



Study of Natural Food Sources of Proboscis Monkey (*Nasalis larvatus*) in the Buffer Zone of New Capital City of Indonesia

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Abstract. The riparian forest area along the Tunan river in Waru District, Penajam Paser Utara, is one of the proboscis monkey habitats in East Kalimantan. This area is included in the buffer zone closest to the new nation's capital city. As a result of the ongoing land use conversion, this area is divided into fragments, which have an effect on reducing the habitat. However, the presence of numerous groups of proboscis monkey indicates that these habitat fragments can still meet their basic needs. The purpose of this study was to identify plant species used by proboscis monkey as natural food sources. Purposive sampling and observation method were used during this research. The result shows that there were 18 plant species as natural food sources, namely *Avicennia marina*, *Elaeis guineensis*, *Excoecaria agalocha*, *Ficus benjamina*, *Sonneratia caseolaris*, *Vitex pinnata*, *Xylocarpus granatum*, *Achantus ilicifolius*, *Derris trifoliata*, *Ficus urata*, *Manihot esculenta*, *Melastoma malabathricum*, *Senna alata*, *Acrosticum aureum*, *Causonis trifolia*, *Flagellaria indica*, *Oxyceros longiflorus*, and *Loranthus* sp. The hugest proportion of plant parts consumed were leaves (66.67%), while flowers and fruits were consumed in a smaller percentage.

Keywords: food sources · *Nasalis larvatus* · proboscis monkeys · riparian

1 Introduction

The plan to move the State Capital (IKN) to the island of Kalimantan, to be precise in the North Penajam Paser Regency area, will cause major changes to the area. Starting with the clearing and conversion of land use will have a very influential impact on biodiversity. Large-scale development in a short time can change habitat conditions and have an impact on the existence of increasingly threatened wildlife. With the movement of the State Capital, it can affect the balance of the ecosystem, not only in the main area undergoing development, but also a surrounding area or buffer zone.

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Primates, as a member of mammals, depend on the existence of forests and have an important role in the distribution of plants. Primates are generalists and have ability to adapt to the changes in the forest's structure and composition of their habitat by changing their home range and food patterns. One of the primates that will be affected by this development is proboscis monkeys [1].

Proboscis monkey (*Nasalis larvatus*) or also known as the Dutch monkey, bekara, and warek Dutch, is one of the endemic primates of Borneo. As an endemic animal, proboscis monkeys have certain criteria in the selection of habitats that can support various life needs. It is mostly found in peat swamp forest, mangrove forest types and on the coastal area; and commonly also depend on the presence of water in their habitat. The distribution of proboscis monkey in East Kalimantan covers the Mahakam river basin to the coastal area of Balikpapan. Until now this species is included as protected animals in Indonesia and is protected under the Forest Protection and Nature Conservation Law no. 5 of 1990, as well as the Decree of the Minister of Forestry of the Republic of Indonesia No. 301/Kpts-II/1991. Internationally, proboscis monkey are categorized as endangered species in the IUCN Red List of Threatened Species and listed in book of Taksonomi Tumbuhan by G. Tjitrosoepomo [3].

One of the watersheds where proboscis monkey can still be found is in the riparian forest along the Tunan River, in Waru District, North Penajam Paser. Nowadays, the existence of the forest in this area is experiencing the conversion of land use, such as into settlements, ponds, coconut and palm oil plantations, and means of transportation (roads), to support human needs. The land use conversion leads to the formation of forest fragments, reducing habitat of primates. Fragmentation can limit the movement of animals from one habitat fragment to another. Since proboscis monkey are very sensitive to changes in their habitat, it can affect the existence of the population. However, the presence of several groups of proboscis monkey in riparian forest fragments along the tunan river indicates the carrying capacity of these fragments is still adequate to support their basic needs. Until now, there is no information about natural food sources used by proboscis monkey in fragmented areas of the Tunan river. Therefore, this study needs to be carried out to identify the natural food sources of proboscis monkey (*Nasalis larvatus*) in the fragmented riparian forest of the Tunan River, Waru District, North Penajam Paser Regency, East Kalimantan.

2 Methods

2.1 Research Location

The research is conducted in the riparian forest along Tunan river, Waru District, North Penajam Paser, East Kalimantan (1°22'21.8"S and 116°38'45.3"E) (Fig. 1).

2.2 Research Procedures

2.2.1 Observation

Field observations were carried out for two purposes. First observation was made by exploring the area on foot and by motorboat to determine the spots for the feeding

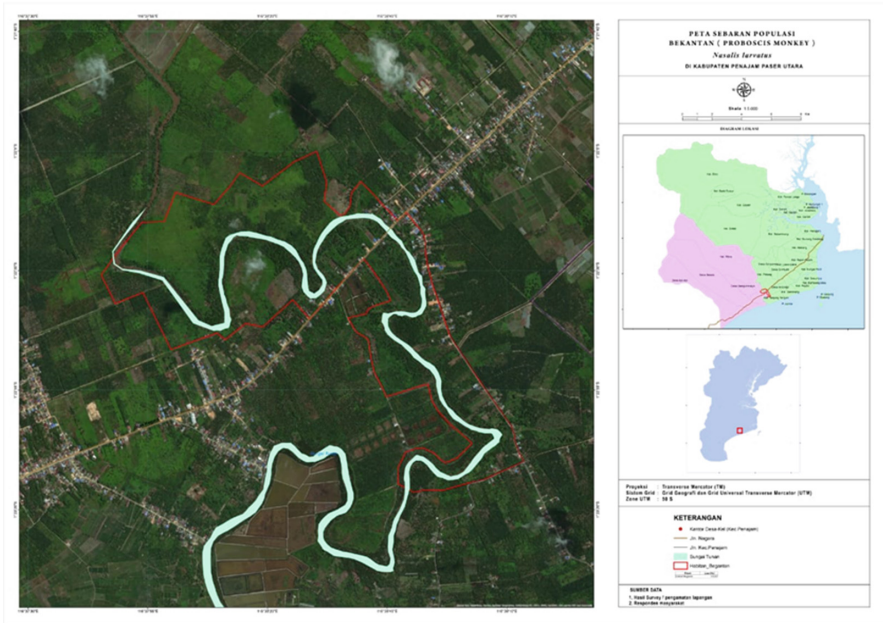


Fig. 1. Research location in the riparian forest along Tunan river, Waru District, North Penajam Paser, East Kalimantan.

behavior observation. The coordinates of the encounter point are recorded for further observations. Observations were carried out for 4 days by observing the groups of proboscis monkeys found to determine the observed group. The next step is observing their feeding behavior, which is carried out using purposive sampling method. Observations of feeding behavior were carried out starting from taking feed until food was eaten by proboscis monkey, and individuals who were observed eating were recorded. Observations were also made to determine the plant species and part of the plant consumed, whether it was in the form of leaves, flowers, or fruits. No specific criteria such as gender (male or female) or age group (adult, juvenile, child) for proboscis monkey were observed. The time of observation was in the morning (06:00–10:00) and afternoon (15:00–18:00) and tabulated into the observation table. The results of the observation of feeding behavior were presented descriptively.

2.2.2 Sampling and Identifying Natural Food Sources of Proboscis Monkeys

Samples of the observed plant species were taken and their local names were recorded. The samples taken were then made herbarium specimens following the rules described by Tjitrosoepomo (1993). Plant species were identified using several books, such as the identification book by Noor *et al.* (2006) “Panduan Pengenalan Mangrove di Indonesia”, and Setyawan AD (2008) “Biodiversitas Ekosistem Mangrove di Jawa; Tinjauan Pesisir Utara dan Selatan Jawa Tengah” as an accurate reference [3, 4]. In addition, the species

identity was confirmed following conventional methods, as verified by the botanist, Dr. Medi Hendra (second author).

2.2.3 Data Analysis

Data on natural food plant species are presented qualitatively in the form of figures and tables. The percentage of plant parts consumed by proboscis monkey is presented quantitatively, with the formula:

$$\frac{\text{number of plant parts consumed}}{\text{number of plant species}} \times 100\%$$

3 Results and Discussion

3.1 Habitat Description of Proboscis Monkey in Fragmented Riparian Forest Area of Tunan River, Waru District

The riparian forest area along the Tunan river has naturally occurring plants such as Nipah (*Nypa fruticans*), rambai (*Sonneratia caseolaris* L.), buta-buta (*Excoecaria agallocha* L.), api-api (*Avicennia marina* (Forssk.) Vierh), bintaro (*Cerbera manghas* L.), paku laut (*Acrosticum aureum* L.), jeruju (*Acanthus ilicifolius* L.), and laban (*Vitex pinata* L.). These species are distributed differently depends on the location. The estuary area up to one kilometer upstream is specifically dominated by nipah (*N. fruticans*) and rambai (*S. caseolaris*). Meanwhile, the vegetation on the riverbanks is dominated by bintaro (*C. manghas*), laban (*V. pinata*), and buta-buta (*E. agallocha*). Based on the types of plants that grow in the riparian forest area along the Tunan river are categorized to be an association mangrove or brackish mangrove, which is usually found along the river with brackish to almost freshwater. The dominant existence of nipah (*N. fruticans*) and rambai (*S. caseolaris*) along the location is in accordance with the statement of Noor *et al.* (2006) which states that in the brackish mangrove area, it is usually dominated by the Nypa or Sonneratia community even though there are other vegetation such as *Cerbera* sp., *Gluta renghas*, and *Xylocarpus granatum* [3].

As the area along Tunan river is experiencing conversion of land use from the forest into human accommodation, the habitat of proboscis monkeys is in contact with human activities. This condition is resulted in the existence of cultivated plant species apart from natural plants, such as banana (*Musa* sp.), cassava (*Manihot esculenta*), coconut (*Cocos nucifera*), and palm oil (*Elaeis guineensis*).

3.2 Natural Food Sources for Proboscis Monkeys

Based on the results of observations and identification, there are 18 plant species consumed by proboscis monkey in the riparian forest area of the Tunan river (Table 1). The plants species used by primates depend on the availability of food sources in their habitats. The number of plant species used as natural food sources in this area is similar in number, but not in species composition with the observation in Kutai Lama Dalam river

[5]. Meanwhile, the number of plant species in this research is higher when compared to the plant species found in the mangrove area of Nipah Panjang Village, namely as many as 15 species as reported by Kartono (2008) [6]. According to Atmoko (2012) [7] the availability of feed is one of the most important factors due to its availability in sufficient quantity and quality can properly support animal life. The proboscis monkey's habitat in the riparian area of the Tunan river has more diverse in number of species than the mangrove forest in Nipah Panjang Village (Kartono, 2008) and rubber plantations in the Batu Kumpai Protected Forest in Tabalong Regency (Soendjoto, 2002) [6, 8].

Proboscis monkey is often seen using *S. caseolaris*, *M. esculenta*, *E. guineensis*, *V. pinata*, *E. agallocha*, and *F. benjamina*, as main food sources and have several complementary food consumed in smaller proportion (Table 2). Meanwhile, even grouped as complementary food, proboscis monkey is frequently consumed *M. malabathricum*. The results showed similarity to what stated by Atmoko (2014) that *S. caseolaris* and *V. pinnata* are the main food sources for proboscis monkey in the isolated area of Kuala Samboja [9]. However, proboscis monkey is frequently observed on the main tree, *S. caseolaris*, as this species is quite widespread in the area and has a bunch of young leaves and fruits (Fig. 2). The distribution of rambai tree (*S. caseolaris*) along the Tunan river affects the distribution pattern of proboscis monkey. It is also found consumed other mangrove species, such as *A. marina* and *X. granatum*. In addition to feeding tree species, proboscis monkey also consumed several types of shrubs such as jeruju (*A. ilicifolius*), bung (*D. trifoliata*), fig wood (*F. aurata*), needle flower (*Oxyceros longiflorus*), and ketepeng (*Senna allata*). Proboscis monkeys were also observed to eat ferns such as paku laut (*A. aureum*); some lianas such as galing (*Causonis trifolia*), owar (*Flagellaria indica*); and a parasite plant, *Loranthus* sp.

The composition and plant species as natural food sources are differed and varied among habitats lead to the differences in their main diets. The result of Atmoko et al. (2014) about *S. caseolaris* and *V. pinnata* as main diets in Kuala Samboja; and as stated by Hendra et al. (2015) that the main diet of proboscis monkey at Kutai Lama Dalam (*F. benjamina* L., *S. caseolaris* L., *Syzigium grande* Wight., *Gluta renghas* L., *Gluta wallicii* Hook. And *Heritiera elata* Ridl.) showed that those species are naturally grown along the river [5, 9]. Meanwhile, unlike the previous information, main diet of proboscis monkey at riparian forest along Tunan river is a mixed between natural vegetation and cultivated plants, as a result of its habitat intersect with humans.

Proboscis monkey eats various types of food in the form of leaves, flowers, and fruit from different plant species and consume a part or all part of plants depend on species. There are 3 species (16.67%) that all parts are chosen by proboscis monkey, namely *S. caseolaris*, *M. malabathricum* and *O. longiformis* although with different proportions (Fig. 3). In accordance with Zainudin & Rizki (2016), proboscis monkey is included in the foraging specialist group and have a digestive system with a fermentation technique or can be called polygastric [10]. Ninety percent (90%) of proboscis monkey feed is part of plants and 10% is insects.

Rambai (*S. caseolaris*) is very popular from the leaves, flowers, to the fruit. According to Dari et al. (2020) rambai fruit or also known as pedada fruit, has a fairly high nutritional content and can be used as a food source [11]. The nutritional content in 100 g of fruit is vitamin A 221.97 IU, vitamin B 5.04 mg, vitamin B2 7.65 mg, vitamin C 56.74 mg. The

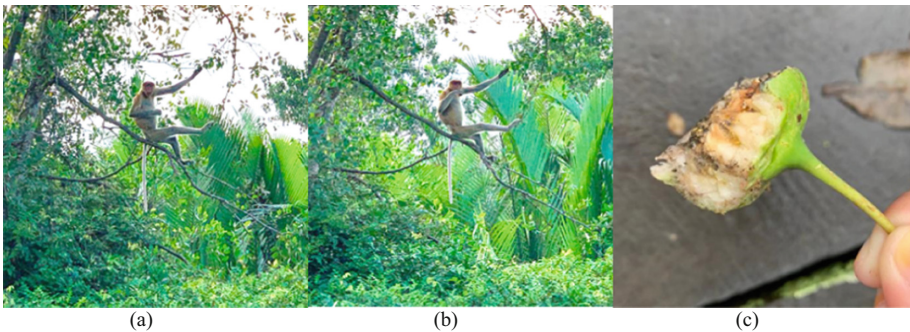
Table 1. Natural Food Sources for Proboscis Monkey at Fragmented Riparian Forest of Tunan River

No	Family	Species	Habitus	Parts consumed		
				Leaves	Flowers	Fruits
1.	Acanthaceae	<i>Acanthus ilicifolius</i> L.	Shrub	✓	✓	
2.	Acanthaceae	<i>Avicennia marina</i> (Forssk.) Vierh.	Tree	✓		
3.	Arecaceae	<i>Elaeis guineensis</i> Jacq.	Tree			✓
4.	Euphorbiaceae	<i>Excoecaria agallocha</i> L.	Tree	✓		
5.	Euphorbiaceae	<i>Manihot esculenta</i> Crantz.	Shrub	✓		
6.	Fabaceae	<i>Derris trifoliata</i> Lour.	Shrub	✓		
7.	Fabaceae	<i>Senna alata</i> (L.) Roxb.	Shrub	✓		
8.	Flagellariaceae	<i>Flagellaria indica</i> L.	Liana		✓	
9.	Lamiaceae	<i>Vitex pinnata</i> L.	Tree	✓		
10.	Loranthaceae	<i>Loranthus</i> sp.	Liana	✓		
11.	Lythraceae	<i>Sonneratia caseolaris</i> L.	Tree	✓	✓	✓
12.	Melastomataceae	<i>Melastoma malabathricum</i> L.	Shrub	✓	✓	✓
13.	Meliaceae	<i>Xylocarpus granatum</i> J. Koenig	Tree	✓		
14.	Moraceae	<i>Ficus aurata</i> (Miq.) Miq.	Shrub	✓		
15.	Moraceae	<i>Ficus benjamina</i> L.	Tree	✓		
16.	Pteridaceae	<i>Acrostichum aureum</i> L.	Shrub	✓		
17.	Rubiaceae	<i>Oxyceros longiflorus</i> (Lam.) T. Yamaz.	Liana	✓	✓	✓
18.	Vitaceae	<i>Causonis trifolia</i> L.	Liana	✓		

results of the research analysis also show the proximate levels contained in this fruit. The proximate levels are: water content (wet weight) 84.76%, ash content (dry weight) 8.4%, fat content (dry weight) 4.82%, protein content (dry weight) 9.21%, and carbohydrate content (dry weight) 77.57%. Rambai fruit contains phytochemicals, namely steroids, terpenoids, and flavonoids. It is known that chemical compounds such as flavonoids are antioxidants that can neutralize free radicals that can attack the body so they are safe for consumption.

Table 2. Feed Plants of Proboscis Monkey Based on the Duration of Feeding Time

No.	Species	Duration (second)
1	<i>Sonneratia caseolaris</i>	380
2	<i>Manihot esculenta</i>	250
3	<i>Elaeis guineensis</i>	227
4	<i>Vitex pinnata</i>	198
5	<i>Excoecaria agallocha</i>	173
6	<i>Ficus benjamina</i>	153

**Fig. 2.** Proboscis monkey (a) reaches rambai fruit, (b) picks rambai fruit, (c) leftover of rambai fruit (*S. caseolaris*)

However, the most plant part preferred by proboscis monkey is leaves, as many as 12 species (66.67%), and other single parts in lower percentages (Fig. 3). The leaves, especially the young ones, are their main choice as stated by several researchers, such as Anda et al. (2018) and Yashaningthias (2010) [12, 13].

Anda et al. (2018) stated that the leaves are the most preferred plant parts by proboscis monkeys, especially young leaves which contain more protein than other parts. Proboscis monkeys are arboreal animals that have a need for protein twice as much as their body size [12]. In addition, another factor of the high rate of leaf feeding is due to the production of fruit and flowers that are seasonal. According to Yasaningthias (2010) proboscis monkeys in the Taman Safari Indonesia area only consume the tops of leaves and flesh of the fruit, so that many other plant parts such as roots, stems, and some seeds are still left [13]. Young leaves that are still fresh contain levels of toxins that are quite low when compared to old leaves, besides that the protein contained in young leaves is also higher and contains less fiber. The fruit eaten by proboscis monkeys is generally raw fruit, with the flesh and seeds to meet nutritional needs, and to avoid food poisoning. The possibility of food poisoning can be minimized because proboscis monkeys are classified as primates that are selective in their feed.

Proboscis monkey often uses forage trees as roosting/sleeping trees. Based on field observations, there are 3 tree species that used as roosting trees, namely *Sonneratia*

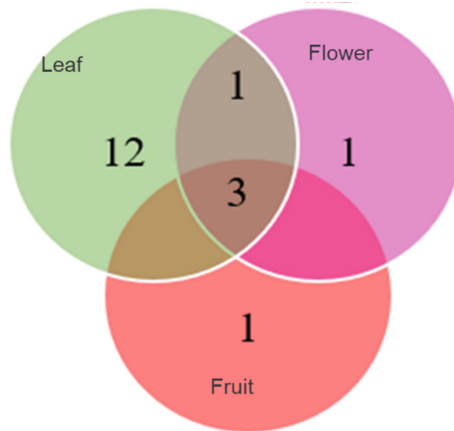


Fig. 3. Number of plant species based on the parts consumed by proboscis monkeys

caseolaris (Lythraceae). *Avicennia marina* (Acanthaceae) and *Excoecaria agallocha* (Euphorbiaceae). These trees can be found on the left and right sides of the Tunan river. According to Wicaksono (2008) the canopy strata that are widely used by proboscis monkeys to carry out activities are trees that have a height of 20–30 m [14]. Proboscis monkeys also choose trees that have a wide canopy with a number of horizontal branches for rest and sleep. Retanti et al. (2021) stated that proboscis monkeys choose roosting trees which can provide food as well [15].

4 Conclusion

In the fragmented riparian forest area in the Tunan River, Waru District, 18 species of plants from 14 family were found as the natural sources of proboscis monkeys' diets. These species in form of tree, namely *Avicennia marina*, *Elaeis guineensis*, *Excoecaria agallocha*, *Ficus benjamina*, *Sonneratia caseolaris*, *Vitex pinata*, and *Xylocarpus granatum*; in the form of shrubs, namely *Achantus ilicifolius*, *Derris trifoliata*, *Ficus aurata*, *Manihot esculenta*, *Melastoma malabathricum*, and *Senna allata*; and a fern, namely *Acrosticum aureum*; and several lianas, namely *Causonis trifolia*, *Flagellaria indica*, and *Oxyceros longiflorus*. Proboscis monkeys were also observed to eat one type of parasitic plant, namely *Loranthus* sp. The main natural food source for proboscis monkeys in this area is the rambai tree (*Sonneratia caseolaris*).

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