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Population and distribution of Javan langur (*Trachypithecus auratus* Geoffroy E. 1812) in Sokokembang Forest, Petungkriyono Sub-district, Pekalongan District, Central Java, Indonesia

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Abstract. *Al-Huda IR, Nayasilana IN, Masyithoh G, Setiawan A. 2024. Population and distribution of Javan langur (*Trachypithecus auratus *Geoffroy E. 1812) in Sokokembang Forest, Petungkriyono Sub-district, Pekalongan District, Central Java, Indonesia. Biodiversitas 25: 1514-1520.* Sokokembang is one of the potential habitats that provide a source of feed, means of movement, and shelter for Javan langurs (*Trachypithecus auratus* Geffroy E, 1812), which are one of the threatened Colobinae, the endemic primate of Java and Bali. Javan langur has been in decline for the last three generations. Javan langur conservation requires data and assessment of natural habitat distribution, size, and condition. This study aims to determine the population size and distribution pattern of Javan langurs in the Sokokembang forest, Central Java, Indonesia, which can be used as a basis for habitat management. The demography parameters used in this study were the population size, population density, age structure, and sex ratio. The study has been conducted from May to June 2023 on plots 18 to 21 of Sokokembang forest, Central Java. The study used the concentration count method and the nearest neighbor analysis using Arcmap 10.8. Eleven groups were identified, with the population size of each group ranging from 3 ± 23 individuals. The population density of Javan langurs was 7.46 individuals/km^2. The age structure of Javan langurs in Sokokembang was dominated by the adult age class, and the male-to-female sex ratio was 1:3. The results showed a random distribution pattern of Javan langurs in the Sokokembang forest.

Keywords: Distribution, Javan langur, Nearest Neighbor Analysis, population, Sokokembang

INTRODUCTION

Indonesia is a mega biodiversity country because of an abundant diversity consisting of gen diversity until species diversity was found in Indonesia (Ruskhanidar 2017). One species diversity was found in the primate group, including Javan langur. Javan langur (*Trachyphitecus auratus* Geoffroy E. 1812) is one of the threatened Colobinae that are endemic primates of Java and Bali. Javan langur belongs to arboreal primates that spend most of their lives on trees. In the Javan langur habitat, the role of vegetation other than as a source of feed is as a sleeping tree and also a protector of Javan langurs from predators because Javan langur's activities are mostly carried out on trees or arboreal (Sontono et al. 2016). The Javan langur population was estimated to have decreased by 30% over the last three generations (36 years or 1984 to 2020); this species decline is due to habitat decline and poaching (Nijman 2021). One of the efforts to maintain the existence of Javan langurs is to maintain the quality and quantity of their habitat (Eliana et al. 2017).

Javan langurs (*Trachypithecus auratus*) were categorized as primates protected since 1999 based on the Decree of the Minister of Forestry and Plantations Number: 733/Kpts-11/1999 concerning the Determination of Javan langur (*Trachypithecus auratus*) as a protected animal. The decision was strengthened by the Regulation of the Minister of Environment and Forestry concerning Protected Plant and Animal Types Number: P.106/MENLHK/SETJEN/KUM.1/12/2018 and is included in the Vulnerable category according to the IUCN Red List 2021. Meanwhile, according to CITES, the Javan langur is included in the Appendix II category. According to Sulistyadi et al. (2013), the decline of Javan langur species results from forest degradation and fragmentation, which leads to habitat isolation. This condition can further threaten the sustainability of the Javan langur population and other animals.

Javan langur population numbered only 2,700 individuals in 2010. It spread across various locations on Java Island, including protected forests, national parks, nature reserves, and botanical forest parks based on Javan langur Center/JLC records (Wahyu 2021). Sokokembang forest is one of the habitats of Javan langur. The habitat of the Javan langur is spread from lowland rainforests to highland forests with an altitude of 1,600 meters above sea level (masl). The size of the Javan langur's home range can reach 15 hectares, and there is usually little overlap with the home range of other Javan langur groups (Leca et al. 2013). Javan langur conservation efforts require data and assessment of the distribution, size, and condition of the Javan langur population in its natural habitat. Sokokembang is a potential habitat that provides a source of feed, means of movement, shelter, and sleeping trees for Javan langurs.

This forest in Petungkriyono stores very high biological wealth (Fatmasari et al. 2017). Sokokembang Forest is a limited protected forest based on the Decree of the Minister of Forestry Number 359/Menhut.II/2004 concerning the Designation of Forest and Water Areas of Central Java Province. This area is a habitat for various types of primates, including javan gibbons (*Hylobates moloch*), surili (*Presbitys comate*), Javan langurs (*Trachypithecus auratus*), and long-tailed monkeys (*Macaca facscicularis*) and was dominated by vegetation from the families Moraceae and Myrtaceae with tree species that can be found in the form of *Ficus* sp., *Artocarpus* sp., *Eugenia* sp., *Syzygium* sp., and *Myristica* spp. (Utari 2018)

According to Mustari and Pasaribu (2019), the demographic parameters of Javan langurs are population size, population density, age structure, sex ratio, natality, and mortality rates. Demographic parameters are specific characteristics used to describe and analyze a population. This study aims to determine the population and distribution of Javan langurs in the Sokokembang forest, which can be used as a basis for habitat management. Our objectives were to obtain total population size, group size, age structure, sex ratio, population density, and distribution pattern of Javan langur in Sokokembang.

MATERIALS AND METHODS

Study area

This study was located in Sokokembang forest, Kayupuring Village, Petungkriyono Sub-district, Pekalongan District, Central Java, Indonesia. Especially on plot 18 to plot 21, which has a land area of 1338 km^2. The location and path of observation can be seen in Figure 1. Sokokembang Forest is included in the mixed secondary forest type, with a land area of 65.69 km^2. Sokokembang Forest is located in the Petungkriyono Forest area at 600-1,700 masl. This research activity has been carried out from May to June 2023.

Procedures

Collecting data

This study used the concentration count method with the observation location point determined through an initial survey conducted on routes that often found Javan langurs based on information from the management, previous research, and the surrounding community. Mustari and Pasaribu (2019) state that this method is suitable for calculating Javan langur populations with group patterns. Data collection of Javan langur population size was carried out during the active hours of Javan langur, namely in the morning and evening. The data taken from this population size observation is the number of groups and individuals in each group.

This age structure data collection is done by recording the number of individuals in each age class in a group. The age class differences used in field identification based on Napier and Napier (1967) were referred to in Mustari and Pasaribu (2019) and divided into Table 1.

The calculation of the sex ratio is only done in the adult age class because it is difficult to do for the juvenile and infant age classes. After all, the sex difference is still very small to be seen. The data recorded in this observation were the number of male and female adult individuals in one group. Physical characteristics of male and female Javan langurs based on Lim and Sasekumar (1979) were referred to in Mustari and Pasaribu (2019) and can be seen in Table 2.

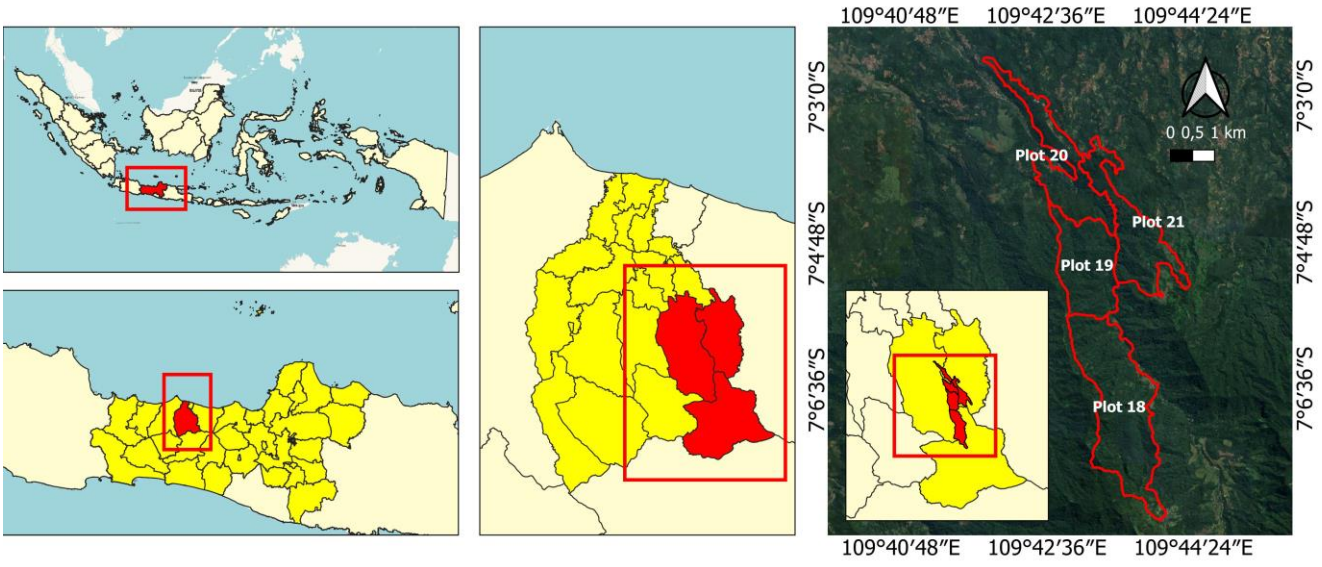

Figure 1. Location of plot 18-21 in Sokokembang Forest, Petungkriyono Sub-district, Pekalongan District, Central Java, Indonesia

Table 1. Javan langur individual characteristic by age class

Category	Age range	Physical feature
Infant	0-4 years	The body size is still small, the hair is yellow-orange, still suckling, and is in the arms of the mother
Juvenile	4-8 years	Medium body size, sexual characteristics are not too visible, the color already resembles an adult individual, has been able to mobilize itself, but is still around the mother
Adult	8-20 years	The dominant behavior supervises the physical organs that have developed perfectly, especially the sexual organs (mature sex), and generally have the largest body size compared to the age class below

Table 2. Javan langur characteristic by sexual characteristic

Category	Physical feature
Male	The body is larger than females, the head is pursed and crested, and has testicles, some make sounds in the form of distinctive screams as a sign
Female	It has a vaginal vulva, has hanging nipples. There is a clear difference in females, namely an irregular yellowish-white field on the female's pelvis and pale feathers on the rump and back that are blacker than the back of the male langur

Data analysis

Population size

Santoso (2014) states that population size refers to the number of individuals of a primate species living in a particular area; it means that the population size is the total size of the Javan langur group in the Sokokembang forest. The number of individuals in a group of Javan langurs is determined by calculating the highest number of individuals in a group ever recorded at the same observation location (Höing et al. 2013).

Age structure

Determination of age structure used an approach based on Hidayatullah (2015) and Andarini et al. (2021) by considering the age range, age interval, and number of individuals to obtain an annual average.

$$Annual\ average = \frac{Number\ of\ Individual}{Age\ interval\ (years)}$$

Sex ratio

The sex ratio is the ratio of adult male Javan langur and adult female Javan langur in one population (Wahyu 2021).

$$Sex\ Ratio = male : female$$

Population density

The equation used to calculate the population density of Javan langurs in the study is based on Santoso (2014) and Wahyu (2021):

$$D = \frac{Xi}{A}$$

Where: D is the number of population density of the species, *Xi* is the number of individuals or population size in the area, and A is the area of research location.

Distribution pattern

Data analysis of Javan langur's distribution patterns was carried out using the Nearest Neighbour Analysis introduced by Clark and Evans, a quantitative geographic analysis method used to determine distribution patterns using ArcGIS 10.8 software.

RESULTS AND DISCUSSION

Javan langur population data

Based on the group identification results, 100 Javan langur individuals divided into 11 groups were observed (Table 3). The study's group structure of Javan langur varies between 3 to 23 individuals per group. Therefore, to avoid accumulating the number of individuals at the widest age interval, the age structure can be calculated using the same age interval or annual average composition (Santosa 2008; Rahmawati and Hidayat 2017). Based on Figure 2 of the age structure of Javan langur in the Sokokembang Forest based on the annual average, the comparison results show that the age structure of the seven groups of Javan langurs in the Sokokembang forest is dominated by young individual age classes (infant and juvenile). Adult individuals dominate the three groups; one group has the same age structure as young and adult individuals.

Javan langur distribution data

The group analysis results identified 11 groups of Javan langur scattered in the Sokokembang forest (Figure 3). Plot 20 is the plot with the highest distribution of Javan langur groups; 4 groups of Javan langur are observed in the plot. In comparison, the distribution of the lowest Javan langur group was identified in plot 19 and plot 21; only 2 groups were observed in each.

Table 3. Data population of Javan langur at Sokokembang, Pekalongan District, Central Java, Indonesia

Group	Total ind.	Age class			Sex		Sex ratio
		Infant	Juvenile	Adult	Male	Female	
1	13	1	5	7	1	6	1 : 6
2	6	1	1	4	1	3	1 : 3
3	9	-	2	7	2	5	1 : 3
4	9	3	-	6	1	5	1 : 5
5	4	1	-	3	1	2	1 : 2
6	7	2	-	5	1	4	1 : 4
7	7	2	-	5	1	4	1 : 4
8	8	1	1	6	2	4	1 : 2
9	3	1	-	2	1	1	1 : 1
10	11	-	4	7	1	6	1 : 6
11	23	2	6	15	3	12	1 : 4
Total	100	14	19	67	15	52	1 : 3

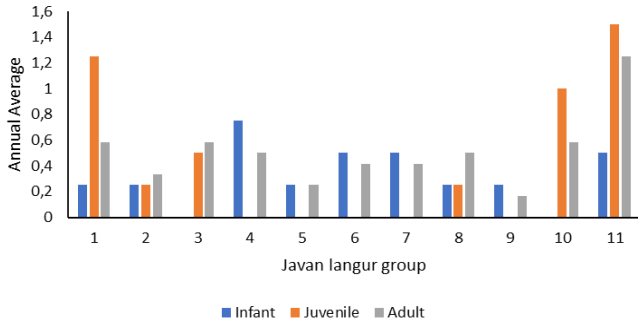

Figure 2. Age structure by annual average of Javan langur in Sokokembang Forest, Pekalongan District, Central Java, Indonesia

Discussion

The results showed that the highest group size was identified in group 11, with 23 individuals of Javan langur, and the lowest group size was in group 9, with 3 individuals. Javan langurs' size ranges from 6 to 23 individuals in each group (Supriatna and Wahyono 2000 in Mustari and Pasaribu 2019). Meanwhile, according to Andarini et al. (2021), the Javan langur group size usually ranges from 3 to 30 individuals in each group. The size of Javan langur group in the Sokokembang forest consists of an average of 9 individuals in one group.

The difference in group size of Javan langurs is due to the ability of female Javan langurs to reproduce new individuals, success in parenting their children in each group, and the presence of predators (Yusrizal 1999; Hidayatullah 2015). The size of the Javan langur group is dynamic; changes in the size of this group can be influenced by internal factors from their individuals, such as the death and birth of Javan langur individuals, and external factors in the form of predators (Asyrofi et al. 2022). Eliana et al. (2017) stated that the size of the Javan langur group is influenced by climate and seasons related to food availability and adaptability to human activities.

The age structure of seven groups of Javan langurs in Sokokembang forest was dominated by young individual age classes (infant and juvenile). While adult individuals dominate the three groups, one group has the same age structure as young and adult individuals. Javan langurs carry out polygamous marriages in one group (Wahyu 2021), so age structure measurements were carried out in each group to assess the success of Javan langur breeding in the Sokokembang forest. The breeding of Javan langurs in groups 1 and 11 can be considered the best compared to other groups of Javan langurs, indicated by the presence of a complete age class with a composition of young individuals that is higher than that of adult individuals. This can happen because of the high population size, so the chances of Javan langur regeneration in the group are higher than in other groups.

The sex ratio of the Javan langur in this location is 1:3.4, with variations in each group of 1:2 to 1:6 individuals (Table 3). According to Leksono (2014), *Trachypithecus auratus* generally forms uni-groups (one male and multi-female), and only one adult male is in each group. Therefore, young males of Javan langur will form a new group if they have entered adulthood; this encourages competition within a group for the position of a new leader. Male individuals who are unable to survive will be left out so that they will form new groups (Leksono 2014; Astriani 2015). In addition, Atmoko (2011) and Khaer et al. (2020) explained that the Javan langur grouping system is a one-male system with only one male in one group.

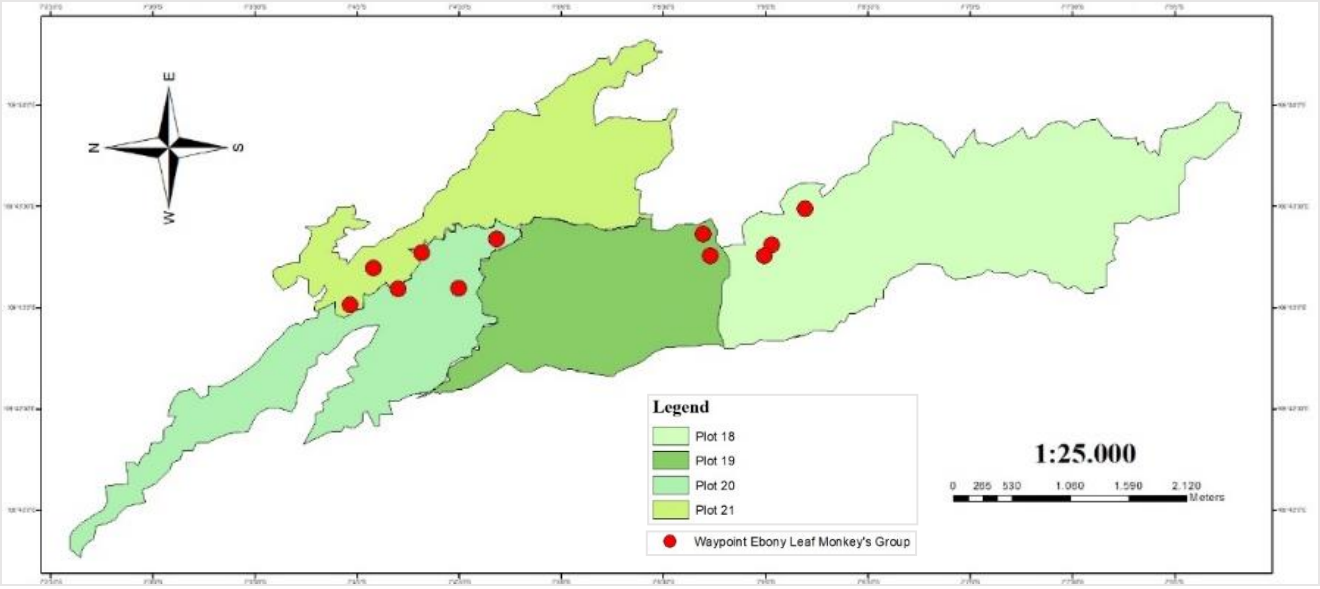

Figure 3. Waypoint of Javan langur in Sokokembang Forest, Pekalongan District, Central Java, Indonesia

The population density of Javan langur in Sokokembang Forest is 7.46 individuals each km^2. The population density value in Sokokembang Forest tends to be small when compared to the value of individual densities based on the IUCN Redlist 2020 in Baluran National Park at 15 individuals/km^2 (Hansen 2020), Dieng at 23 individuals/km^2 (Nijman and Van Balen 1998), and Pangandaran at 190 individuals/km^2 (Brotoisworo 1983; Kool 1993). Based on Asyrofi et al. (2022), the value of the Javan langur population density represents the condition of its habitat's carrying capacity.

Biotic factors affecting the size of the Javan langur's population density are the presence of feed and sleeping trees and abiotic factors, such as locations far from human reach. The Javan langur usually chooses locations with the lowest level of human activities (Asyrofi et al. 2022); the *Trachypitecus auratus* is a shy primate species that avoids direct contact with humans. Another factor is that the low population density value of these primates is also caused by predators that threaten the existence of Javan langur in the Sokokembang forest.

In addition to Javan langur, several other primate species that can be found in the Sokokembang Forest include surili (*Presbitys fredericae*), Javan gibbons (*Hylobates moloch*), and long-tailed monkeys (*Macaca fascicularis*). In addition to primates, there are also several other species of animals, such as Javan eagle (*Nisaetus bartelsi*), golden julang (*Rhyticros undulatus*), wild boar (*Sus scrofa*), antelope (*Muntiacus muntjak*), and Javan leopard (*Panthera pardus melas*). The location of the Javan langur is not far from the long-tailed monkeys because their habitats have similarities, including feeding and sleeping trees that will not be far from the river (Fakar 2022).

The analysis of the distribution pattern of the Javan langur population showed a random pattern in the eleven groups in the Sokokembang forest. The analysis showed a Nearest Neighbor Ratio of 1.171663, an average distance of 217.8582 meters, (p-value) 0.276071, and (z-score) 1.089188 (Figure 4). Random distribution patterns in animals are distribution patterns of individuals or groups in a population independent of other individuals or groups and not influenced by varying environmental factors (Solehudin 2018). Therefore, random distribution patterns generally occur in habitats with consistent resource and environmental conditions, so significant changes rarely occur due to disturbances (Lubis et al. 2021).

Javan langur in Sokokembang Forest is found in many pathways or observation locations adjacent to river flows. This correlation is comparable to the vegetation type near the water flow, with more lush growth of branches and headers, and the plant types more varied. In addition, vegetation around water sources usually has a wider canopy so that Javan langur can use it as shelter from predators. For example, Figure 5 shows Javan langur in Sokokembang forest has been observed exploring to find feed sources and observed eating bleeding leaf shoots (*Horsfieldia irya*).

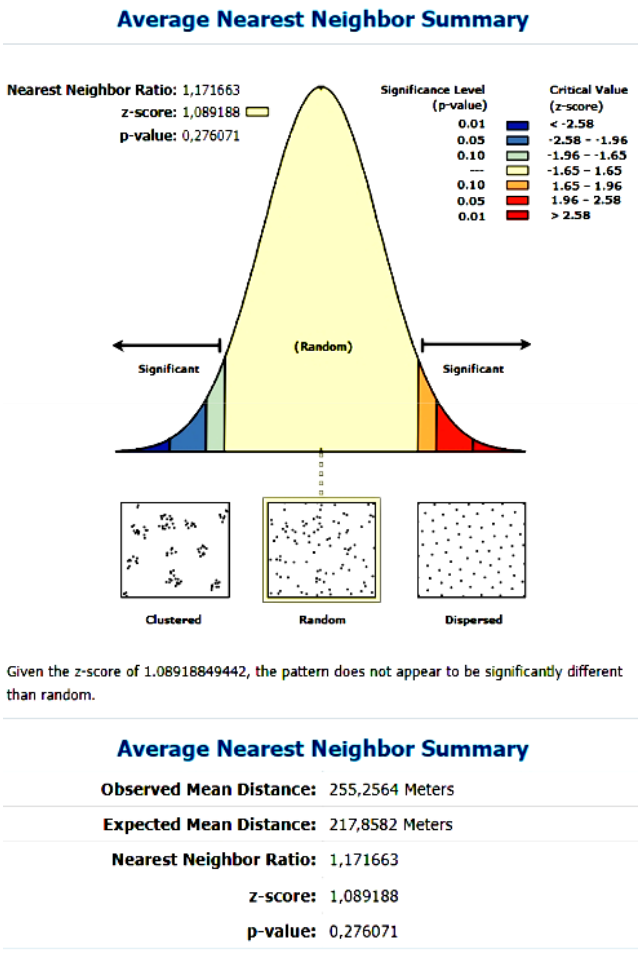

Figure 4. Distribution pattern of Javan langur

Figure 5. Javan langur was observed exploring the feed source

Table 4. Javan langur group's distance in Sokokembang forest, Pekalongan District, Central Java, Indonesia (km)

Group	1									
2	3.73	2								
3	0.39	3.5	3							
4	0.47	4.18	0.78	4						
5	3.38	0.46	3.15	3.83	5					
6	3.31	0.57	3.08	3.74	0.11	6				
7	1	2.81	0.67	1.44	2.5	2.43	7			
8	2.82	0.96	2.6	3.27	0.57	0.5	1.93	8		
9	2.77	0.96	2.53	3.24	0.63	0.6	1.86	0.21	9	
10	0.54	3.22	0.44	0.97	2.87	2.78	0.55	2.3	2.27	10
11	0.29	3.92	0.45	0.42	3.59	3.52	1.14	3.04	2.98	0.77

The study revealed the average distance between the groups was 1.95 km with an area of 13.38 km^2; the farthest distance between groups was 4.18 km, while the closest distance was 0.11 km (Table 4). According to Giovana (2015) in Asyrofi et al. (2022), the occurrence of overlapping home range tinding (cruising area) due to the evenness of feed sources with high potential so that the group's defense their cruising areas. According to Sari et al. (2020), Javan langurs have a fairly wide cruising area, reaching 15 ha, so corridors are needed for their movement. The roaming area size of an animal species depends on feed availability; the fewer feed sources, the wider the roaming area of animals (Basalamah et al. 2010; Afifa 2021).

Javan langur in Sokokembang forest is spread at 300 to 700 masl altitude. This follows Maryanto (2008) in Astriani (2015) who states that the habitat of the Javan langur is in lowland forests and highlands with an altitude of 1,600 masl. Therefore, one effort to maintain *Trachypitecus auratus*'s existence is to maintain the quality and quantity of their habitat (Eliana et al. 2017).

This study concluded that 100 individuals of Javan langur (*Trachypitecus auratus)* in the Sokokembang forest are spread into 11 groups. The population size of each group is composed of 3 to 23 individuals, with an average of 9 individuals in each group. The Javan langur age structure is dominated by adult individuals, thus forming an inverted pyramid indicating a declining population and the overall male-to-female sex ratio is 1:3.4. The Javan langur distribution pattern showed a random with the Nearest Neighbor analysis with the most encounters in plot 20 while the fewest encounters were found in plots 19 and 21.

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