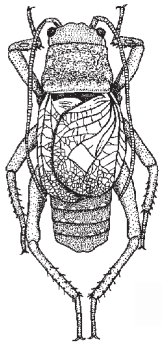

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TERMITE *HOSPITALITERMES BICOLOR* (HAVILAND, 1898) (ISOPTERA: TERMITIDAE) AS A SUPPLEMENTARY PROTEIN SOURCE FOR SUMATRAN ORANGUTAN (*PONGO ABELII*) IN THE SWAMP FORESTS OF SUMATRA

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Summary. The Sumatran orangutan (*Pongo abelii* Lesson, 1827) is an endemic and critically endangered primate. One important but less-studied component of its diet is termites, particularly the open-air processional species *Hospitalitermes bicolor* (Haviland, 1898). Results revealed that *H. bicolor* colonies were widely distributed in lowland peat swamp habitats, with a mean density of 3.4 colonies/ha. Foraging trails extended up to 28 m from the nest and termites were most active during the late afternoon (15:00–18:00). Orangutans consumed termites opportunistically, with 17 feeding events observed, suggesting that termites provide a supplementary protein source. The findings highlight the significance of termites in orangutan diets and provide new insights into the cross-taxa interactions between primates and termites in tropical forest ecosystems.

Key words: termites, colony density, trail formation, temporal foraging activity, orangutan diets, Indonesia.

Мунавира Н., Ризки А, Сутекад Д., Новита Н., Фитри А., Сяукани С. Термит *Hospitalitermes bicolor* (Haviland, 1898) (Isoptera: Termitidae) как дополнительный источник белка для суматранского орангутана (*Pongo abelii*) в болотистых лесах острова Суматра // Дальневосточный энтомолог. 2026. N 543. С. 1-9.

Резюме. Суматранский орангутан (*Pongo abelii* Lesson, 1827) – эндемичный и находящийся под угрозой исчезновения примат. Важным, но малоизученным компонентом его рациона являются термиты, в частности, открыто живущий вид *Hospitalitermes bicolor* (Haviland, 1898). Показано, что колонии *H. bicolor* широко распространены в низинных торфяных болотах со средней плотностью 3,4 колонии/га. Кормовые тропы простирались на расстояние до 28 м от гнезда, и термиты были наиболее активны в конце дня (с 15 до 18 часов). Орангутаны потребляли термитов по мере возможности, было зафиксировано 17 случаев кормления, что позволяет предположить, что термиты *H. bicolor* являются дополнительным источником белка. Полученные данные подчеркивают значимость термитов в рационе орангутанов и дают новое представление о межвидовых взаимодействиях между приматами и термитами в тропических лесных экосистемах.

INTRODUCTION

The Sumatran orangutan (*Pongo abelii* Lesson, 1827) is among the most critically endangered great apes, with fewer than 14,000 individuals remaining in the wild, mostly confined to the Leuser Ecosystem in northern Sumatra (Singleton *et al*., 2024). As highly frugivorous primates, orangutans depend on a diverse range of food sources, but their diet also includes insects, especially termites, which can provide essential protein and micronutrients (Wich *et al*., 2011; Russon *et al*., 2009).

Among termite prey, open-air processional species of the genus *Hospitalitermes* Holmgren, 1912 (Termitidae: Nasutitermitinae) are ecologically distinctive. These termites forage in conspicuous columns across the forest floor and vegetation, often in large numbers, making them a readily available food resource for predators, including primates (Jones & Prasetyo, 2002; Syaukani & Thompson, 2011). The species *Hospitalitermes bicolor* (Haviland, 1898) is widely distributed in Southeast Asian lowland rainforests and is known for its efficient trail organisation and foraging behaviour.

Although the general ecology of orangutans has been well-documented, few studies have concentrated on their interactions with termites, especially in terms of foraging ecology. Understanding these interactions is vital not only for primate behavioural ecology but also for recognising the broader ecological significance of termites in tropical forests (Collins, 1989; Eggleton, 2000).

The present study examines the foraging ecology of *H. bicolor* in the peat swamp forests of Suaq Balimbing, Leuser Ecosystem, and its function as a food source for Sumatran orangutans. Specifically, we aim to: (1) map the distribution and density of *H. bicolor* colonies, (2) outline their foraging behaviour and daily activity, and (3) record orangutan feeding events involving termite processions.

MATERIAL AND METHODS

Study site

Fieldwork was carried out in the peat swamp forest of Suaq Balimbing (3°02′ N, 97°25′ E), situated within the Leuser Ecosystem, South Aceh, Sumatra, Indonesia (Fig. 1). The site exemplifies a lowland peat swamp habitat, characterised by permanently waterlogged soils, high humidity, and an extensive closed canopy dominated by *Shorea* spp. and other Dipterocarpaceae. The understory is relatively open but contains dense patches of palms (Plectocomiopsis spp.) and climbers. Mean annual rainfall exceeds 3000 mm, with minimal seasonal variation, and average monthly temperatures range from 25–28 °C, reflecting an equatorial climate regime. The peat deposits in Suaq Balimbing reach several metres in depth, supporting specialised vegetation adapted to nutrient-poor, acidic soils. Suaq Balimbing has been recognised as a long-term orangutan research station since 1990, hosting one of the largest habituated populations of *Pongo abelii* (van Schaik & Azwar, 1991; Wich *et al*., 2011).

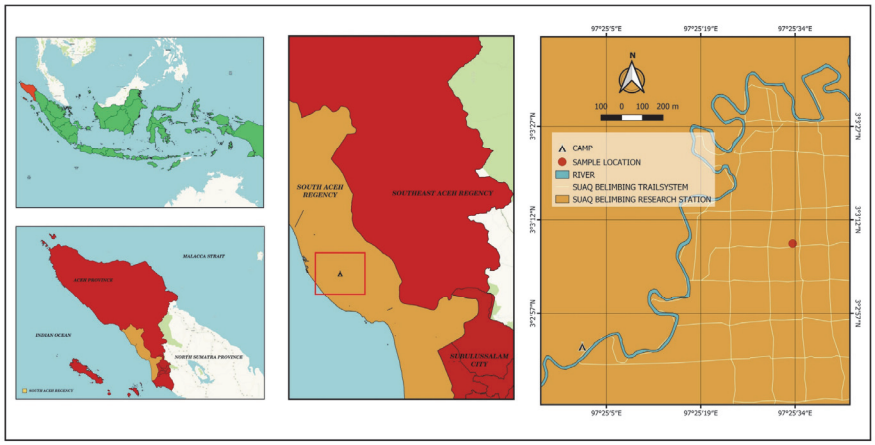

Fig. 1. Research location and sample collection site of *Hospitalitermes bicolor* in the peat swamp forest of Suaq Balimbing, Leuser Ecosystem, Sumatra (N 03°03.1666′, E 097°25.5523′).

Orangutan observations

Orangutan feeding behaviour was documented between April and September 2024 using focal animal follows (Altmann, 1974). Habituated individuals from the Suaq long-term study population were observed for 6–8 hours each day, covering both morning (06:00–11:00) and afternoon (12:00–18:00) activity periods. During these follows, all feeding events involving termites were recorded ad libitum, including: (i) the identity, sex, and age class of the focal orangutan; (ii) the time of

encounter with termite processions; (iii) the duration of the termite feeding bout; and (iv) the context of the encounter (e.g., during travel, fruit feeding, or resting). The behavioural definitions adhered to standard protocols for primate feeding ecology (Russon *et al*., 2009; Harrison *et al*., 2010). Feeding duration was measured with a digital stopwatch to the nearest minute.

Termite colony surveys

To assess the abundance and distribution of *H. bicolor*, five parallel line transects were established in representative peat swamp forest areas. Each transect measured 500 m in length and 5 m in width (2.5 m on either side of the central line), covering a combined sampling area of 1.25 ha. Colonies were located by visually following processional trails back to the nest entrances, which were typically situated at the bases of trees or within root buttresses. For each colony, the following variables were recorded: GPS coordinates, microhabitat type, and distance to the nearest tree with DBH> 20 cm.

Foraging trails were measured using a 50 m measuring tape, with length recorded as the maximum distance from the nest entrance to the visible end of the procession, and width as the average across three points along the trail. To document diel activity, trail monitoring was conducted at 5-hour intervals (06:00, 11:00, 16:00, 21:00, and 02:00) over a series of 48-hour observation periods. Trails were scored for activity intensity on a semi-quantitative scale (low, medium, high), based on procession width and termite movement density (Miura & Matsumoto, 1997).

Data analysis

Colony density was determined by the number of colonies per hectare, expressed as mean ± standard error (SE). Foraging trail measurements (length, width) were summarised using descriptive statistics (mean ± SE, range). Temporal activity patterns were displayed as relative frequencies of activity intensity across observation intervals. Orangutan feeding events were standardised as the number of termite-feeding bouts per 100 hours of observation, and the proportion of observation hours with termite feeding was calculated. Differences in termite foraging intensity across time intervals and in orangutan feeding duration among age–sex classes were evaluated descriptively due to the small sample size.

RESULTS

Colony distribution and density

A total of 17 colonies of *H. bicolor* were recorded along the five transects, with a mean density of 3.4 ± 0.6 colonies per hectare. Colonies were unevenly distributed across the study site. The highest frequency of nests was found in transects crossing low-lying peat swamp habitats, whereas upland forest margins had comparatively

fewer colonies. Colonies were commonly situated at the bases of large trees (Dipterocarpaceae and Myristicaceae), where root buttresses and dense litter offered shelter and microclimatic stability. In several instances, multiple colonies were found within 50 m of one another, indicating that favourable microsites support localised clustering.

Foraging trails and temporal activity

The foraging trails of *H. bicolor* extended between 12 and 28 metres from nest entrances, with an average length of 19.6 ± 1.8 metres. Trail width varied from 2.1 to 3.4 centimetres, and trails were clearly visible as dark moving bands against the forest floor. Although most trails were confined to ground surfaces, around 24% of observed trails extended onto fallen logs, decaying woody debris, or low understory vegetation (Fig. 2). This behaviour increased the accessibility of termites to arboreal mammals, including orangutans.

Fig. 2. Feeding trail of *Hospitalitermes bicolor* in the Suak Balimbing forest, Sumatra.

Temporal monitoring over 48 hours revealed that foraging activity occurred throughout the day, though not evenly. The highest activity was seen in the late afternoon (15:00–18:00), when procession widths were at their largest and termite movement was most noticeable. Less activity was observed in the early mornings (06:00–09:00) and midday (11:00–13:00). Night observations were not conducted; however, several inactive trails were visible at dawn, indicating reduced nocturnal foraging.

Orangutan feeding observations

During focal follows, a total of 17 termite-feeding events by orangutans were documented. Feeding was opportunistic, occurring when individuals encountered

active termite processions while travelling or foraging for fruits and young leaves (Fig. 3). Both adult females (n = 6 events) and juveniles (n = 4 events) consumed termites, whereas adult males were not observed engaging in termite feeding during the study period.

Feeding bouts lasted 3–12 minutes (average 7.1 ± 0.9 minutes), during which orangutans collected termites directly from the moving processions and ate them without obvious processing. Feeding frequency did not vary significantly across months of observation, but more events occurred in the late afternoon, coinciding with the peak of termite foraging activity. On several occasions, orangutans were seen pausing their travel to exploit termite trails for several minutes before resuming plant foraging.

Fig. 3. Sumatran orangutan feeding termites in the peat swamp forest of Suaq Balimbing, Sumatra.

DISCUSSION

The present study offers the first systematic documentation of the foraging ecology of *H. bicolor* and its role in the diet of Sumatran orangutans in Suaq Balimbing. Colony densities of *H. bicolor* (3.4 colonies/ha) were relatively high for a peat swamp forest environment and comparable to reports of other Nasutitermitinae in lowland and hill dipterocarp forests of Southeast Asia (Jones & Prasetyo, 2002; Syaukani & Thompson, 2011; Thapa, 1981). The tendency for colonies to cluster in low-lying areas near tree bases suggests a microhabitat preference related to moisture stability and litter accumulation, consistent with patterns observed for processionary termites in Borneo and Peninsular Malaysia (Tho, 1992; Miura & Matsumoto, 1997).

The observed foraging trails of *H. bicolor* (12–28 m long, 2–3 cm wide) reflect the highly conspicuous group-foraging behaviour characteristic of the genus. Similar processionary movements have been described in *Hospitalitermes hospitalis* and *H. umbrinus*, in which trails facilitate the mass exploitation of patchily distributed leaf litter and woody debris (Collins, 1989; Miura & Matsumoto, 1997). The peak in foraging activity during late afternoon parallels findings in other Nasutitermitinae, in which diel rhythms are shaped by microclimatic factors such as humidity, temperature, and predation risk (Jones & Prasetyo, 2002; Evans *et al*., 2011). These traits not only enhance termite survival but also increase their detectability by visually oriented predators, including primates and birds.

The opportunistic consumption of termite processions by orangutans in this study highlights the dietary flexibility of *Pongo abelii*. Although orangutans are primarily frugivorous, insects may provide an important supplementary source of protein, fat, and micronutrients, particularly when fruit availability is low (Russon *et al*., 2009; Wich *et al*., 2011). Insectivory has been widely documented in African apes, where chimpanzees (*Pan troglodytes*) use tools to extract termites and ants (McGrew, 2001; Fowler *et al*., 2007), and gorillas (*Gorilla gorilla*) consume termites as part of a fallback strategy (Yamagiwa et al., 2005). In contrast, orangutan insectivory has been reported less frequently, likely reflecting both ecological variation in termite availability and methodological differences in behavioural sampling (Russon *et al*., 2009; Harrison *et al*., 2010). The consistent observations of termite consumption in Suaq Balimbing, therefore, expand our understanding of orangutan dietary ecology and suggest that termites may play a more significant role than previously recognised.

The alignment of orangutan feeding events with peak afternoon termite activity suggests a temporal synchrony that reduces orangutan search effort and enhances foraging efficiency. Such cross-taxon behavioural overlaps have been observed in other primate–insect interactions, including capuchins exploiting diurnal peaks in ant activity (Boinski & Fowler, 1989) and chimpanzees targeting termite swarms (McGrew, 2001). For orangutans, which must balance high energetic costs of locomotion with unpredictable fruit availability, exploiting accessible termite processions may be an adaptive strategy that cushions against nutritional shortfalls (Knott, 1998; Vogel *et al*., 2012).

From a conservation perspective, documenting orangutan–termite interactions offers further insight into the ecological networks that support peat swamp forest ecosystems. Termites are recognised as key ecosystem engineers, contributing to decomposition, nutrient cycling, and soil aeration (Eggleton, 2000; Bignell & Eggleton, 2000; Jouquet *et al*., 2011). The persistence of their colonies benefits not only orangutans but also a diverse range of other taxa reliant on soil fertility and forest productivity. Protecting peat swamp habitats is therefore essential, as their degradation would weaken termite populations, disrupt ecosystem processes, and threaten higher trophic levels, including critically endangered primates. Conservation strategies should thus combine the safeguarding of orangutan habitats with the preservation of the invertebrate communities vital to their survival, underscoring the importance of a multi-trophic perspective in biodiversity conservation.

CONCLUSION

This study shows that *H. bicolor* is an ecologically important termite in the peat swamp forests of Suaq Balimbing, providing a supplementary protein source for the critically endangered Sumatran orangutan. Colony densities were relatively high, and processional foraging behaviour increased the accessibility of termites to orangutans. Feeding was opportunistic but occurred consistently, especially in the late afternoon when termite activity was at its peak. These findings highlight the importance of insectivory in orangutan foraging ecology and emphasise the need to conserve peat swamp habitats where primate–termite interactions take place.

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