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THE HABITAT CHARACTERISTICS OF JAVAN LUTUNG (*Trachypithecus auratus*) IN BANDEALIT COASTAL FOREST AT MERU BETIRI NATIONAL PARK, EAST JAVA, INDONESIA

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ABSTRACT

Javan lutung (*Trachypithecus auratus*) is an endemic primate species which mostly occurs in protected areas, such as the Bandealit Resort of Meru Betiri National Park (MBNP), East Java, Indonesia. However, scientific information related to the habitat characteristics of *T. auratus* in this resort is limited. Therefore, the aim of this study is to investigate the habitat characteristics of *T. auratus* based on the vegetation stratification in the Bandealit coastal forest of MBNP. This research was conducted in March, April, May, and September 2022 using the scan sampling methods at two sites, including Site I (Camping Ground Block) and Site II (Wisma Block). The data on tree species was collected using a plot method (40 m x 20 m). Furthermore, we used the Spatially Explicit Individual-based Forest Simulator (SexI-FS) version 2.1.0 to construct the stratification profile. Based on the results, there were 17 individuals of *T. auratus* found in two sites along the observation. This species is recorded as occupying seven tree species, including *Alstonia scholaris, A. spectabilis, Calophyllum inophyllum, Dracontomelon* sp*., Pongamia pinnata, Syzigium* sp*.* and *Terminalia catappa*. According to stratification, *T. auratus* was found in Stratum B (21-30 m) to Stratum C (5-20 m) at all sites. Furthermore, this species was widely distributed in Stratum C for locomotion, foraging, social activities and self-protection. Meanwhile, *T. auratus* was observed using *A. spectabilis* in Stratum B as a sleeping tree in the afternoon and evening. These results can be the basis for in-situ conservation strategies for *T. auratus* species in MBNP, particularly for habitat management based on occupied vegetation.

Key words: Bandealit coastal forest, Javan lutung, Meru Betiri National Park, stratification

INTRODUCTION

The Javan lutung (*Trachypithecus auratus* (É. Geoffroy Saint-Hilaire, 1812)) is a species of Cercopithecidae that is restricted to Java, Bali, and Lombok (Dwijayanti et al., 2020; Nijman, 2021). This species is protected by the Indonesian government through Minister of Environment and Forestry Regulation Number P.106/MENLHK/SETJEN/KUM.1/12/2018. It is due to a decreasing population over the last three decades. The population of *T. auratus* decreased by >30% during 1986–2020; thus, this species was listed in the vulnerable category in the International Union for Conservation of Nature (IUCN) Red List (Nijman, 2021) and Appendix II in Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). There are several factors that cause threats to this species, such as poaching, land conversion, illegal trade, and habitat destruction (Shepherd, 2010; Nijman, 2021).

Habitat destruction causes *T. auratus* to seek safer areas away from human disturbance, such as in the conservation area of Meru Betiri National Park (MBNP) East Java, Indonesia (Syarief et al., 2018; Rusdi et al., 2018). This species is widely distributed in several habitat types at the Bandealit Resort of MBNP, i.e., tropical rainforest, mangrove forest, and coastal forest (Rusdi et al., 2018). Coastal forest vegetation in the Bandealit resort has a relatively dense canopy cover (Angio et al., 2022). It is suspected to support the ecological activity of *T. auratus*, as reported by Astriani et al. (2015) in Balanan Resort of Baluran National Park, that this primate species prefers to occupy dense vegetation, particularly in overlapping crown cover areas. It is also similar to Maulahila et al. (2023), who reported that *T. auratus* in Kucur Resort of Alas Purwo National Park was found to be more active in dense vegetation areas.

Tree vegetation is a crucial resource for *T. auratus* in its natural habitats. In particular, tree vegetation is used by *T. auratus* for locomotion (Subarkah et al., 2011), foraging (Wardhana et al., 2022), sheltering (Maulahila et al., 2023), and self-protection from predators (Ayunin et at., 2014). As reported by Rusdi et al. (2018), some tree vegetation types are also used for sleeping trees. This species has a variety of diets, including leaf, seed, fruit, and flower (Tsuji et al., 2019; Wardhana et al., 2022; Putra et al., 2024), so it acts as a primary consumer in the forest ecosystem. Besides, the daily movement of *T. auratus* in vegetation plays a direct role in the seed dispersal process and forest regeneration (Tsuji et al., 2017). Thus, both *T. auratus* and tree vegetation have an interdependence on each other. Vegetation stratification consisting of several canopy layers is essential to support the Javan lutung habitat. However, information on vegetation stratification in the Bandealit coastal forest as a habitat characteristic of *T. auratus* is still not available.

Previous research related to the ecology of *T. auratus* in the Bandealit coastal forest has been reported by Rusdi et al. (2018) through local distribution and habitat as well as percent canopy, temperature and humidity. Tree stratification is important to be studied because it is suspected to affect the daily activities of *T. auratus*. According to the lack of data, it is necessary to investigate the habitat characteristics of *T. auratus* based on tree stratification in the Bandealit coastal forest, MBNP. These results will provide current information related to which canopy level is occupied by *T. auratus*, so that the dataset can be useful for MBNP management in planning in-situ conservation of *T. auratus* in coastal forest habitat.

MATERIALS AND METHODS

Study Sites

This research was conducted in March, April, May, and September 2022 in Bandealit coastal forest at MBNP (Fig. 1). There are two sites for data collecting, i.e., Site I Camping Ground Block (8°28’51.03”S, 113°42’40.48”E) and Site II Wisma Block (8°28’58.57”S, 113°42’50.84”E). Site determination was considered by reports from Rusdi et al. (2018), previous observations in February 2022 and MBNP staff information.

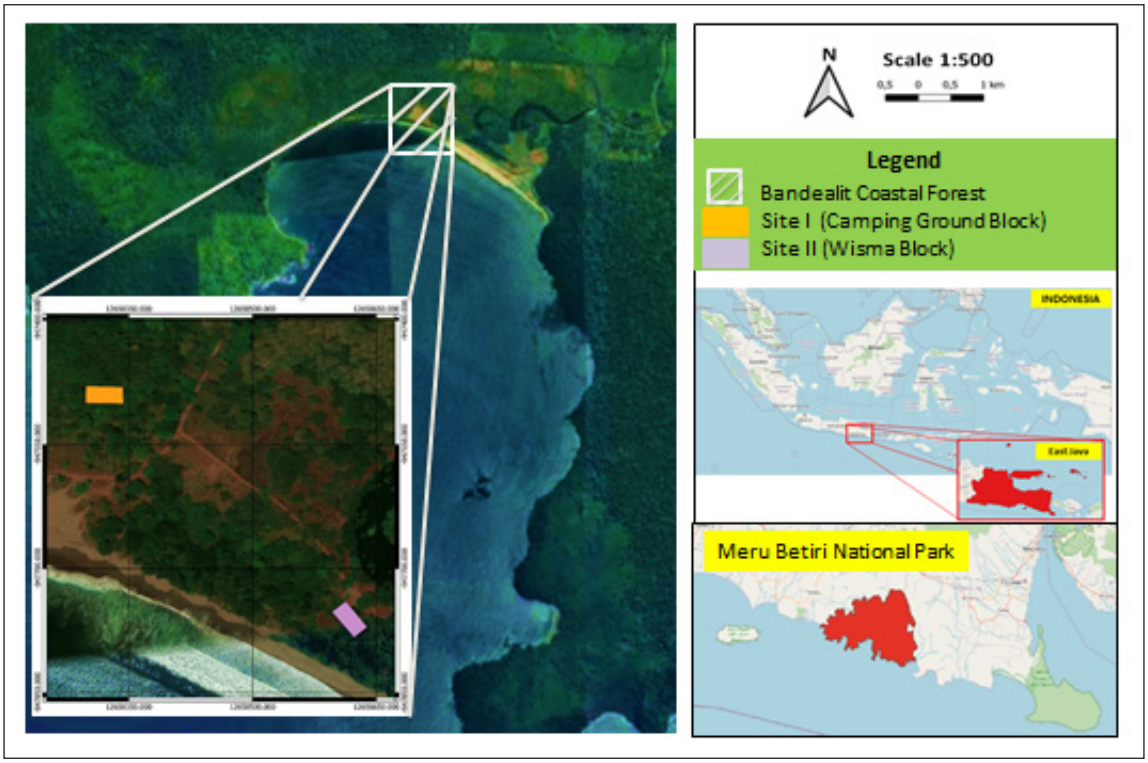

Figure 1. Study area in Bandealit Coastal Forest of Meru Betiri National Park.

Vegetation Analysis

The measurement of vegetation stratification was carried out using the plot method with a size of 40x20m at two sites. This plot size and placement have been adjusted to the homerange area of Javan lutung in the Bandealit coastal forest. It was proven the high occurrence of Javan lutungs happened in these sites during previous observations in February 2023. Vegetation data collected included tree species, number of individuals of each tree species, tree diameter, total tree height, branch-free tree height, crown height and width, and distance between trees in the observation plot. This is measured directly with a measuring tape and clinometer. The data were analyzed using Spatially Explicit Individual-based Forest Simulator (SExI-FS) software version 2.1.0 to construct forest profile diagrams (Harja & Vincent, 2008). Furthermore, we also measured the correlation between existence of Javan lutung with tree vegetation (species richness and diversity) using Rstudio program version 3.2.1 (R Core Team, 2021). Ultimately, the correlation between Javan lutung and tree species was performed by Principal Component Analysis (PCA) in Rstudio program version 3.2.1 (R Core Team, 2021).

Data Collection of Javan lutung

We observed Javan lutungs using the scan sampling method (Altmann, 1974; Darmono, 2020) in both study areas. Observations were conducted three times, including 07.00–09.00 AM, 11.00 AM–13.00 PM, and 15.00–17.00 PM using an Aculon Powerview 10 x 50 binoculars,

a Canon EOS 60D DSLR camera, a Thamron 75–300 mm Tele Lens, and stationery. During this study, we obtained the Javan lutung encounter 12 times at Wisma Block and six times at Camping Ground Block. The ecological data collected included the total individuals in the group, ecological activities (resting, foraging, infant-handling, socializing, self-protection, and locomotion), the type of tree occupied by each individual, and the height of the tree occupied by each individual.

Stratification Analysis of Javan lutung

The stratification analysis of Javan lutung was carried out descriptively and illustrated on a forest profile diagram. The process of overlaying the occurrence of Javan lutung in the forest profile diagram was carried out manually using the CorelDRAW 2021 application. The layer of occupied vertical strata follows Septiawan et al. (2017) with five categories, i.e., stratum A (>30 m), stratum B (21–30 m), stratum C (5–20 m), stratum D (1-4 m), and stratum E (<1 m).

RESULTS

The results recorded that one group of Javan lutung occupied the Bandealit coastal forest area of MBNP. This group consisted of 17 individuals and composed of adults (10 individuals), juveniles (5 individuals), and infants (2 individuals) (Fig. 2). According to morphological characteristics (Rowe, 1996; Supriatna & Wahyono, 2000), infants have striking characteristics of being small, still being carried by their mothers, and having orange hair, while juveniles and adults are larger and have black hair (Fig. 3). There were six ecological activities of Javan lutung recorded during the observation, including locomotion (38%), self-protection (20%), resting (15%), socializing (12%), infant-handling (9%), and foraging (6%) (Fig. 2).

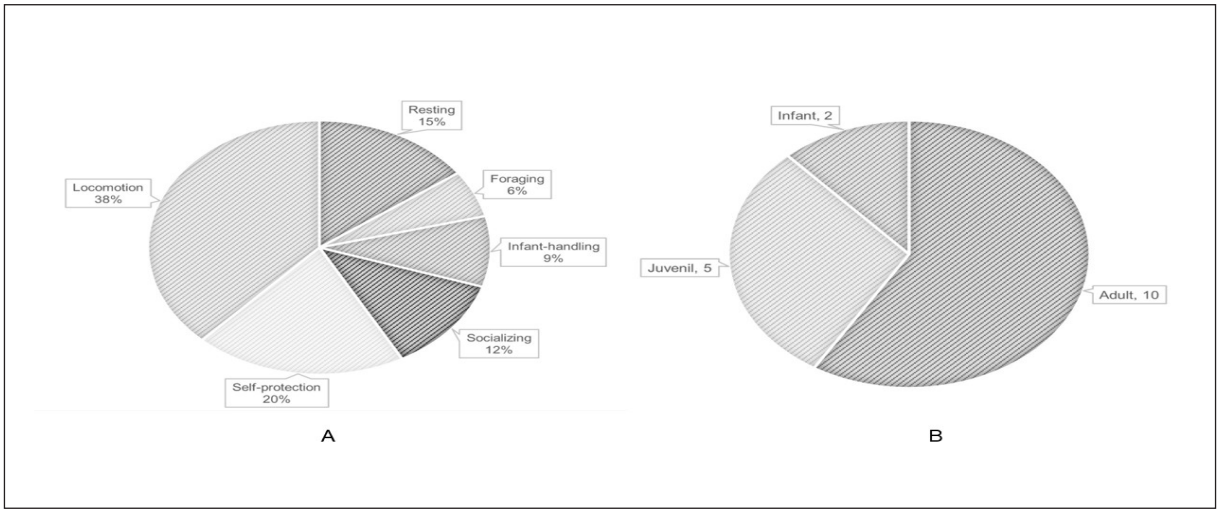

Figure 2. Percentage of activities (A) and age structure of Javan lutung in Bandealit Coastal Forest, MBNP, East Java, Indonesia (B).

The Javan lutung group in this study was found at both observation sites with different vegetation characteristics (Table 1). There were 13 tree species belonging to nine families recorded in both sites, but only seven tree species were occupied by the Javan lutungs, including *Dracontomelon* sp.*, Alstonia scholaris, A. spectabilis, Calophyllum inophyllum, Syzigium* sp., and *Terminalia catappa*. Furthermore, the diversity index (H') of tree species in the study site is 2.35, which is in the medium category. Based on the evenness index (J'), the value is in the high category of 0.91, which means no dominant tree species in terms of the number of individuals, with a totally individual ranges 1-6 individuals.

Table 1. Species composition of tree vegetation in Bandealit Coastal Forest, MBNP

Tree Family	Tree Spesies	∑ individuals	Tree Height (m)	Sites
Anacardiaceae	*Dracontomelon* sp.*	1	14	I
Apocynaceae	*Alstonia scholaris**	6	5 - 13	I
	*Alstonia spectabilis**	2	24 – 28.5	I & II
	Tabernaemontana macrocarpa	4	8 – 11	I
Calophyllaceae	*Calophyllum inophyllum**	2	6 – 22	I & II
Combretaceae	*Terminalia catappa**	4	15 – 20.5	II
Euphorbiaceae	*Mallotus mollissimus*	1	25	II
Fabaceae	*Erythrina* sp.	4	8.5 – 17.5	II
	*Pongamia pinnata**	6	6 – 19	I & II
Myrtaceae	*Syzygium* sp. *	2	15	I & II
Moraceae	*Artocarpus elasticus*	1	23	II
	Ficus racemosa	1	9	II
Primulceae	*Ardisia humilis*	1	17	II
Diversity Index (H') = 2.35				
Evenness Index (J') = 0.91				

Notes: *occupied by Javan lutung

Principal Component Analysis (PCA) showed that age structure of Javan lutungs have different tree preferences for ecological activities between juveniles and adults (Fig. 3). The adults occupied seven tree species, including *Alstonia scholaris, A. spectabilis, Terminalia catappa, Syzigium* sp.*, Dracontomelon* sp.*, Pongamia pinnata* and *Calophyllum inophyllum*. While juveniles were only found in five trees, including *Alstonia scholaris, A. spectabilis, Terminalia catappa, Syzigium* sp. and *Calophyllum inophyllum*. The highest tree preference for the adult category is *Alstonia spectabilis*, while for the juvenile category it is *Syzigium* sp. The value obtained in this PCA analysis is 0.2229, with a standard deviation of 1.2491.

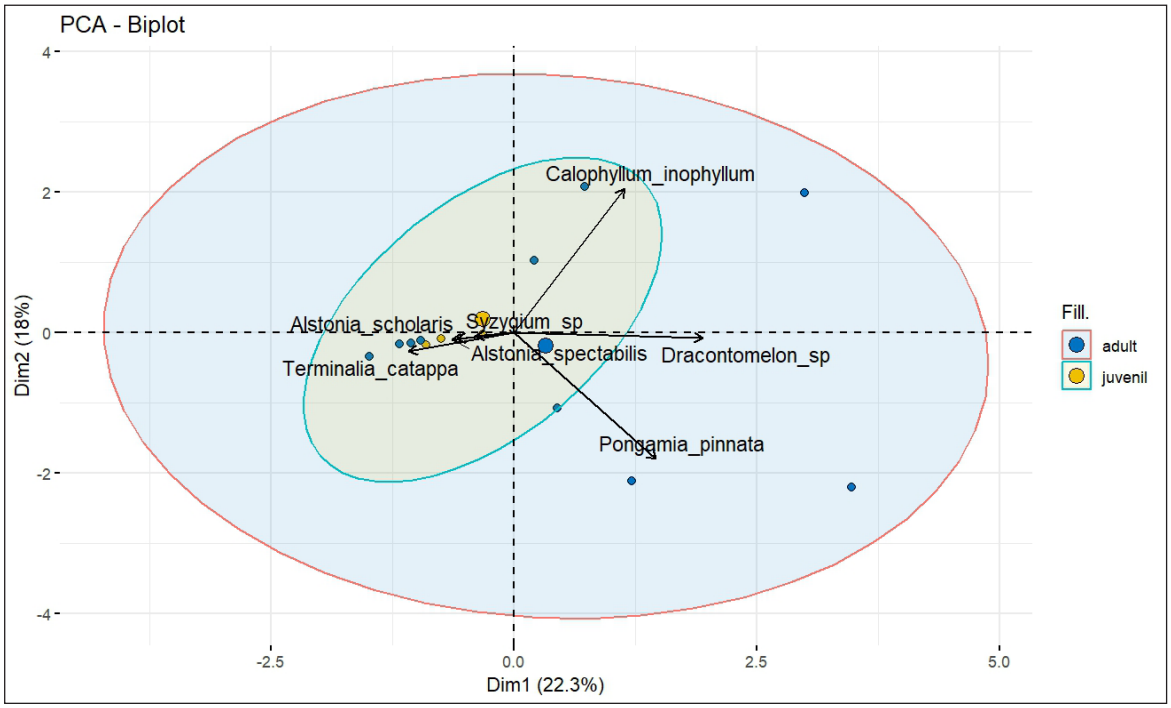

Figure 3. Principal Component Analysis between Javan lutung and tree species in Bandealit coastal forest at Meru Betiri National Park.

According to correlation results between Javan lutung presence and ecology index, it shows that Javan lutung prefer areas with high tree species richness. Secondly, the Javan lutung was also more observed in areas with higher tree diversity (Fig. 4). This suggests that this arboreal species prefers areas with high tree richness and diversity.

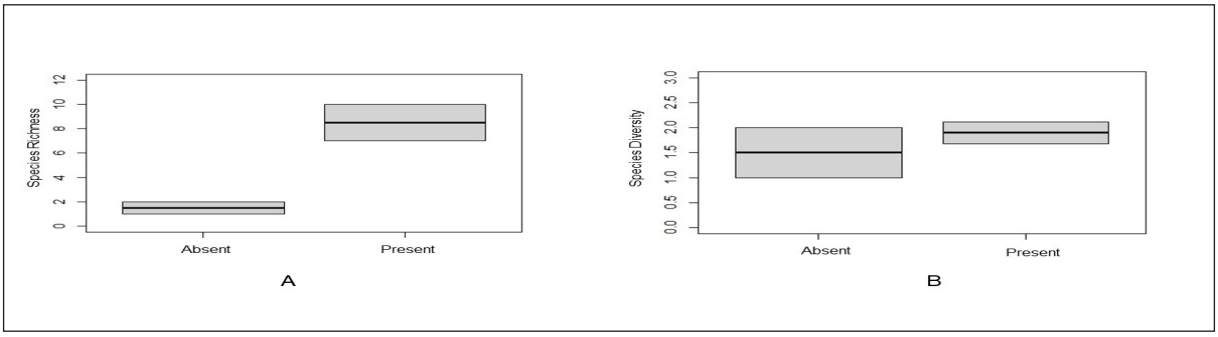

Figure 4. The occurrence of Javan lutung on species richness of tree species (A) and species diversity of tree species (B).

Four activities (resting, socializing, self-protection, and foraging) were observed in stratum C on *Terminalia catappa* trees. However, in the evening, this species was also recorded occupying stratum B on *Alstonia spectabilis* trees in Site II as sleeping trees. Based on visualization, adult Javan lutung were recorded eating young leaves of *T. catappa* and fruit (unidentified) (Fig. 5). Infant-handling activities were also recorded in stratum C (*T. catappa*) trees and stratum B (*P. pinnata*) trees.

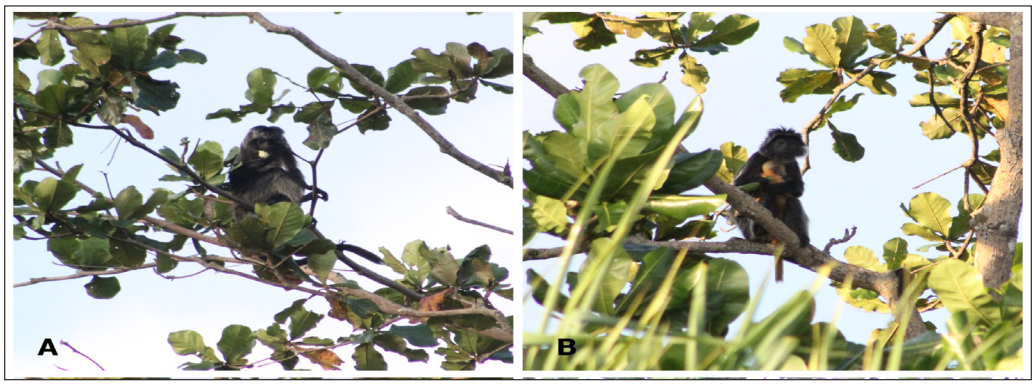

Figure 5. Documentation of Javan lutung: foraging activity (A) and resting with infant handling (B). Photos by A.M. Siddiq

Furthermore, locomotion activity was recorded in stratum B and C in several tree species, such as *Dracontomelon* sp*., Alstonia scholaris, Calophyllum inophyllum, Terminalia catappa, Syzigium sp*., and *Pongamia pinnata.* It was recorded that alpha males followed females and juveniles that moved from one tree to another (Fig. 6).

Figure 6. Locomotion of male Javan lutung in the Bandealit Coastal Forest of MBNP. Photos by A.M. Siddiq

Site 1 (Camping Ground Block) consisted of 10 tree species with an average height of 15.2 m, while Site II (Wisma Block) consisted of seven tree species with an average height of 12.1 m. Javan lutung in Site I was found occupying five tree species, including *Alstonia spectabilis, Pongamia pinnata, Syzigium sp., Dracontomelon sp.,* and *A. scholaris*. Furthermore, in Site II, this primate species occupied three tree species, including *Terminalia catappa, Calophyllum inophyllum,* and *Alstonia spectabilis*. Stratum C was dominant in both sites, such as Site I

(stratum B: 40% and stratum C: 60%), then Site II (stratum B: 20% and stratum C: 80%). According to the stratum levels, Javan lutung preferred to occupy stratums C (5–20 m) and B (21–30 m) in both observation sites (Fig. 7).

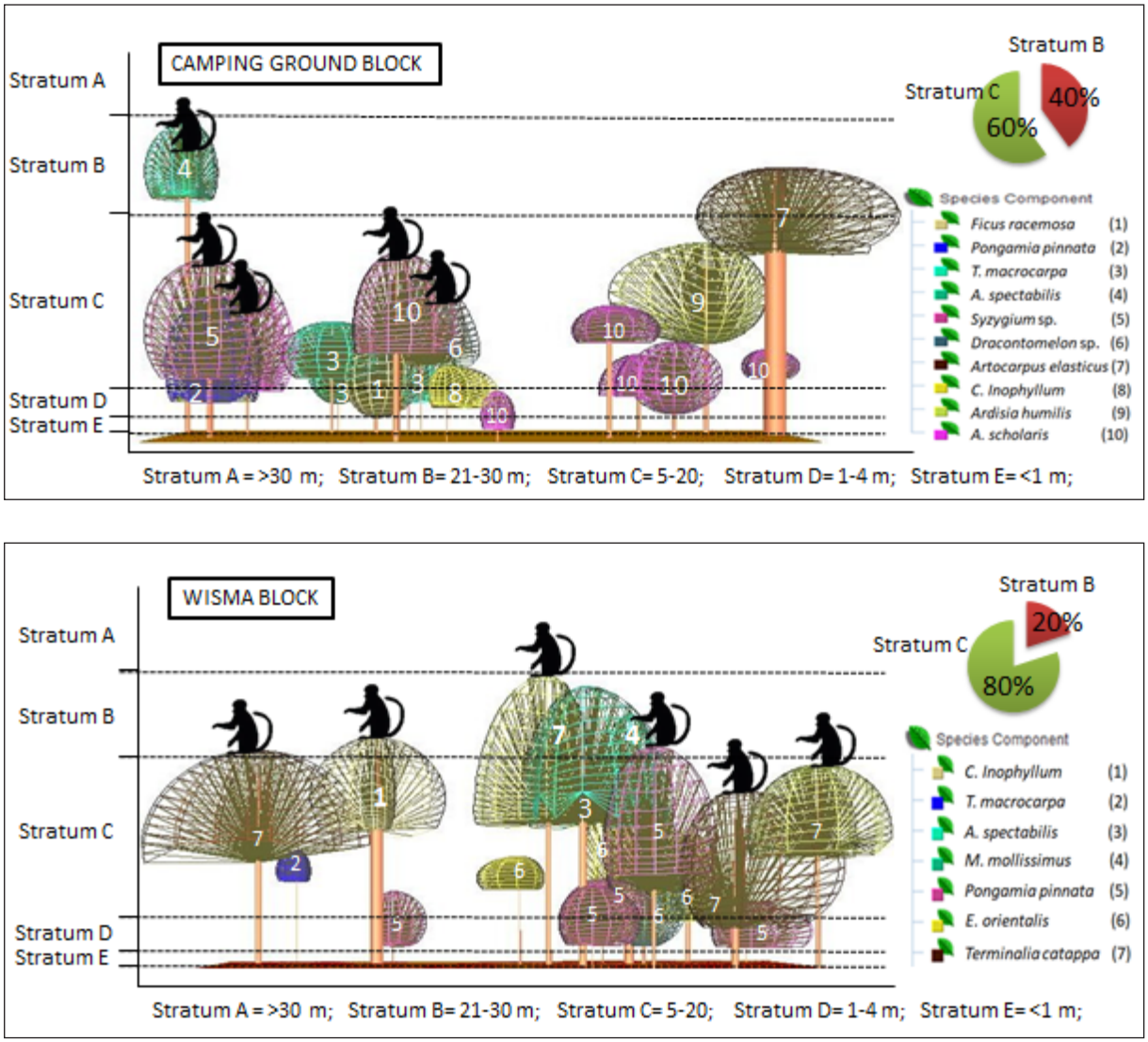

Figure 7. Forest Diagram Profil of Javan lutung in Bandealit Coastal Forest of MBNP.

DISCUSSION

The Javan lutung observed during this study were 17 individuals in a group, consisting of adult males and females, juveniles, and infants. This suggests that this group has an adequate population structure. However, further research needs to be done regarding the sex ratio clarification in this group. On the other hand, the existence of Javan lutung in Bandealit coastal forest indicates that the forest provides lutung's primary needs such as food, shelter and sleeping trees. This result is in accordance with previous reports, which revealed that Javan lutung group in the Bandealit coastal forest area consisting of 6–18 individuals (Rusdi et al., 2018).

Javan lutung were observed to occupy stratum C (5–20 m) more than other strata. This is due to the height of the constituent vegetation, which is mostly in stratum C; thus, the canopy connectivity in this stratum is higher. It is required for Javan lutung to move from one tree to another in order to carry out their activities. Javan lutung were observed locomoting from Site I to Site II, with the connectivity formed by the canopy in stratum C. This is in accordance with the statement of Subarkah et al. (2011) that Javan lutung require high canopy connectivity for locomotion, social activities, protection and feeding.

The food sources for Javan lutung are mostly found in stratum C; hence, the availability of food species in this stratum is sufficient. Most of the tree species in stratum C at Sites I and II are food sources for Javan lutung. There are two tree species in Bandealit Coastal Forest also found in Watangan Natural Reserve, such as *Artocarpus elasticus* and *Syzygium* sp. (Asyrofi et al., 2022) with more species in Leuweung Sancang Natural Reserve, such as *Terminalia catappa, Pongamia pinnata, Ardisia humilis,* and *Calophyllum inophyllum* (Mustari & Pasaribu, 2019). Javan lutung were most abundant in strata C and B on *Terminalia catappa* trees at Site II. These primates were observed climbing to the canopy to feed on leaves, especially young leaves. This is consistent with Tsuji et al. (2019), who revealed Javan lutung feeds more young leaves (69.9%) than fruit (21.2%).

Furthermore, Javan lutung also used tree vegetation for sleep or rest. This species was observed occupying stratum B of the *Alstonia spectabilis* tree in Site I in the afternoon; therefore, it is suspected that this diurnal primate uses *Alstonia spectabilis* as a sleeping tree. However, this was only observed once during the observation, and the Javan lutung was not found sleeping in the tree. Therefore, it is assumed that Javan lutung sleep in different trees every day. This is in accordance with the results of Mustari and Pasaribu (2019), who found that Javan lutung tend to use more than one type sleeping tree. This arboreal primate will often change sleeping trees but can return to the original sleeping tree for a long time. The purpose is to protect itself from diseases due to parasite infection from its own faeces. The *Alstonia spectabilis* tree is the highest tree (24–28.5 m) in Site I which is needed for Javan lutung to self-protect from terrestrial predation.

Javan lutung were found using stratum B less than stratum C. It is due to the fact that trees with a height of >20 m were only found in a few individuals at the sites. This condition causes the canopy at this height to be more open and less dense, so that the locomotion of Javan lutung is limited. While stratum C has a higher density. These results are in accordance with the research of Sulistyadi et al. (2013), which revealed that Javan lutung occupies stratum C (82.40%) and stratum B (16.31%). Other Cercopithecidae species, such as the Bornean langur (*Presbytis chrysomelas cruciger*) (Musyaffa & Santoso, 2020) and the booted macaque (*Macaca ochreata*) (Fairuztania & Mustari, 2017), also use strata C and B for their ecological activities. Stratum A does not exist in these sites, so the Javan lutung were only observed in stratum B. While strata D and E were also not observed because Javan lutung are more active on the trees (arboreal) and rarely found going down to the ground. Based on these results, it can be concluded that the average height of trees in this research area affects the use of vegetation

stratum by Javan lutung. The highest vegetation height was in stratum B, so Javan lutung were found to occupy stratum B as a place to sleep, rest and shelter. Stratum C is the most occupied by Javan lutung because it is related to canopy connectivity and the presence of food trees that support their needs.

Finally, the existence of tree vegetation in an area is a pivotal requirement for the Javan lutung. This is evidence in the results of this study, which show that this species prefers high tree richness and diversity. The existence of these tree species is important to the ecological activities of Javan lutung. In the Bandealit coastal forest, Javan lutung was mostly observed with locomotion activities that utilize tree vegetation, as well as several other essential activities such as self-protection, resting, socializing, infant-handling and foraging. The results of this study can be a significant scientific basis for MBNP to design a strategy for in-situ conservation of Javan lutung, in particular to maintain the existence, richness and diversity of tree vegetation, which is an essential aspect of Javan lutung habitat.

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