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A first investigation on tricolor langur (*Presbytis chrysomelas* subsp. *cruciger*) exhibits significant terrestrial activity in their natural habitat

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Abstract. *Sutopo, Santoso N, Mardiastuti A, Mulyani YA. 2024. A first investigation on tricolor langur (*Presbytis chrysomelas *subsp.* cruciger*) exhibits significant terrestrial activity in their natural habitat. Biodiversitas 24: 3431-3440.* Until now, it has only been reported that the tricolor langur (*Presbytis chrysomelas* subsp. *cruciger* Thomas 1892) is a semi-terrestrial primate, but there has never been any proof from their natural habitat that they actually engage in ground-level activities. This research aims to investigate terrestrial daily activity and the daily time budget for the tricolor langur. To determine the duration and type of their natural behaviors, observations using camera traps. This research was conducted from July 2022 to June 2023 in the lowland forest around the foot of Semujan Hill, which is part of the Danau Sentarum National Park Area, Kapuas Hulu District, West Kalimantan, Indonesia. The results of observations using camera traps showed that the one group langurs engaged in terrestrial activities for 5,830 seconds and arboreal activities in the tree canopy for 15,160 seconds. The percentage of total time recorded by the camera traps indicates that terrestrial activity accounts for only 34% of the total recorded time. The most dominant activities during both terrestrial and arboreal activities were eating and locomotion, with the rest being grooming, resting, and playing. The findings of this research contribute to our understanding of primate behavior, highlight effective methods for observing primates in their natural habitat, especially the *Presbytis* group and raise awareness among park managers and local communities. It is important that langurs are not disturbed during their terrestrial activities to ensure their continued presence and population growth in the study area.

Keywords: Danau Sentarum, endangered species, land-dwelling, *Presbytis*, time budget

INTRODUCTION

There has been no research to prove whether the tricolored langur (*Presbytis chrysomelas* subsp. *cruciger* Thomas 1892) is a primate that carries out semi-terrestrial activities. In fact, it is very difficult to find research references that discuss the daily activities of this group, especially using camera traps. Tricolor langur with local name *sentarum langur* is one of the many endemic primate species in Borneo Island and is known to only be distributed in the North of Kalimantan, Indonesia (Nijman et al. 2020). If compare the distribution of the *Presbytis* group among islands in Indonesia, there is a tendency that the *Presbytis* group on the islands of Sumatra and Java is known to carry out more activities in the tree canopy (arboreal) like *P. thomasi* Collett 1893 in Jantho Nature Reserved areas (Ruskhanidar et al. 2023), while the *Presbytis* group in the Borneo Island only a small number are known to carry out activities that go down to the forest floor like at red langur in Sebangau-Central Kalimantan, Indonesia (Cheyne et al. 2018).

This is strongly suspected to be due to the presence of predatory animals such as tigers (*Panthera tigris* subsp. *sumatrae* Pocock 1929) or other groups of big cats and the natural habitat for the *Presbytis* group on the islands of Java and Sumatra has begun to decrease, as well as interference from human activities (Supriatna 2022). Therefore, this research is very important as part of basic research on animal behavior which is carried out using combined methods both the direct observation and camera traps. Basically, the *Presbytis* group of primates are arboreal animals (Nijman and Nekaris 2012). However, this statement still needs to be reviewed because it is difficult to define animals as arboreal animals, considering that the ancestors of modern Asian Langurs or Colobinae are believed to be semiarboreal/semiterrestrial animals (Zhao-Yuan 1993). This species also known do the terrestrial activity in Jemoreng Protected Forest (Sarawak-Malaysia) using camera trap, but only on time recorded (Ampeng et al. 2023), and *P. rubicunda* Müller 1838 also recorded by camera trap have terrestrial activity (Cheyne et al. 2018).

Research conducted on the *P. leucocephalus* group showed that this group spent 51.8% of their daily time in trees and 48.2% on rocks. Even the tricolor langur's close relative, some species like red/maroon langur (*P. rubicunda*), is known to carry out more arboreal activities (Supriatna et al. 1986; Smith 2013), *P. chrysomelas* Müller 1838 have arboreal until to 1-3 above ground in fruits season (Ampeng and Md-Zain 2012). These studies can show that land-dwelling activities for the *Presbytis* group in Kalimantan, Indonesia are still small (Ampeng and Md-

Zain 2012; Smith 2013). This is because studies on observing the daily activities and behavior of primates in natural habitats rely more on direct observation, while the weakness of direct observation is that animals will tend to avoid observers so that the duration of their activities is not optimally recorded and observed. Members of *Presbytis* who have different natural habitat locations will likely carry out different daily activities, and there are factors that are thought to influence their habits of preferring arboreal activities over terrestrial ones.

Several researchs have proven that *P. chrysomelas* subsp. *cruciger* occur in specific habitats, especially at swamp forest, mixed lowland forest around the sub-hills (Santoso et al. 2023a,b). While the langur habitat in Java Island for example for *P. comata* have occur in highland (Nijman 2017; Widiana et al. 2018), mixed habitats (Supartono and Kosasih 2022), lowland, hills, natural forest and plantation forest that have diverse vegetation, including those adjacent to settlement (Supartono et al. 2016). And almost similar habitat is that of *P. chrysomelas* subsp. *chrysomelas* Müller 1838 in Similajau National Park occurs in peat swamp and heat forest (Noor-Faezah et al. 2023), *P. frontata* Müller 1838 at rubber plantations, secondary forests, mixed gardens, dryland agriculture, and mining areas (Fithria et al. 2023)

The aim of this research is to investigate terrestrial daily activity and it's specific time budget each day in their natural habitat specific at Semujan Hill, Danau Sentarum National Park, Kapuas Hulu District, West Kalimantan, Indonesia. It is hoped that the results of this research will provide an overview of the natural behavior of langurs without interference from observers, so that the proportion of time spent captured by camera traps can be obtained and can provide an answer as to whether sentarum langurs actually carry out terrestrial activities. Apart from contributing to science in the field of behavior and ecology, research on locomotion is also important to support management actions by parties for species and habitats in areas where they naturally spread so that the existence of species can survive for a long period of time and avoid population pressure that can occur leading to local extinction (Buchanan et al. 2012). The goal of this research is to discover new facets of tricolor langur behavior, ultimately enhancing the awareness and interest of all stakeholders in this species.

MATERIALS AND METHODS

Study area

Site was located in Danau Sentarum, especially in the Bukit Semujan area, which management unit included in the Betung Kerihun and Danau Sentarum National Park. Government administratively, this location is included in the Kapuas Hulu District, West Kalimantan Province, Indonesia. All time budget of langur activity collected by scan sampling using camera traps, and was carried out from July 2022 to June 2023, but the recording process was only effective for 10 months. This is because in November-December 2022 the water level in the lake is very high, so it is not possible to install the camera above ground level (<1 meter) because the camera will be submerged and not function, so it is feared that this could cause problems in the activity data collection process. The total number of camera traps installed to record langur activity is 20 units, with 10 units installed for arboreal activity with coordinate location is 0°47'20.54"N-112°15'0.53"E and 10 cameras installed on the ground at a height of between 0.5-1 meter to record terrestrial activity at coordinate location is 0°47'14.25"N-112°15'5.23"E. The distance between a group of camera traps installed above the canopy to observe activities in the tree canopy (arboreal) and cameras above the ground surface to observe terrestrial activities is 1 kilometer. The following is how camera traps installed to observe these two langur activities (Figure 1).

Rely on camera traps to get data on their natural activities and behavior. This is because, when directly observing them, they are really very sensitive to human presence, so other alternatives are needed to observe them and the best option to use a camera trap. They can hear and detect human presence without the observer realizing that at the location they are going to, there is already a group of langurs carrying out activities. Initial observations to confirm the routes used for daily movement and to determine areas where food trees are distributed. So the placement of the camera is more purposive with the aim of getting a higher chance of langurs being recorded on camera. The following is a map of the research location and camera trap placement points (Figure 2).

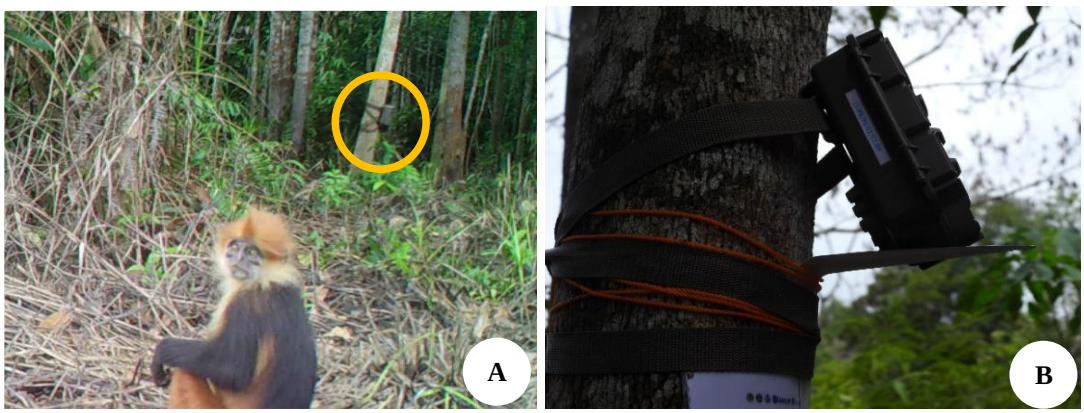

Figure 1. Camera trap position for arboreal activity A. Putted with high 50 centimeter from above ground level, and for terrestrial activity that; B. Putted from 5-12 meter from above sea level (asl)

Data collection

Set up the recording duration of each camera traps unit with a time stamp of 35 seconds using video mode and sett interval only 1 seconds, it's amied to produced continuous recording. To make the resulting video quality clearer, the video settings use High Definition quality (1080P) image size. This mode produces better image quality, making it easier to identify the individual and gender of each individual langur caught on camera. Once a week check the camera results and replace it with new memory because high video modes and quality cause the external memory to fill up quickly so if it is not replaced could be worried that there will be activities that will not be recorded. Furthermore, the data collected includes activities and duration of activities at each camera trap point that has been installed. There are two groups of sizes of langur that suspect have activity at the study site. We filter only langur activity, and if any other primate that was recorded do not included into time budget and daily activity analysis, but as supplement information. The first group has 7 individuals (1 male adult; 4 female adults and 2 male adults) and the second group has 6 individuals (1 male adult; 3 female adults; and 2 female juveniles). But in this observation can only record and observe for one group (first group) and not differentiate the duration of time based both groups, because for the first investigation is aimed to prove that they carry out terrestrial activities and what forms of activity they have. Behavioural data collected for each arboreal and terrestrial activity includes feeding, resting, locomotion, and social behavior (e.g., playing, self-grooming, and allogrooming). All of these behavior setts into ethogram activity with scope definition as following in Table 1.

Observations of these behaviors are then recorded in an ethogram for each activity every day. Identify every second the tricolor langur behaviors in each arboreal and terrestrial that have recorded automatically by camera traps are very important to do input process well. Average time each behavior recorded by camera traps no more than 1 hours and the highest is only have 272.47 seconds for feeding behaviors for all terrestrial and arboreal activity. All data behaviors of each activity were arranged into ethogram table behavior for 87 days of recording (Table 2).

Table 1. Scope and definition of each behavior on observing the tricolor langur activities

Behaviours	Code	Definition	Total day	Sum	Mean
Feeding	F1	Starting from picking (at arboreal), taking seeds (at terrestrial), peeling the skin and putting food into the mouth and chewing	77	20980	272.47
Resting	R1	Sitting or lying down on a tree branch for a long time (>30 seconds) and not involved in other activities	72	3933	54.625
Locomotion	L1	Moving from one point to another by stepping, walking, climbing and jumping using two feet and two hands	16	545	34.063
Self-grooming	S01	Scratching the body using hands, feet or mouth without involving other individuals to help clean the body	1	10	10
Allogrooming	S02	Cleansing the body of parasites or other dirt by involving one or more individuals to help clean the body	7	185	26.429
Playing	S03	Mutual pursuit between two or more individuals within a group and is not agonistic behaviours towards another group	5	135	27

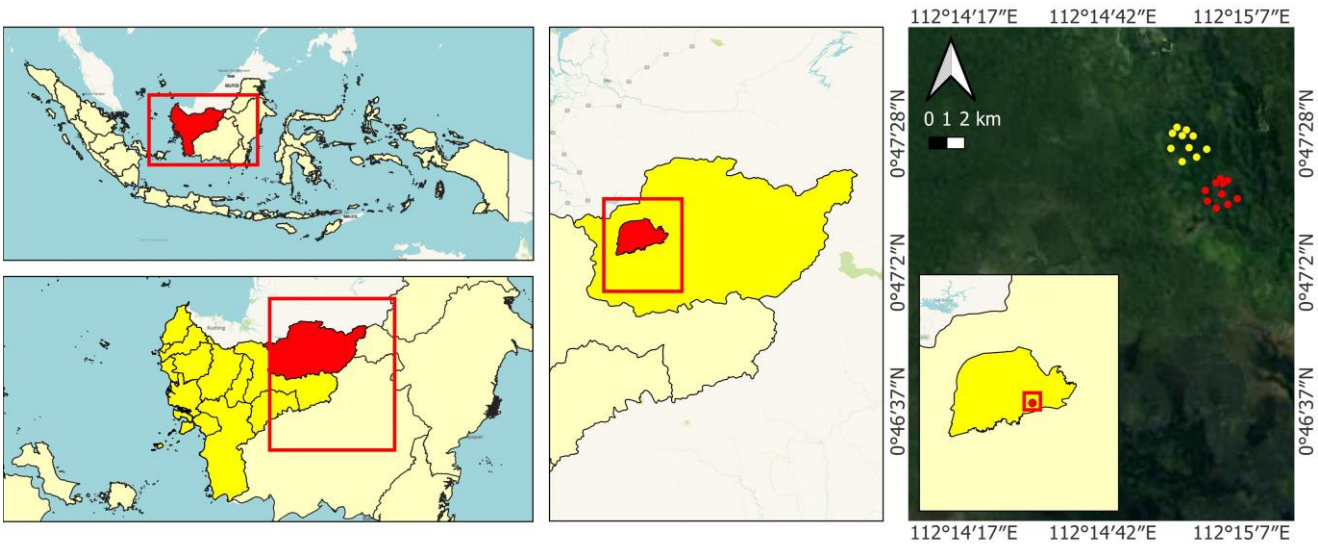

Figure 2. Map of the study area in Danau Sentarum National Park, Kapuas Hulu District, West Kalimantan, Indonesia. Red dot: Terrestrial camera; Yellow dot: Arboreal camera

Table 2. Ethogram of tricolor langur behavior for all activity recorded by camera traps

Behaviors	Day and durations																			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
F1	0	0	0	10	550	750	500	430	490	625	905	640	40	650	0	60	100	30	430	30
L1	30	20	10	30	60	150	208	20	120	85	105	130	10	210	35	30	45	20	60	30
R1	10	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
S01	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
S02	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0
S03	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	40	0
Sum/days	40	20	10	40	610	900	708	450	610	730	1060	770	50	860	35	90	145	50	530	20
	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
F1	30	70	40	30	15	35	90	20	80	30	50	75	15	130	80	30	10	0	20	40
L1	20	0	60	0	0	25	10	0	30	30	70	45	0	35	20	0	0	30	0	30
R1	0	0	0	0	0	0	0	0	20	10	0	0	0	0	0	0	0	0	0	0
S01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum/days	71	92	123	54	40	86	127	48	159	100	151	152	48	199	135	66	47	68	59	110
	41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
F1	100	25	55	10	10	60	70	30	640	20	30	0	15	0	80	200	0	30	110	30
L1	30	10	25	0	0	25	10	0	80	20	20	0	0	10	0	50	40	0	120	10
R1	10	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0
S01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
S03	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
Sum/days	181	77	123	54	55	131	127	78	769	110	101	82	68	64	135	316	97	88	289	100
	61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
F1	50	0	20	10	0	875	830	665	1225	490	280	355	175	90	0	90	875	35	385	675
L1	30	10	10	20	80	70	30	35	175	0	0	30	30	0	30	0	105	0	35	105
R1	30	0	0	10	10	0	0	0	0	0	0	0	0	0	0	0	105	0	70	70
S01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	35	0
S03	0	0	0	40	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum/days	171	72	93	144	165	1011	927	768	1469	560	351	457	278	164	105	166	1197	113	604	930
	81	**82**	**83**	**84**	**85**	**86**	**87**	**mean**												
F1	1915	140	1290	945	315	350	245	272.47												
L1	240	35	290	185	0	0	105	54.625												
R1	20	0	35	70	0	35	0	34.063												
S01	0	0	0	0	0	0	0	10												
S02	35	35	10	0	0	0	0	26.429												
S03	0	0	0	0	0	0	0	27												
Sum/days	2210	210	1625	1200	315	385	350	296.41												

Data analysis

All data performed by time stamp scan analysis and some data to test the normality and significance differentiation both the activities using the statistical non-parametric analyses Mann-Whitney U Test from SPSS version 24 To ensure that each activities have significant different (Figure 3). While the camera traps were installed from July 2022-June 2023, we only recorded activity for 87 days for a total of 25,328 seconds and the individuals caught in the camera traps were identified as consisting of 2 groups with a total 13 of individuals langurs, but theses time stamp only focused for first group of tricolor langurs (7 individuals). The following are the results of hypothesis summary test (N = 1,332; std = 5,464.682) and for the time variable used to carry out arboreal and terrestrial activities (Table 3).

RESULTS AND DISCUSSION

Duration each terrestrial and arboreal activity

Tricolor langur activities that were recorded by camera traps has shown two variable activities (arboreal and terrestrial) based to their position from ground level. In this investigation only can recorded one group, these caused very difficult if recorded for another group without preliminary home range position to make sure the camera traps were right placed. Arboreal activity was found in rubber plants, and terrestrial found in ecotone habitat both swamp forest and hill forest. Explorations carried out by the National Park management team in 2019 were only able to record encounters with langur group activities in Semujan Hill which were carried out arboreally, but failed to observe activities carried out terrestrially. This is very natural, considering that the exploration activities carried out only rely on direct observation with a large number of observers, so this affects the chances of encountering langurs in carrying out each activity. Following is time stamp scan the langur activity duration that recorded by camera trap (Table 4 and Figure 4).

Feed and locomotion are two dominant activities for each arboreal and terrestrial variable. Total time budget for feed at terrestrial activity is 5830 seconds and arboreal is 15160 seconds. This means that based on this data, semi-terrestrial langur activity is only 26% of the total time and activity recorded by camera traps. Satisfying performance that shown with the results of the camera trap which succeeded in recording their natural behavior, especially feeding behavior. These primates are very difficult to observe directly, especially when the observer wants to get an idea of the time allocation for each of their activities without the langur group knowing. When compared with all daily activities, the proportion of time captured by camera traps each day is only 0.34% of the total time spent per day and night (24 hours) used by the langur group. This percentage can actually prove that they carry out terrestrial activities, but still carry out the Pearson correlation test to see how much significance there is in the duration of time recorded between arboreal and terrestrial activities. Before carrying out this test, first carried out a data normality test (Mann-Whitney U Test), and it was found that the data obtained had a normal distribution with a sig value <0.05. Likewise, the results of the Pearson correlation test which was carried out produced a sig value. <0.05.

Table 3. Hypothesis test summary for duration each variable activity

Null Hypothesis	Test	Sig.	Decision
The distribution of Duration (second) is the same across categories of Variable Activities	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis
The distribution of Timestamp is the same across categories of Variable Activities	Independent-Samples Mann-Whitney U Test	.000	Reject the null hypothesis
Asymptotic significances are displayed. The significance level is .05			

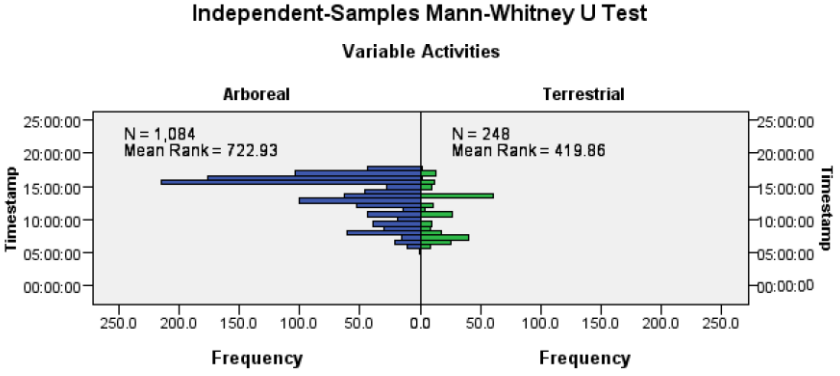

Figure 3. Independent-Sample Mann-Whitney U Test result for timestamps analysis each arboreal and terrestrial activity of tricolor langur by came traps

Table 4. Ethogram for duration (seconds) each terrestrial and arboreal activity recorded by camera traps

Variable			Time budget duration (seconds)						Total
			3	10	15	25	30	35	
Terrestrial	Type of behavior	Feed	0	84	3	0	13	130	230
		Locomotion	0	5	2	0	1	10	18
	Total		0	89	5	0	14	140	248
Arboreal	Type of behavior	Feed	0	466	16	106	40	183	811
		Locomotion	1	160	10	16	9	30	226
		Rest	0	16	0	0	0	11	27
		Self-grooming	0	1	0	0	0	0	1
		Allogrooming	0	2	0	1	0	4	7
		Play	0	11	0	1	0	0	12
	Total		1	656	26	124	49	228	1084
Total	Type of behavior	Feed	0	550	19	106	53	313	1041
		Locomotion	1	165	12	16	10	40	244
		Rest	0	16	0	0	0	11	27
		Self-grooming	0	1	0	0	0	0	1
		Allogrooming	0	2	0	1	0	4	7
		Play	0	11	0	1	0	0	12
	Total		1	745	31	124	63	368	1332

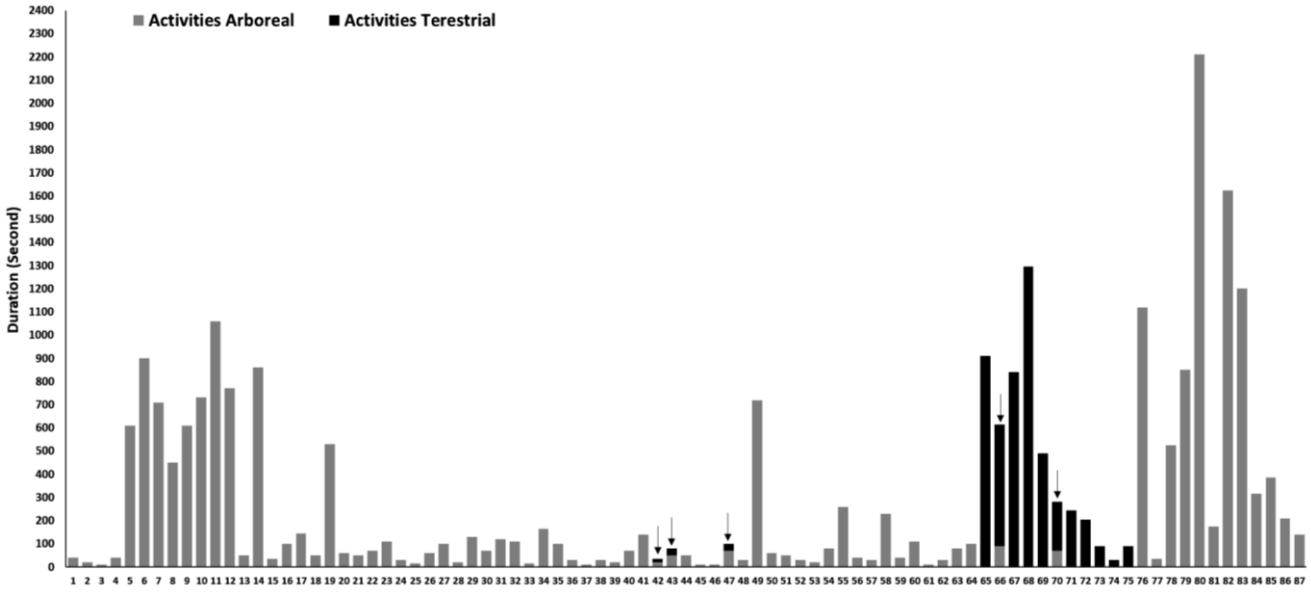

Figure 4. Histogram per-day duration of activities recorded by camera traps in their natural habitat of Bukit Semujan, Danau Sentarum National Park, West Kalimantan, Indonesia

First hypothesis has resulted that since the significance value (Sig.) is .000, which is less than the significance level of 0.05, we reject the null hypothesis. This means that the distribution of duration (in seconds) is significantly different across the categories of variable activities. The second hypothesis also has the similarly result that since the significance value (Sig.) is .000, which is less than the significance level of 0.05, we reject the null hypothesis. This indicates that the distribution of timestamps is significantly different across the categories of variable activities.

Their active time can be grouped into two, namely morning activities before noon and afternoon activities until late evening. In the morning, they start carrying out monitored activities from 05.30-11.30 Indonesian Western Time (WIB) and in the afternoon from 12.30-17.30 WIB. However, variations in time recorded by camera traps show that the longest active time interval only lasts 30 minutes a day in the morning and almost an hour more in the afternoon towards the evening. This means that not the entire time range was recorded by the camera. Predicted, many other time allocations for the same or different activities, such as naps that are not monitored by cameras and are carried out in places where camera traps are not installed. Try to trace the area used as a place to rest during the day, especially on the day after they have done terrestrial and arboreal activities and it is known that they choose a location to rest in a higher area, namely between 90-100 sea above level with cover conditions in the form of secondary forest. still very close. This covering condition

provides a cooler temperature so that it avoids hot air during the day. Following is graphic that show each duration for terrestrial and arboreal of langur activity (Figure 5).

What they eat during the arboreal and terrestrial activity?

Apparently, not all places in the home range are used for terrestrial activities. They choose a relatively clean area on the ground surface of the bushes so that it is easier to observe, find and pick up seeds that have fallen on the surface. It was observed that the surface area where they were active was not overgrown with bushes because it seemed that it would make it difficult to find fallen seeds because it was covered in bushes and disguised the fallen seeds, so they would spend too much time looking for them, so they would prefer areas that were relatively cleaner. They are very good at finding and distinguishing every rubber (*Hevea brasiliensis* (Willd. ex A.Juss.) Müll.Arg.) seed that is suitable for eating. The rubber seeds they choose are those that still have good flesh, even the rubber seeds that are still at the top of the twig (haven't fallen) are also eaten. However, They rarely do that, because the outer shell of the rubber seed is very hard so it will take longer to peel it. done if conditions require it, especially when the availability of fruit and seeds in their natural habitat has almost run out, or almost no old seeds have fallen to the surface. The behavior when doing activities on the surface is very interesting, descending from tree trunks while jumping and prancing. They observe the seeds that fall on the surface by standing on their two legs, sitting on a wooden stump, then picking them up and sitting down to peel them. Behavior like this has never been observed and recorded before, so it is especially important to know the behavior they carry out on the ground and its implications for the development of animal behavior science, especially the Presbytis group. The following are several forms of behavior of the tricolor langur when carrying out activities on the ground (Figure 6).

Some behavior in arboreal activities is different from activities carried out terrestrially. The initial arrival at the hill kamsia food tree (*Syzygium acuminatissimum* (Blume) DC.) was monitored by jumping from the canopy of other trees around it. Then take the food seeds while sitting between the twigs and branches of the tree. This food tree was observed to be very strong and elastic, even when installed a camera trap at a height of 12 meters, the trunk of the tree climbed was really very strong and did not break easily. They can reach the *kamsia* seeds up to the top of the smallest twig, the way to reach them is by holding the twig on the branch at the top with one hand and the other hand picking the seeds. So that in this way they can reduce their body weight when they are above the canopy, especially when they reach the furthest part of the leaf tip. When they carry out arboreal activity in tree branches canopy they use two arm and two legs, and then sit between tree branches when eating the seeds that have been obtained. Several arboreal documentations that recorded by camera traps when feeding the *S. acuminatissimum* (Figure 7).

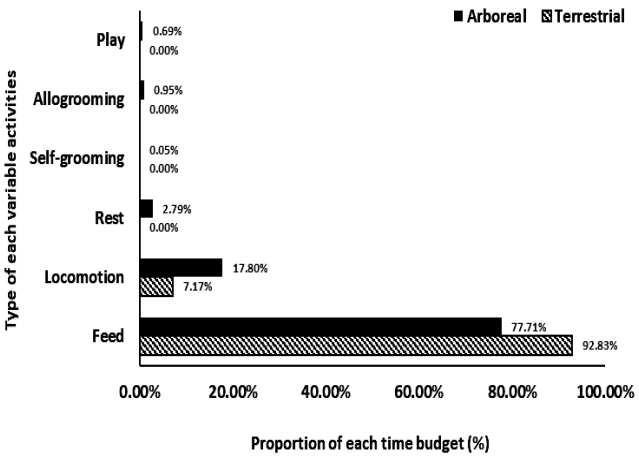

Figure 5. Time budget graphic for each activity (arboreal and terrestrial) that recorded in time stamp of camera trap during the research to prove the tricolor langur have terrestrial activity

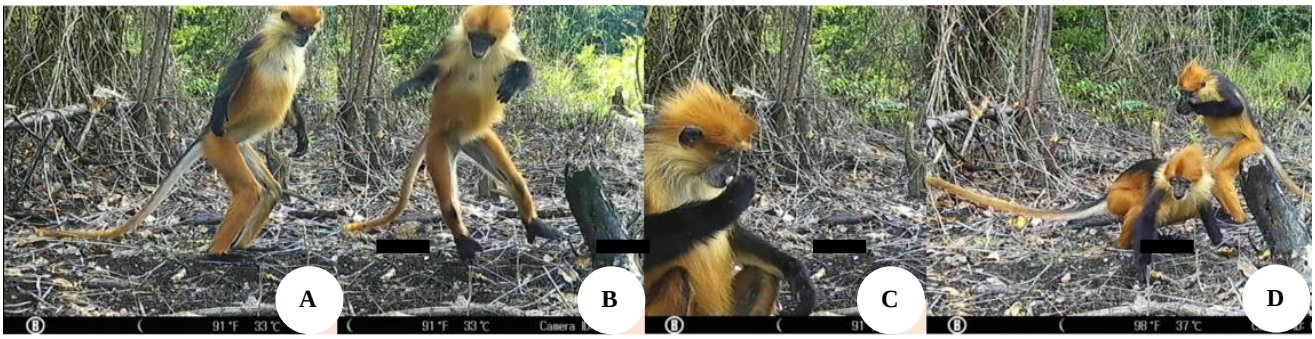

Figure 6. A time set as feeding activity by female adult: A. Search to find out seed on above the ground; B. Move to search from another angle; C. Eats the seed; D. Search seed together among the male adult

Check and search to confirm what they had eaten when it was recorded by the camera trap, and the result was that found some remains of skin and pieces of seeds and flowers that had been eaten. Based on the identification results of the plants they eat, it is known that there are 3 types of plants that are eaten, namely the seeds and flowers. These three plants include rubber (*H. brasiliensis, kamsia bukit* (*S. acuminatissimum*) and medang perawas (*Baccaurea sumatrana* (Miq.) Müll.Arg.)-arboreal. Two food species are apparently not available throughout the year, namely the *S. acuminatissimum* and *B. sumatrana* types, while the *H. brassiliensis* type is still relatively available, although in small and limited quantities, especially when other food plants are not in fruiting season. In a year, both were observed producing flowers and seeds only once. The part that is eaten for both types is the seed flesh, while they throw away the outer skin because it contains sap which tends to stick to the hands and mouth when eaten. Meanwhile, the type of *B. sumatrana* that is eaten is the entire flower and seeds. The results of camera trap footage did not observe them eating leaves, perhaps because leaves in tropical areas are more available throughout the year, so they can get them easily at any time. Following are several species that are eaten by langurs, like flowers and shells, that remain from the core flesh (Figure 8).

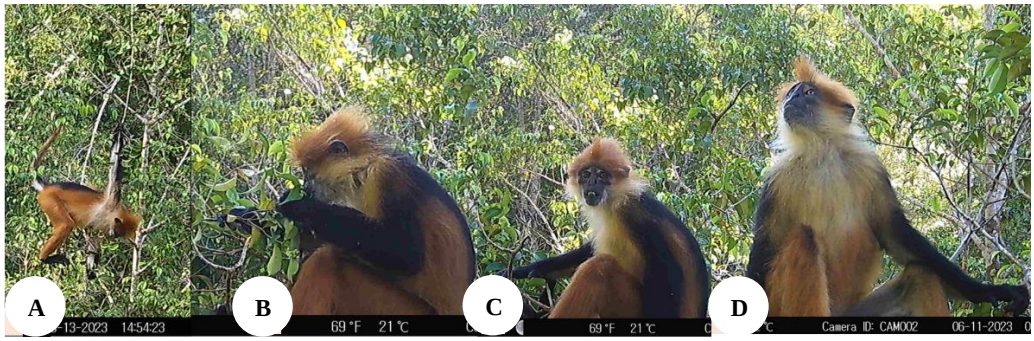

Figure 7. Some arboreal activity such as: (A,B). Take and eat the seed and; (C,D). Searching the seed to eat next in the tree of *S. acuminatissimum* by A. Male sub-adult and; (B,C). Alpha male

Figure 8. Flower and seeds from several plants species that eaten by tricolor langur after investigation using camera trap like A. *Baccaurea sumatrana;* and shell of seed; B. *Syzygium acuminatissimum*; C. *Hevea brassiliensis*

Discussion

The time budget and recorded activities show that the first investigation into behavior in their natural habitat has shown that they actually carry out activities on the ground (terrestrial), especially for looking for food and moving around. Other activities recorded on camera include resting, self-grooming, allogrooming and playing. These four activities have a smaller proportion of time compared to the two dominant activities. The observed rest is only a short pause, not a rest activity in the form of a nap during the day. This pause is used to observe the surrounding area before taking seeds or flowers to eat, or carrying out the next activity. Self-grooming is the activity of scratching the body using the right and left legs. Meanwhile, allogrooming is the activity of searching for and removing ticks by other individual members of the group using both hands. Allogrooming behavior is carried out by two individuals, and has never been observed carried out by more than two individuals. This activity is usually carried out between mother and offspring, and has never been observed between female parent and female or female parent and male, unlike in other primate groups such as allogroming behavior of non-*Presbytis* groups such as long-tailed macaque (*Macaca fascicularis* Raffles 1821) (Fitriyah et al. 2021; Al Hakim et al. 2023), and *Macaca nemestrina* Linnaeus 1766 that carried out between different individuals even though they are not the same parent (Rupert et al. 2018).

There is assumption that the tricolor langur in the study site and even other Presbytis groups on the island of Kalimantan sometimes carry out activities on the ground (terrestrial) apart from the availability of food, but sometimes as anti-predators' strategy when in the local habitat any terrestrial predator such as tigers or leopards (Nijman and Nekaris 2012). This condition is different from the Presbytis group on the islands of Sumatra and Java which tend to be predominantly arboreal (Nijman and Nekaris 2012). Identification the study location there are no predator groups, there are only reptile groups such as fresh water crocodiles, but their habitat is not in the location where langurs carry out terrestrial activities. Meanwhile, human disturbance is very unlikely, because hunting activities are not allowed in conservation areas. In fact, the presence of langurs in the study site and in the lake actually has established coexistence between langurs and the people in the lake area who work as fishermen (Santoso et al. 2023a).

Activities recorded by camera traps have shown that there are many other food plants are used as a daily diet for langur groups in the area around Semujan Hill and the Lake Sentarum area. There are 27 plants eaten by langurs in the habitat around the foothills of Semujan Hill (Santoso et al. 2023c). The results of further research identified 7 types of langur food plants besides *H. brassiliensis*, including *Diospyros coriacea* Hiern, *Nephelium* sp., *Whiteodendron moultonianum* (W.W.Sm.) Steenis, *Xanthophyllum vitellinum* (Blume) Dietr., *Sloetia elongata* (Miq.) Koord., the seeds or young leaves of *Shorea balangeran* (Korth.) Burck, and *Eichhornia crassipes* (Mart.) Solms (Musyaffa and Santoso 2020). They are known to share food with other primate groups such as *Nasalis larvatus* van Wurmb 1787 and *M. fascicularis* (Santoso et al. 2023b). If examine it more deeply, *H. brassiliensis* is actually not a local plant species but was introduced to Indonesia more than two centuries ago. This type is very massive and is planted by the community to extract the sap, producing seeds almost continuously at all times, even though sometimes it is not during the peak season for producing rubber seeds. So under these conditions it seems that langurs are used to young leaf shoots and rubber seeds as a source of food. Rubber is also apparently consumed by another *Presbytis* species like Raffles' Banded Langur (*P. femoralis* Martin 1838) in secondary forest habitats in the Johor area (Najmudin et al. 2021). Apart from *H. brassiliensis*, the types of food that exist in the natural habitat are types that are really only found in the lake area, not found outside their natural habitat. With these conditions, it is feared that the tricolor langur will become a specific native species and find it difficult to migrate far from lake and swamp habitats.

Conclusions and conservation contribution

Based on the results of observations using camera traps and analysis of the duration of arboreal and terrestrial activities, it is known that tricolor langur actually carry out semi-terrestrial activities at the study location which is in the lowland forest habitat around the foot of Semujan Hill which is still included in the Danau Sentarum ecosystem landscape. The most dominant forms of terrestrial and arboreal activities are eating and locomotion, and the rest are grooming, rest and play activities. By knowing their natural behavior, this research has contributed not only to supporting science, but it is an important contribution to supporting species and natural habitat conservation efforts in the form of updated data and information relating to behavior in their natural habitat. It is also hoped that the results of this research can help managers and provide insight to the community in efforts to protect species and habitats, because they are not just identified in the Danau Sentarum area by any type of habitat. Only special habitat types can provide sufficient food sources at all times. Observation routes by other groups of langurs, especially those in swamp forest habitats, seem to require the same research, namely by installing camera traps to determine whether they also carry out the same activities, especially in swamp forest habitats which are still flooded with lake water. This research also contributes to providing data and information for managers to be able to take policies in prioritizing certain areas for monitoring activities for priority species in the Lake area.

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