

**PRILIMINARY RESEARCH ON ACTIVITY BUDGET
OF INDOCHINESE GREY LANGUR *Trachypithecus crepusculus*
AT HANOI ZOO UNDER HUMAN INFLUENCE**

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Abstract. Two individuals of Indochinese grey langur (*Trachypithecus crepusculus*) at Hanoi Zoo were studied from August 2014 to January 2015 with a total of 47 observation days and 4290 records to preliminarily determine their activity budget, food composition, and the influence of environmental factors including temperature, humidity, and human impact on their behaviours. The results show that there is a big difference between the activity budget of the two captive individuals and that of free-ranging individuals. Furthermore, their food composition was also very different from that of individuals living in the wild and it may be the main reason. From this result, changing the composition of food for Indochinese grey langurs in Hanoi Zoo and limiting the visitors' food provision needs to be carried out immediately to ensure the health and welfare of these langurs.

Keywords: *Trachypithecus crepusculus*, grey langur, activity budget, primate, animal welfare, human influence.

1. Introduction

The Indochinese grey langur *Trachypithecus crepusculus* (Elliot, 1909) is a leaf-eating primate belonging to the subfamily Colobinae, listed as Endangered by the IUCN Redlist (2022) [1] and Vulnerable in the Vietnam Red Data Book by the Ministry of Science and Technology and Vietnam Institute of Science and Technology (2007) [2] due to a small number of individuals and population decline. In Thailand, some wild populations of the species have been studied for distributional behavior in relation to geophagy (Pages et al., 2005) [3], or the influence of neighbour groups and environmental factors on the home range of three focal groups (Gibson and Koenig, 2012) [4]. The composition of plant species in the diet of Indochinese grey langur has been mentioned by Rowe (1996) [5], Aziz and Feeroz (2009) [6], Suarez (2013) [7], and Decemson et al. (2018) [8]. In Laos, Timmins et al. (2013) [9] reported on the conservation status of this

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langur species. In Vietnam, there are only studies on taxonomy (Roos, 2007 [10]; Groves (2001 [11], 2007 [12]), food list in captivity (Pham Nhat, 2002) [13], and its distribution in Vietnam (Nadler et al., 2003) [14]. However, studies on the behavior, biology, and ecology of Indochinese grey langur in Vietnam are still limited, no research has been carried out in the wild because it is very difficult to find the langurs. There are 02 individuals of this species kept at Hanoi Zoo to serve visitors. However, to date, there have been no studies on the behavior of this species in captivity. According to our reconnaissance observations, compared to *Macaca* monkeys in nearby cages, the two grey langurs seem to be indifferent and less interactive with human activities, including visitors' actions. This may be different from the behaviors of macaque species (genus *Macaca*) living at Hanoi Zoo when macaques seemed to interact strongly with visitors. To clarify this, our study was conducted to determine the langur's activity budget in captivity and the relationship with temperature and humidity, the influence of humans on the langur behavior in captivity, the langur's response to that impact, and the cause. The results of this study will serve to improve the captive conditions of Indochinese grey langur in the future.

2. Content

2.1. Time, place, and research methods

Within 7 consecutive months from August 2014 to January 2015: there are a total of 47 days of observation and 4290 records for 2 individuals of *Trachypithecus crepusculus* kept in captivity at Hanoi Zoo. Both focal subjects are female individuals and they do not have their names. Individual 1 (Subject 1): the body is larger, stronger, and more agile, the tip of the tail is ruffled, and the eyes are normal. Individual 2 (Subject 2): the body is smaller, weaker, and slower, the tail is oblong without the ruffled tip of the tail, and the eyes are malformed.

The Indochinese grey langur cage at Hanoi Zoo (coordinates 21⁰⁰1'54.2"N, 105⁰⁴8'31.1"E) is designed in a circular cylinder form, with concrete columns, a smooth cement floor, surrounded by steel net and a concrete roof. To block the wind in the winter, the cage is partly surrounded by plastic panels. Inside the cage there are trays for food and water, and the branches are fixed as a support for the langurs to move and play. In addition, in the cage, there is a small wooden box with 2 compartments for them to sleep. Outside the cage, there is also a steel fence separating visitors from close contacting the cage. The sampling observation location is about half a meter away from the langur cage, outside the fence of the cage.

We use *ad libitum* to record the types of behavior to be encountered, the levels of interaction, and the level of human impact, through researcher's reconnaissance observations (Paterson, 2004) [15]. After 3 reconnaissance days, the level of human impact and the level of langur response were determined based on researcher's experience (Table 2). Of these, it turned out that the actions of zoo staff, not the actions of visitors, have the strongest impact on the behaviors of the gibbons. They have regularly forced the gibbons to move into selected locations to facilitate the repairing or cleaning of the cage. After 1 month of observation, almost types of behaviors have been recognized and defined to create Table 1 (see below). The rare or undefined behavior has been added to

the group “Other activities” later. Based on the table of behavior definitions along with the scales that have been developed for Indochinese grey langurs (Tables 1, 2) from these initial observations, two individuals of grey langurs were sampled using focal animal sampling (Altmann, 1974) [16] and improved by Paterson (2004) [15] with a sample interval of 10 minutes. Their food composition was also recorded by this method. At the same time, a Nakata NJ-2099TH temperature and humidity meter (accuracy for temperature is +/-1⁰C, for humidity is +/-5%) is located next to the cage to record the corresponding parameters.

Table 1. Behavior definition of *Trachypithecus crepusculus* in captivity at Hanoi Zoo

No.	Behavior	Definition
1	Feeding	Eat: put food in its mouth, chew and swallow Drink: bend down, use its mouth or tongue to take water, or use its hands to scoop water into the mouth
2	Resting	Lie or sit, eyes closed or aimless, and do not engage in any other activities, the body does not move
3	Moving	Change from one position to another in the cage
4	Self-caring	Include activities such as scratching an itch, catching lice, picking up waste from its body...
5	Playing	Perform an activity or move without accomplishing a specific goal.
6	Observing	Eyes wide open, looking in many directions while doing no other activities
7	Vocalization	Emits sounds from the respiratory organs and mouth
8	Intraspecific Interaction	Allo-groom, pick up waste on other individuals, compete for food, sit positions or threaten and attack each other
9	Interacting with humans	When people have different impacts on animals, the animals react at different levels.
10	Other activities	Includes activities other than those defined above.

Table 2. Definition and scale for assessment of the degree of human impact on the focal individual

<i>Human impact on the focal individual</i>	<i>Score</i>
Human standing or moving far away from the langur's cage	0
Humans move near the cage	1
Humans stand next to the cage, quietly observing	2
Human standing next to the cage, pointing and talking with low intensity sound.	3
Human standing next to the cage, pointing and talking in medium intensity audio	4

People standing and observing, pointing, calling the animal or making sound effects (music at high volume) from entertainment places near the cage area	5
People gather in large numbers, shouting, whistling, calling the animal to create a loud sound	6
Humans point, roll their eyes, bar their teeth, wave their hands, yell, and threaten the focal animal	7
People use food, objects or use their hands to attract or threat the animals	8
People throw food, objects inside the cage or poke the animals with sticks.	9
Zoo staff entering the cage to clean or feed; Visitors break through the security fence and get close to the inside of the cage.	10

Table 3. Scale for assessing the response of the focal individual to human impact

<i>Animal's reaction</i>	<i>Score</i>
Do not react, continue the behavior as if nothing happened	0
Have a glance and continue the current behavior	1
Temporarily stop the current behavior to observe for a short time then continue the current behavior	2
Stop the current behavior, keep its position, move the head to observe the person attentively	3
Observe people and have a change in posture and position at a slow rate	4
Changing behavior and moving slowly	5
Change its behavior and move at a moderate pace	6
Enhance play behavior or other behavior due to human impact	7
Interact with people with moderate intensity	8
Interaction with people with high intensity: move at a fast speed to the side of the human, stare at the person to beg for food	9
Pulling on the clothes of the caretaker or snatching food from visitors when visitors break through the security fence and contact to the cage	10

The overall score of human influence on the focal animal was calculated as the average of the human impact score and the animal's reaction score.

Excel 2010 was used to calculate the percentage of each worksheet type, using the following formula:

$$\text{The ratio of each type of behavior} = \frac{\text{The number of occurrences of each behaviour}}{\text{Total number of occurrences of all behaviors}} \times 100\%$$

SPSS 19.0 software was used to analyze the correlation between temperature, humidity, and human impact on the langur behavior.

2.2. Results and Discussion

The general activity budget of 2 individuals of Indochinese grey langur (n = 4290 observation records) is shown in the chart of Figure 1. The results in Figure 1 showed that resting (34%), observing (25%), and feeding (15%) accounted for the highest percentage, while vocalization (1%), playing (1%), and other activities (2%) occupied the lowest proportion of Indochinese grey langur's activity budget.

The activity budget of each individual is compared and shown in the graph of Figure 2.

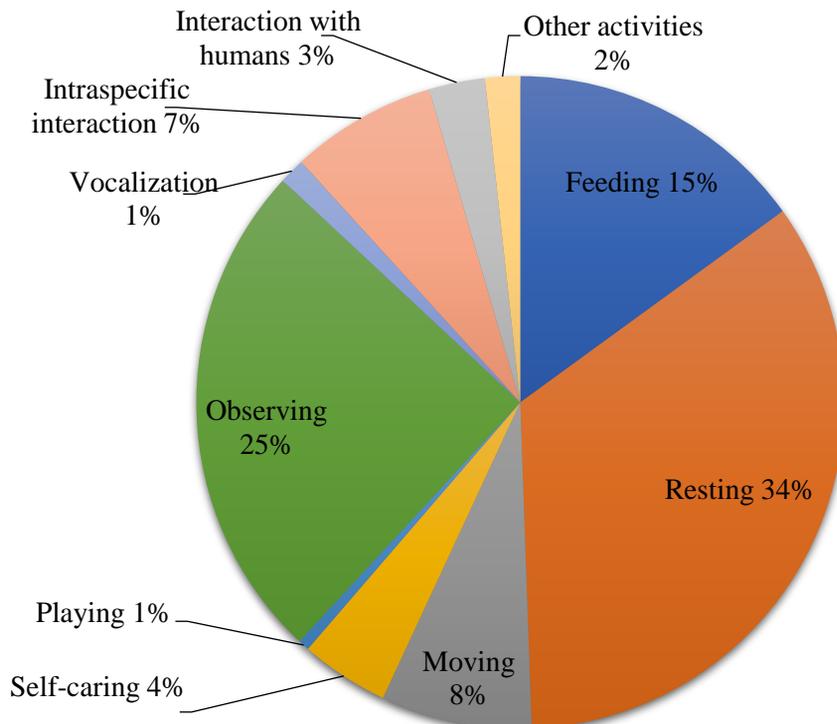


Figure 1. General activity budget of both individuals

From Figure 2, we can see that the behaviors which accounted for the largest proportion of the time budget of Subject 1 were observing, resting, and feeding. Among them, observing occupied the highest proportion with 33%. Subject 1 usually sits on the upper crossbar near the roof of the cage or sits on the roof of the cage to sleep, or the branches of the tree to observe. From this position, she had a fairly wide viewing angle to observe human activities taking place around the outside or inside the cage. She not only observed the activities of visitors in its enclosure but also guests in the enclosure area with other animals or zoo staff working in the vicinity of its enclosure. Playing made up the lowest proportion in Subject 1 - 1% of the time budget. This behavior was only observed in Subject 1 but not in Subject 2, including various activities such as: playing with leaves, manipulating objects thrown by humans or with fruits and vegetables, and running around the cage and on the branches inside the cage. Self-caring took up 8% of the activity budget. Moving and interacting with humans comprised a low percentage of about 5% of their time.

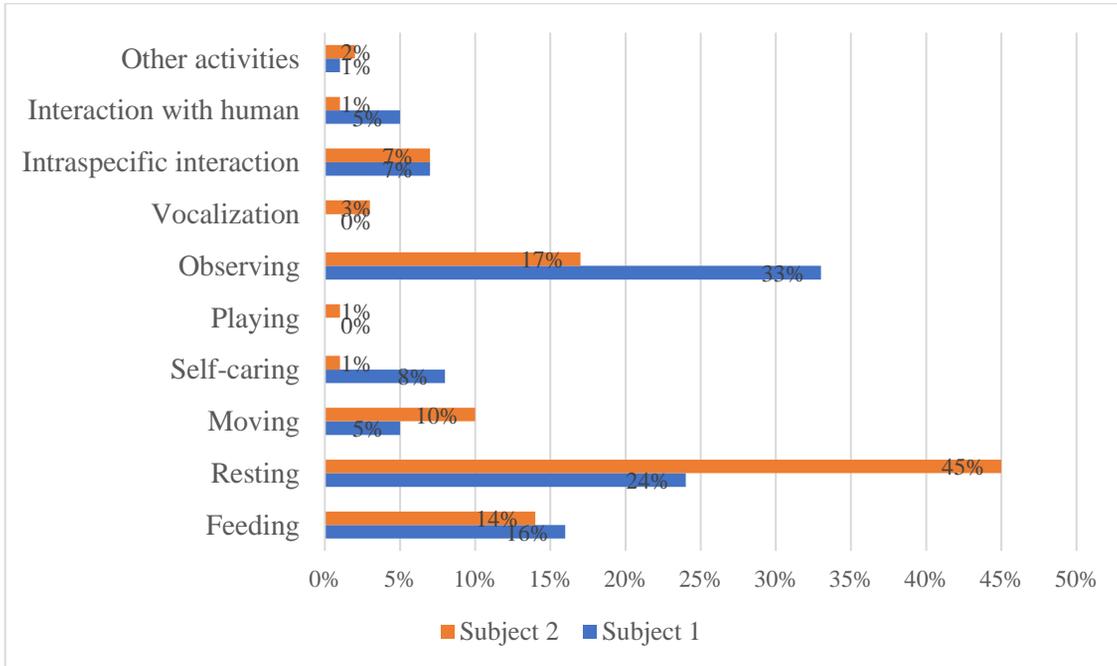


Figure 2. Detailed comparison chart of the activity budget of the two individuals

Furthermore, from the chart in Figure 2, we can see that the most significant portion of the difference in activity time between Subject 1 and Subject 2 was their resting - Individual 1 spent almost half of the total daily time (45%) resting, followed by observing (17%) and feeding (14%). Individual 2 was not observed performing playing. Moving also accounted for a fairly high rate with 10% of the day time. Self-caring and interaction with humans occupied the lowest percentage of the behaviors observed in Individual 2 (1%). In particular, Individual 2 also emitted vocalization - a behavior not observed in Individual 1, contributing 3% of the active time of Individual 2. The call of Subject 2 sounds like a bird singing, calling is intermittent, not consecutive and the number of sounds in each call can be 1, 2, or 3. During the call, Subject 2 may move from one position to another between calls or may call while moving. The call of Individual 2 in the morning often started at about 8:30 or 9 am and stopped when she was fed by the zoo staff. Sometimes after being fed, Individual 2 continued to chirp for a short period of time.

The test results for the normal probability distribution of the variables (the frequencies of temperature, humidity, and Human impact) by the Kolmogorov-Smirnov test ($p < 0.01$) and the Shapiro-Wilk test ($p < 0.01$) showed that they were not normally distributed. Performing correlation analysis between temperature and these behaviors by coefficient R_s showed no correlation ($R_s < 0.12$). Similarly, there was no correlation between humidity and these behaviors ($R_s < 0.1$).

Similarly, Human impact was also uncorrelated with most behaviors, except for a weak correlation ($R_s = 0.275$) between Human impact and Interaction with humans (Figure 3). Regression model analysis was carried out with the assumption that the relationship is linear, $df = 1$; $F = 1090.783$; $P \approx 0.0001$.

ANOVA analysis showed that $a = 0.035$; with $t = -11.186$; $P = 0.0001$.
 $b = -0.032$; with $t = 33.027$; $P \approx 0,0001$.

As a result, between Interaction with humans and uman impact exists a function:
 $y = 0.035x - 0.032$.

To explain the relatively weak interaction with human when compared to a representative of a macaque species, *Macaca leonina*, also kept at Hanoi Zoo, a species that interacted quite strongly with human (Nguyen Vinh Thanh and Tong Thi Nhai, 2018) [17], we checked the food composition of the Indochinese grey langur (Figure 4).

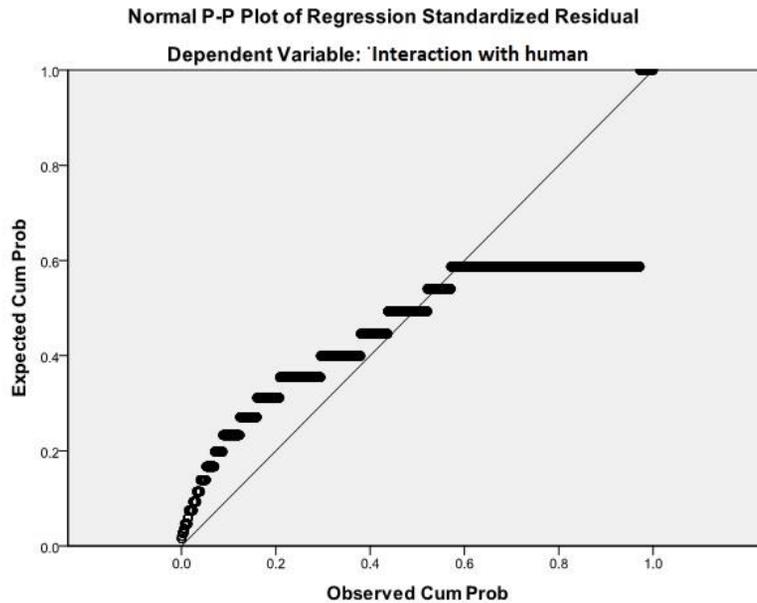


Figure 3. Relationship between interaction with human and human impact

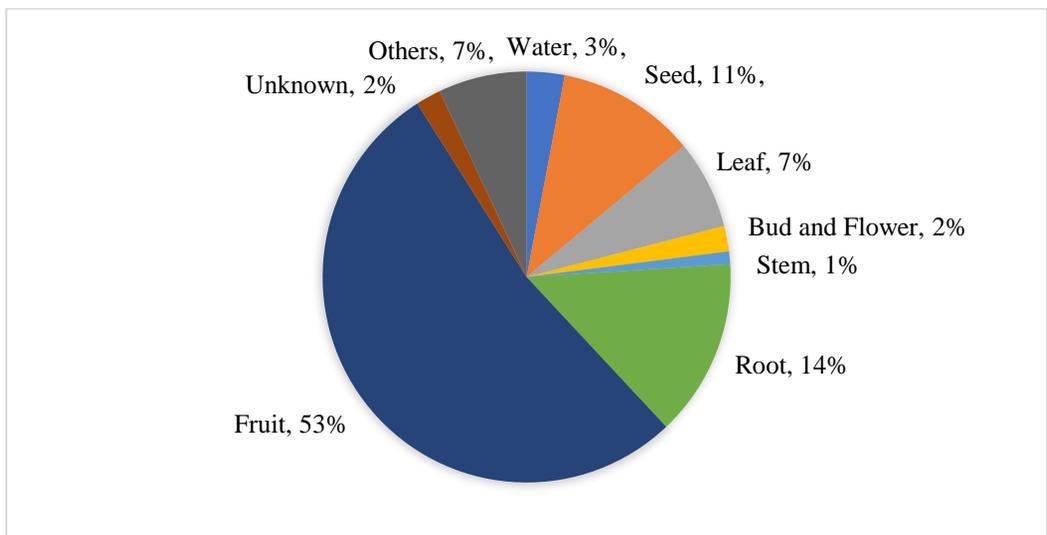


Figure 4. Percentage of plant parts eaten by Indochinese grey langurs at Hanoi Zoo

From the chart of Figure 4, in captivity at Hanoi Zoo, fruits accounted for a large proportion of the diet composition of Indochinese grey langur (53%) and leaves occupied only 7%. This result is very different from the results of studies on the diet of the langurs and other free-ranging colobine monkeys where leaves are the predominant food, such as Aziz and Feroz (2009) [6] reported leaves contributed 47% while fruit comprised 14% of the food composition; Suarez (2013) showed that leaves and fruits made up 46.2% and 39.5%, respectively. Similarly, Decemson et al. (2018) [8] report the rate of 31% young leaves, 15% fruits, 8% flowers and 46 mixed plant parts. Although the langur was previously thought to be herbivorous (Pham Nhat, 2002) [13], it has been reported that the species eats insects in small amounts (Suarez, 2013) [7]. Possibly because in captivity, the choice depends on the supply of the zoo, the main food is tubers, leaves are provided limited in both quantity and type, so the langur has fewer options. In addition, visitors also throw human foods such as bread, sticky rice, spring rolls, chips, candy, ice cream, popcorn, cakes, etc. adversely affecting the digestive system of the langurs if ingested. Their digestive system has the common characteristics of colobine monkeys, and has a very rich fermentable microflora to ferment and digest plant cell walls containing cellulose and hemicellulose (Waterman and Kool, 1994) [18]. With foods containing a lot of sugar, starch when ingested by Indochinese grey langurs can be fermented by the microflora in their intestinal tract, causing dyspepsia. It is possible that due to this dyspepsia, other activities have been affected, making them have to rest for a long time.

From Figure 2, we can see in both langurs, resting, observing, and feeding contributed a large proportion (total of 74%) of the day time. Playing occupied a very small percentage (1%). In particular, resting comprised the highest percentage of the time budget (34%). However, this result is different from studies on free-ranging langurs where feeding accounted for the highest proportion, as reported by Gupta (1997) [19], Gupta and Kumar (1994) [20] reported on *T. crepusculus* individuals in Tripura, India, whose time budget consisted of 41.7% Feeding, 28.3% Resting, 8.2% Moving, and 21.8% other activities (grooming, vocalization, playing, etc.). Bose and Bhattacharjee (2002) [21] in the southern region of Assam, India, showed the langur's time budget for activities including 39.4% feeding, 14.8% moving, 34.4% resting, 7.2% grooming, 1% playing, and 3.2% other activities. The proportion of Decemson et al. (2018) was 38% resting, 34% feeding, 18% travelling, 7% grooming, and 3% other activities. It is possible that in the wild, individuals have to be more active, and expend more energy for different activities, and the amount of food is not always available as in zoos, so individuals must spend more time feeding and eating more to accumulate more energy than the animals in the zoo. Pages *et al.* (2005) [3] showed that Indochinese grey langurs have to travel longer distances, and the home range increases when they need to supplement minerals by eating soil in some locations. In addition, the free-ranging langurs naturally have to compete for food with each other and the nutrients in leaves are lower than in tubers, fruits, and seeds, so the amount of food taken in must be in higher quantity. Meanwhile, in the zoo, the provisioned langurs do not need to search and compete with other groups, so they spend less time eating.

Playing occupied a very small percentage (only 1%) possibly because in captivity there is limited space, there are not as many trees as in nature for them to move, climb, or play. On the other hand, the number of individuals in the cage is two and both are adult females,

so playing activities are not performed much, instead feeding and resting account for a large proportion (15% and 34%, respectively).

Observing took up 25% of the time. Individual 1 usually sits on high and observes around the cage area. This behavior comprised a high rate, possibly because the grey langur cage is located near the entrance area and the aviary area, so in addition to interacting with people who visit the cage, the langurs also observe the visitors at the entrance gate area and the nearby cages. Moreover, the langur cage is located in a large yard that is often chosen by large groups of visitors as a place to rest and have a snack. Therefore, the number of people around the cage is quite large, affecting the time budget of the langurs.

Interaction between the two individuals was mainly taking care of each other. Fighting has not been observed but possibly occurred. This is probably because both individuals are adult females, so they show a caring instinct. Aggressive behavior was rare, usually caused by Individual 1 threaten Individual 2 when competing in feeding. Especially according to our ad libitum observation, when there were many visitors around the cage, Subject 1 often moved to the position of Subject 2, rubbing her rump against Subject 2 and pushing Subject 2, which can be an act of showing the social hierarchy. At that time, Individual 2 often run away or sit in place with her hands covering her head and face, due to her age and weakness, deformed eyes, no longer strong, so it often yields to Individual 1 in both choosing foods as well as choosing a sitting position in the cage.

Although the cage is located in an area with high visitor presence, interaction with human did not occupy a large proportion (only 3%) of the total time budget. It is likely that due to the long-time in captivity (22 years for Subject 1, and 27 years for Subject 2), the two individuals are used to the presence and activities of humans, so they are less directly interactive with humans, instead, they spent more time for observing (25%). They often interact when people have strong impacts such as dropping food, throwing food into the cage, poking sticks, or throwing objects at them.

From Figure 2, it can be seen that in both langurs, the 3 behaviours of feeding, resting, and observing contributed a large proportion. Although the specific ratio of each behaviour in each individual is different, the total ratio of all 3 behaviours in each individual made up a large proportion of the time budget and was approximately equal (for Individual 1 was 73% and Individual 2 was 76%). In Individual 1, the observing comprised the largest proportion (33%), and in Individual 2, it was the resting (45%). These were all low energy-consumed activities.

Feeding in both subjects accounted for a high and approximately equal proportion (16% for Individual 1, and 14% for Individual 2). According to our observations, at the time when food (leaves or fruits) was brought by zoo staff, Individual 1 often came to choose the favourite food and ate firstly. When Individual 1 came forward, Individual 2 stopped choosing food or moved to another place to wait until Individual 1 finished food choice and moved to another place (usually climbing high, very rarely Individual 1 was observed to sit on the floor). It is possible that individual 2 is older, weaker, and has to avoid conflicts.

Interaction with the human in Subject 1 contributed a greater proportion than that in Subject 2. When a visitor approached the cage with food or throws food inside, Subject 1

often moved to the side of the human to pick up the food and looked at people as if asking for more food. Subject 2 seemed to pay less attention to human impact. She usually kept sitting or kept distance from people and continued the activity she was doing. Subject 1 may be more agile and active, so it was bold when contacting people. Subject 2 is slow and may be due to the influence of Subject 1, she often moves away, and less interacting with people.

Playing was observed only in Individual 1 but not in Individual 2. It may be due to Individual 2's deformed eyes and the ability to move on tree branches. Individual 1 is also more interested in self-caring than individual 2, and when allogrooming occurred, Individual 1 often emits grooming to Individual 2. Individual 2 does not perform playing, and other behaviors also occupied a very low percentage but spent most of her time resting (accounting for almost half of the day time) and feeding. During cold weather days, individual 2 was observed that often moved to sunny areas to rest as a heating activity to keep the body warm and it might also be a form of energy saving.

3. Conclusions

The activity budget of Indochinese grey langur at Hanoi Zoo is much different from that of the langur in the wild. In the zoo, langurs spent a lot of time in three behaviours: resting (34%), observing (25%), and feeding (15%). Playing has the lowest rate (1%) and was only observed in Subject 1. Vocalization appeared in Subject 2 but the meaning has not been determined.

Comparing between two individuals, despite the difference in the specific time budget of each individual, they all spent most of the day time in the 3 behaviours: feeding, resting and observing. In terms of social behavior, Subject 1 dominated Subject 2 and also interacted more with humans.

No significant correlation has been detected between temperature and humidity with any behaviour of *Trachypithecus crepusculus* in captivity. Only the factor of Human impact had a weak correlation with the behaviour Interaction with humans of these two individuals.

In the food composition of Indochinese grey langur in Hanoi Zoo: fruits contributed the largest percentage (53%), stems made up the least percentage (1%), and leaves accounted for only 7%. This result was very different from the free-ranging langur's food composition. This may greatly affect the digestive system, health, and behaviour of the two individuals.

Recommendation

Conduct more long-time studies (at least 12 consecutive months) and possibly carry out observations at dusk and dawn, even at night for more objective and accurate results, and better understand the meanings of Individual 2's vocalization.

It is necessary to have solutions to limit human impacts on the langurs such as setting up higher protection fences, and longer distance. Propagating needs to be done to improve visitor awareness, preventing and even sanctioning harmful activities such as feeding with unsuitable food, and teasing the langur.

Adjust the provision food composition (type and amount) to appropriate the langur natural diet, giving priority to the use of young leaves and unripe fruits while removing ripe, sweet, and starchy fruits.

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