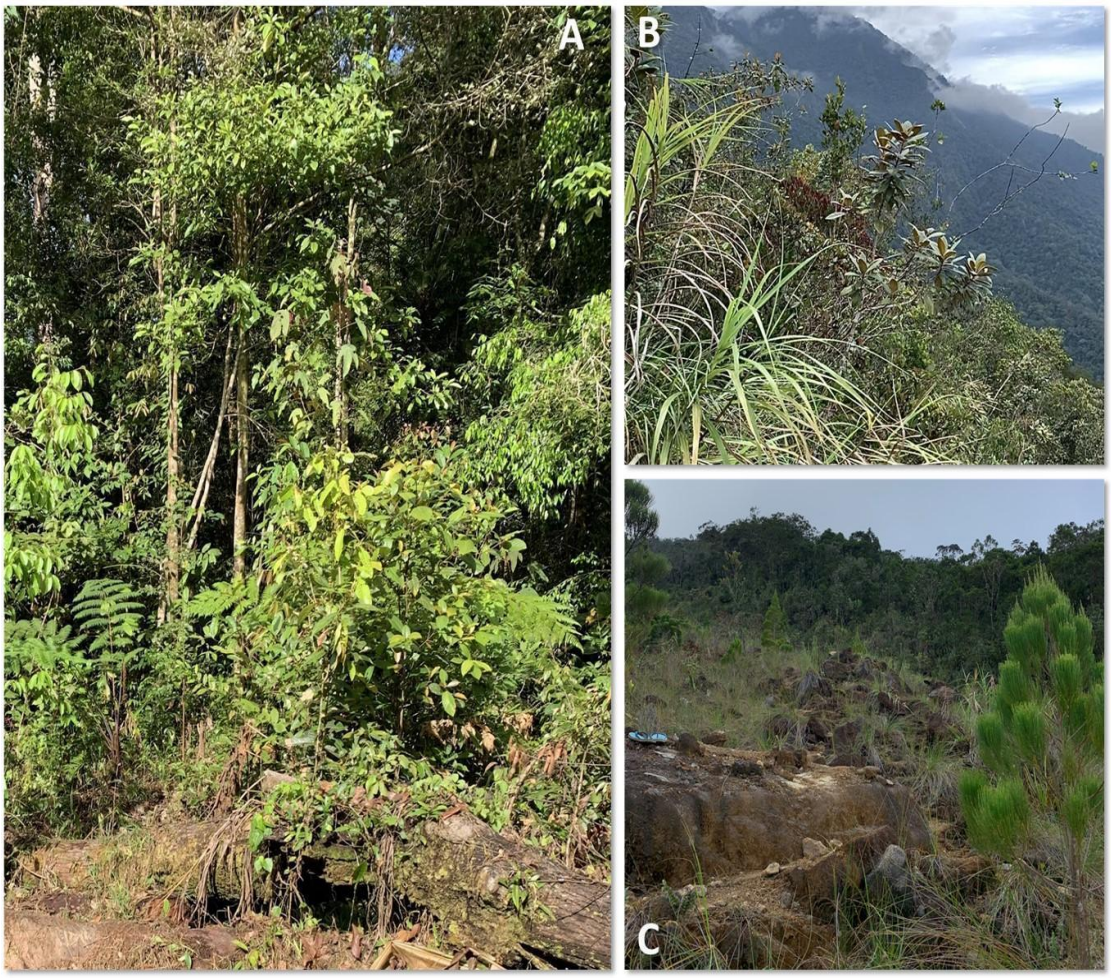

Figure 2. Forest type in Marai Parai Gurkha-Hut Expedition. A. Lowland dipterocarp forest with a dense understorey of Nunuk Subcamp 1177m a.s.l. B. Lower Montane Oak-Chestnut Forest that is dominated by conifers and oaks in Nabalu Sambau 1400m a.s.l.. C. Local ultramafic forest with ultramafic rocks and germinoid 1696m a.s.l.

Figure 3. Foraging sites of honeybees during the expedition. A. *Apis andreniformis* on the food waste accumulated at the basecamp B. *Apis dorsata* on the cut banana leaf C. *Apis nuluensis* on the wet ultramafic rocks. D. Three species of honeybee (Left to right, *Apis dorsata* and *Apis cerana* respectively, Bottom, *Apis andreniformis*) foraging on liquids on the wet cut wood log (Photographed by: Dominic, L.).