Social and reproductive behaviour of proboscis monkey
_Nasalis larvatus_ (van Wurmb, 1787) at Taman Safari Bogor,
West Java

I. Sjahfirdi and D Noviandini
Department of Biology, Faculty of Mathematics and Natural Sciences (FMIPA),
Universitas Indonesia, Depok 16424, Indonesia

Corresponding author’s email: luthfiralda@gmail.com

Abstract. Research on social and reproductive behaviours of proboscis monkey _Nasalis larvatus_
(van Wurmb, 1787) at Taman Safari Bogor has been done. The purposes of the research are to
evaluate social interactions between male and female proboscis monkeys, between the females,
and to evaluate reproductive behaviours in male and female pairs. Observation methods used
were scan sampling and ad libitum sampling with fifteen minutes intervals without pause.
The observation time was six hours per day and was done for four weeks in November 2019.
Subjects observed in the study were one adult male aged 20 years (J) and two adult females aged
14 years (B1) and 11 years (B2) in a glass cage. Social behaviours observed indicate high
affiliative behaviours (average 99.28 %) and low aggressive behaviours (average 0.72 %).
Reproductive behaviours were carried out by both pairs with the higher frequency of
reproductive behaviours happened between J and B1 than J and B2. Based on the t-test carried
out with the value of α = 0.05, the frequency of reproductive behaviours of the pairs significantly
different with the value of P < 0.05.

Keywords: Affiliative, aggressive, proboscis monkey, reproductive behaviour, social interaction

1. Introduction

Proboscis monkey is an animal from the Primate Order and it is endemic to Borneo island in South-East
Asia. Proboscis monkeys have a unique characteristic, the large nose in adult males [1].
The habitat of proboscis monkeys includes areas of land adjacent to water sources, such as mangrove
forests, riparian forests, freshwater swamp forests, and peat swamp forests [2]. Proboscis monkeys have
a role in forming forests in wetlands and mangrove forests in Borneo. Proboscis monkeys eat leaves and
shoots of plants in the forest, so they are involved in the process of managing the natural vegetation of
trees and forest environments [3].

Proboscis monkey populations in the wild are threatened, because of its limited distribution area and
due to human activity [4]. The number of proboscis monkeys has declined over the last three
generations or since around 36–40 years ago by more than 50 %. The habitat area of proboscis monkeys
in the forest has been reduced by 40 %, from 29,500 km² to around 17,700 km². Habitat destruction and
loss are the major threat factors for the survival of a population, including proboscis monkeys [1, 5].

Based on the IUCN Red Data Book, the conservation status of proboscis monkeys is Endangered.
Proboscis monkey is listed in Appendix I at CITES, which means proboscis monkeys included in the
endangered species and may not be traded [6]. The rate of destruction of their natural habitats and its population underlie the need for ex-situ conservation for these animals. Ex-situ conservation through maintenance in zoos serves to protect proboscis monkeys that are facing extinction in nature by breeding and also give educations to the society regarding the conservation of proboscis monkeys [1]. One of the ex-situ locations that protect proboscis monkeys is Taman Safari Bogor, a zoo located in Bogor, West Java.

Proboscis monkeys are arboreal (lives in trees) animals, but occasionally they can be found on the ground [7]. Adult proboscis monkeys have reddish-brown hair on the head, face, shoulders, and upper back [1]. Their hair on the lower back and stomach are grey, on the feet are yellowish-white, and on the neck are white. Proboscis monkeys have clear morphological differences between males and females (sexually dimorphic). Body size of the males are distinctively larger than the females. Adult males have a large and long nose, hanging through the mouth, while adult females have a pointed nose. Specific morphology in the nose of an adult male have functions as a trumpet to amplify the sound while showing aggression or to give a signal if there is a danger that threatens his group [8]. Proboscis monkeys have webs between their fingers for swimming and walking on the muddy ground in mangrove forests. Proboscis monkeys also have sitting cushions (ischial callosities). The sitting cushion is their morphological adaptation to sitting for a long time, especially to maintain their body while sleeping in a sitting position on the branch of trees [8].

Proboscis monkey is classified as a folivorous primate (leaf eaters). Folivorous animals group has a choice of food and a major source of essential protein derived from the leaves. Proboscis monkeys eat young leaves and fruits at the branch tips. Proboscis monkeys can digest foliage because they have a unique digestive system, the stomach with saccules, or compartments like a sack, in which there are bacteria and special enzyme combinations needed to break down plant cellulose [9]. Proboscis monkeys are also frugivorous primates (fruit eaters). Proboscis monkeys eat fruit as an additional source of protein. Other foods of the proboscis monkeys are flowers, tree bark, insects, crabs, and several other foods [10].

Proboscis monkeys are endemic to Borneo island, including Indonesia (all of Kalimantan Province), Malaysia (Sabah and Sarawak), and Brunei Darussalam. Proboscis monkeys are also found on Berhala Island, Sebatik Island, and Laut Island. Proboscis monkeys rarely live far from water sources in their natural habitat, confined to the areas near rivers and beaches [4]. Proboscis monkey’s home range is 300 m along both banks of the river. They prefer locations abundant in leaves, fruits, seeds, flowers, and insects they like [11]. Proboscis monkeys occupy trees along the riverbank in the morning, exploring the forest in the afternoon, and return to sleep before sunset. Proboscis monkeys tend to prefer beds over riverbank trees so they can easily cross the river from a tree to another tree. It is considered as their strategy to face the threat of predators on land such as clouded leopards (Neofelis diardi) as well as predators in rivers such as estuarine crocodiles (Crocodylus porosus).

Proboscis monkeys social unit in nature is generally a group consisting of one male with many females and their children (one-male group or harem) [12, 13]. The function of proboscis monkey social groups are to build bonds between the individuals, obtain foods and shelters, work together in parenting, and as protection from the threats, and reproductive functions. With a social group, when females undergo estrus, they can be detected earlier by males in the group. Due to the close relationship between social aspects and the success of reproductive proboscis monkeys, both aspects are important to consider and can be an indicator of conservation success. The results of the study can be used as reference material by the manager of Taman Safari Bogor for the sustainability and success of the ex-situ conservation program of proboscis monkey.

2. Materials and method
The study was conducted at Primate Center, Taman Safari Bogor, West Java, for 20 days in four weeks in November 2019. Observations were carried out six days a week, Monday to Saturday. Observation in one day is carried out for 6 (six) hours which is divided into two sessions, which is 09.00–12.00 and
13.00–16.00. Subjects observed in the study were one adult male and two adult females placed together in a glass cage at Primate Center, Taman Safari Bogor. The first subject is Jhon (J) (figure 1a). J came to Bogor Safari Park in 2004. The second subject was Intan (B1) (figure 1b). B1 came to Taman Safari Bogor in 2008. The third subject was Fitri (B2) (figure 1c). B2 was combined with J and B1 in 2016. The profile of the research subjects is listed in the following table (table 1).

Observations were made by collecting data on social and reproductive behaviours that were carried out between J-B1, J-B2 and B1-B2. Data was collected with scan sampling method and ad libitum sampling with 15 (fifteen) minutes intervals without pause. Scan sampling is a method that is done by observing and recording the behaviour of all animals in the group. All groups of subjects were scanned within predetermined time intervals and the behaviours of each individual is recorded. Scan sampling can provide a measurement of the frequency of the behaviour that is quite accurate. Ad libitum is the most common recording in the study of behaviours and it also called a field note. Ad libitum recording is done by non-systematic sampling, which records all behaviour in any individual chosen by the observer that occurs during a certain time. Ad libitum recording is useful for knowing specific information in the form of certain behaviours that rarely occur. The ad libitum method is commonly used as a companion method for other sampling methods, such as scan sampling, sociometric, and focal-animal [14].

| Characteristic              | Jhon (J)          | Intan (B1)        | Fitri (B2)        |
|----------------------------|-------------------|-------------------|-------------------|
| Sex                        | Male              | Female            | Female            |
| Age class                  | Adult             | Adult             | Adult             |
| Age                        | 20 years          | 14 years          | 11 years          |
| Special characteristics    | Large nose,      | Body fatter than B2, | Body slimmer than B1, |
|                            | Body larger than females | Shorter and darker than B2, | Longer and brighter |
|                            |                   | brown-colored hairs than B2 | brown-colored hairs than B1 |

Figure 1. Observation subject (a) Jhon (J), (b) Intan (B1) and (c) Fitri (B2).
Behaviours observed in proboscis monkey consists of affiliative, aggressive, and reproductive behaviours. The observed affiliative behaviours consisted of positive approach, social grooming, social playing, while aggression behaviours consisted of contact aggression (fight) and non-contact aggression (facial or body threat, chase, displace, and branch shake). Reproductive behaviours observed consisted of attractivity, proceptivity, and receptivity. Data collection is done by recording every interaction carried out between individual proboscis monkeys. Behaviours observed from the proboscis monkeys are listed on the table below (table 2).

| Behaviours                     | Explanations                                                                 |
|-------------------------------|-----------------------------------------------------------------------------|
| Affiliative                   |                                                                             |
| Positive Approach (PA)        | Individuals approach, sit close together, carry out activities near other individuals, or make body contact without aggression. |
| Social Grooming (SG)          | Individuals clean the hair and body parts of other individuals by searching using fingers or licking. |
| Social Playing (PL)           | Chasing, approaching, hitting, tugging, or wrestling.                       |
| Aggressive Contact            |                                                                             |
| Fight (F)                     | Approaching and making contact that accompanied by aggressive behaviours, such as reaching, biting, or hitting. |
| Facial/Body Threat (T)        | Standing behaviours on four legs, threatening with mouth open and showing teeth, vocalization. |
| Chase (C)                     | Running pursuit accompanied by expressions of aggression.                   |
| Displace (D)                  | Leaving other individuals who approach them, by staring at the individuals they leave behind. |
| Branch Shake (B)              | Aggression behaviours by shaking the branches of the tree using the body and producing vibrations. |
| Reproduction                  |                                                                             |
| Attractivity (AT)             | Behaviours of interest in performing reproductive activities, including persuading and attracting attention (soliciting) by showing a pouted face, shaking head, and showing the back of the body. |
| Proceptivity (PT)             | Behaviours that aim to form and maintain closeness with a partner, such as approaching and body contact. |
| Receptivity (RT)              | Behaviours to facilitate copulation with a partner, by bending down so that the partner can climb the body (mounting). |

Source: [15, 16] with modifications
3. Results and discussion
Observation of the proboscis monkey group at Taman Safari Bogor resulted in a total observation time of 7,200 minutes. Data on social behaviors in the form of affiliative, aggressive, and reproductive behaviors of J-B1, J-B2, and B1-B2 are presented in the form of total (table 3, table 4, table 5) and percentage (table 6, table 7, table 8). The data of behaviors were then converted into graphical form (figure 2, figure 3, figure 4). Statistical analysis with t-test was conducted to determine whether there were differences in the total number of reproductive behaviors between J-B1 and J-B2.

### Table 3. Total of the affiliative behaviors of proboscis monkey group at Taman Safari Bogor.

| Subject | Positive approach | Social grooming | Social playing |
|---------|-------------------|----------------|---------------|
| J-B1    | 422               | 79             | 4             |
| J-B2    | 196               | 2              | 1             |
| B1-B2   | 226               | 61             | 0             |
| Average | 281.33 ± 100.22   | 47.33 ± 32.89  | 1.67 ± 1.70   |

### Table 4. Total of the aggressive behaviors of proboscis monkey group at Taman Safari Bogor.

| Subject | Fight | Threat | Chase | Displace | Branch shake |
|---------|-------|--------|-------|----------|--------------|
| J-B1    | 0     | 6      | 0     | 0        | 0            |
| J-B2    | 0     | 2      | 0     | 0        | 0            |
| B1-B2   | 0     | 0      | 0     | 0        | 0            |
| Average | 0.00 ± 0 | 2.67 ± 2.49 | 0.00 ± 0 | 0.00 ± 0 | 0.00 ± 0     |

### Table 5. Total of the reproductive behaviors of proboscis monkey group at Taman Safari Bogor.

| Subject | Attractivity | Proceptivity | Receptivity |
|---------|--------------|--------------|-------------|
| J-B1    | 18           | 10           | 9           |
| J-B2    | 5            | 0            | 0           |
| B1-B2   | 7            | 3            | 3           |
| Average | 10.00 ± 5.72 | 4.33 ± 4.19  | 4.00 ± 3.74 |

### Table 6. Percentage of the affiliative behaviors of proboscis monkey group at Taman Safari Bogor.

| Subject | Positive approach | Social grooming | Social playing |
|---------|-------------------|----------------|---------------|
| J-B1    | 82.58 %           | 15.46 %        | 0.78 %        |
| J-B2    | 97.51 %           | 1.00 %         | 0.50 %        |
| B1-B2   | 78.75 %           | 21.25 %        | 0.00 %        |
| Average | 86.28 % ± 0.08    | 12.57 % ± 0.09 | 0.43 % ± 0.00 |
Table 7. Percentage of the aggressive behaviours of proboscis monkey group at Taman Safari Bogor.

| Subject   | Aggressive behaviours (Percentage) |
|-----------|-----------------------------------|
|           | Fight    | Threat | Chase | Displace | Branch shake |
| J-B1      | 0.00 %   | 1.17 % | 0.00 %| 0.00 %   | 0.00 %       |
| J-B2      | 0.00 %   | 1.00 % | 0.00 %| 0.00 %   | 0.00 %       |
| B1-B2     | 0.00 %   | 0.00 % | 0.00 %| 0.00 %   | 0.00 %       |
| Average   | 0.00 ± 0 | 0.72 % ± 0.10 | 0.00 ± 0 | 0.00 ± 0 | 0.00 ± 0     |

Table 8. Percentage of the reproductive behaviours of proboscis monkey group at Taman Safari Bogor.

| Subject   | Reproductive behaviours (Total) |
|-----------|---------------------------------|
|           | Attractivity | Proceptivity | Receptivity |
| J-B1      | 48.65 %       | 27.03 %      | 24.32 %     |
| J-B2      | 100.00 %      | 0.00 %       | 0.00 %      |
| B1-B2     | 53.85 %       | 23.08 %      | 23.08 %     |
| Average   | 67.50 % ± 0.23 | 16.70 % ± 0.12 | 15.80 % ± 0.11 |

Figure 2. Percentage of affiliative and aggressive behaviours of proboscis monkeys at Taman Safari Bogor.

Social behaviours occurred between proboscis individuals show high affiliative behaviours (mean 99.28 %) and low aggression behaviours (average 0.72 %) (table 6, table 7, figure 2). The most frequent forms of affiliative behaviours during observation were positive approach J-B1 of 82.58 %, J-B2 97.51 %, and B1-B2 78.75 % of the total social interactions that occurred (table 6, figure 2). Positive approach behaviours occurred in a higher percentage indicates that individuals tend to do more of the general forms of social interactions, such as approaching, following, or sitting together.
while resting without doing other activities, and this happened between J-B2. Meanwhile, the positive approach behaviours that occur in a lower percentage indicate that the individuals allocate their social interactions to the more specific interactions, that was social grooming and social playing, more than between other pairs, and this happened between J-B1 and J-B2.

Positive approach behaviours carried out by proboscis monkeys include approaching, following, and carrying out activities together or in close, such as body contact, moving together, eating, drinking, sleeping, shelter from the rain, and sitting together while resting without doing other activities. Each individual did a positive approach to each other with frequencies that tend to be the same between individuals who approach and individuals who approached. Positive approach behaviours are also done
by proboscis monkey as a form of mutual protection when there is an external threat, such as two or three individuals sitting close together to avoid or show aggression towards external threats.

Positive approach is an approach to build bonds and social interactions that close and stable in groups. A good social interaction can make other interactions run well, such as reproductive activities, childcare, protection from threats, and work together on various other things as a social animal. Positive approach behaviours occurs in high numbers in the proboscis monkey group showing compatibility between each individual, although the three individuals brought in from different locations are then combined by the Taman Safari Bogor manager [16]. The three individuals make a positive approach when they are together and when B2 is placed in a sleeping cage, then other individuals move near the door of the sleeping cage to look for B2.

The mean percentage of social grooming behaviours in the proboscis monkey group (12.57 %) (table 6, figure 3) is higher than social grooming in the two groups of proboscis in nature, the proboscis monkey group only consumes less than 5 % and 6 % of its total activities to conduct social grooming [13]. Animals that live in nature, including proboscis, carry out activities to explore the forest in search of food (foraging), but these activities are not carried out by animals that live in cages and are fed regularly, so the animals and their groups will divert foraging activities into other activities, for example orangutans (Pongo sp.) who reside in zoos do more resting than orangutans living in nature [17]. Based on the percentage of social grooming of the proboscis monkey group (12.57 %) (table 6, figure 3) which is higher than that of the proboscis living in nature based on the previous study (< 5 % and < 6 %), it can be concluded that social grooming is an activity carried out by the proboscis monkey group as an allocation of foraging activities.

The social grooming behaviours of the proboscis monkey group was 15.46 % between J and B1 (table 6, figure 2). Grooming behaviours is performed by B1 and B2 to J, while J does not perform grooming to both the females, because J as an adult male individual is the dominant individual in the group. The correlation between social status by giving grooming is seen from the more dominant individuals giving little or no grooming [18]. Social grooming behaviours between male and female individuals play a role in the formation of stable social relations and reproductive relationships [18]. The percentage of social grooming between females (21.25 %) (table 6, figure 2) is higher when compared to social grooming between females and males, as observed in nature that female proboscis did the activity more to other female individuals than to male individuals, because females tend to build more social ties compared to males [19].

Social playing behaviours was observed several times, which was 0.78 % between J and B1, 0.50 % between J and B2, while B1 and B2 did not do social playing (0.00 %) (table 6, figure 2). Social play behaviours between J and B1 is in the form of researching and hitting behaviours. Social playing behaviours between J and B2 is J in the form of reaching behaviours. So based on observations, social playing behaviours between individual proboscis monkeys is contact and non-contact. Non-contact social playing involves facial expressions so that it can also be called play-face behaviours [20]. Adult individuals do social playing to maintain the typical behaviours of adolescent age class in the form of social playing to reduce aggressiveness in groups [21].

The percentage of aggressive behaviours between individual proboscis monkeys (0.72 %) (table 7, figure 3) is close to that observed in two groups of natural proboscis monkeys, 0.7 % and 0.8 % of the total activity of the proboscis monkey group is the social interaction of aggression [13]. Aggression behaviours only occur in the form of facials and body threats at 1.17 % between J and B1 and 1.00 % between J and B2, while between B1 and B2 there is no aggression (0.00 %) (table 7, figure 2). Facial threat behaviours done by proboscis monkeys is opening the mouth and showing teeth and body threat behaviours, is standing on four legs or two legs. The difference in aggression behaviours between male proboscis monkey and female proboscis monkey can be seen from the threat J behaviours in the form of facial threat which is almost always accompanied by a body threat, whereas the threat behaviours B1 and B2 are only a facial threat.

Reproductive behaviours are quite often performed by both male and female proboscis monkey pairs in Taman Safari Bogor. The attractivity, proceptivity, and receptivity behaviours were carried out
between J and B1 with 18 interactions (48.65 %), 10 interactions (27.03 %), and 9 interactions (24.32 %), with a total of 37 interactions, while reproductive behaviours between J and B2 are only in the form of attractivity of 5 interactions (100.00 %) (table 5, table 8, figure 4). The attractivity behaviours of proboscis monkey group was showing facial expressions called pouted face. Attractivity is a behaviour done by proboscis monkeys as a form of attraction and initiation to carry out reproductive activities. Initiation to reproduce is first shown by both male or females. The attractivity behaviours are also carried out between females as an initiation to carry out noncopulatory mounting [17]. The proceptivity behaviours carried out between J and B1 was approaching the desired individual to reproduce. The approach behaviours were mostly done by B1, but J also approaches B1 first on other occasions. For noncopulatory mounting between females, females who want to climb the body are the individuals who approach other female individuals that they want to climb. The receptivity behaviours performed by proboscis monkeys in the form of bending and showing the back of the body to individuals who will mount him/her [15]. Mounting is the behaviour of one individual climbing up the body of another individual to perform reproductive activities with him. Mounting between male and females had the male (J) climbing the female (B1) and was always followed by copulation. Reproductive behaviours between females lead to noncopulatory mounting behaviour, to provide signals related to reproductive activity between male and females [16]. The frequency of reproductive behaviours between pairs differed significantly based on the t-test conducted on the frequency of the attractivity, proceptivity, and receptivity behaviours of the two pairs. T-test was carried out with a value of \( \alpha = 0.05 \) and obtained a value of \( P = 0.032 \). \( P \) value < 0.05 so that the results of the t-test indicate a significant difference in the frequency of reproductive behaviours between J and B1 with J and B2.

4. Conclusion

Social interactions which happened between male and female proboscis monkeys are considered good because aggressive behaviour occurred in low numbers (average 0.72 %), and reproductive behaviour then followed. Social interaction between female individuals is also considered good because there was no aggressive behaviour, and social grooming behaviour occurred in high numbers (average 21.25 %). Reproductive behaviours in the proboscis group in Taman Safari Bogor was in accordance with the natural behaviour which is the harem system and all individuals support the harem system in the group. J’s preference for reproductive activity was with B1 because the number of reproductive interactions of J-B1 was significantly (\( P <0.05 \)) higher than J-B2. Conservation for the proboscis monkeys conducted by Taman Safari Bogor runs well because there was high compatibility between the individuals to the each other, indicated by high affiliative behaviours, even though they were brought from different locations and combined by Taman Safari Bogor, then reproductive activities occur and each female have borne a child.

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