PREGNANT AND LACTATING *Macaca nigra*: BEHAVIOR AND FOOD SELECTION

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ABSTRACT

Pregnancy and lactation are reproductive phases that require large amounts of energy. Females in the reproductive period need good quality and quantity of food to provide nutrition for the fetus, milk production and child care. The mother will adapt to changes in behavior patterns and food type to meet these needs. The influence of parity and environmental conditions can affect the behavior patterns of females. During pregnancy, the *Macaca nigra* is known to have different proportion of activities in each period, while the behavior during the lactation phase in each mester is unknown. Therefore, this study aimed to analyze the behavior patterns in each mester and the food selection of *Macaca nigra* during the pregnancy and lactation phases, as well as the influence of female parity and environmental toward the behavior patterns. There were 39 females *Macaca nigra* observed from two groups from August 2018 to July 2019. An instantaneous focal sampling method was performed to observe females' daily activities, continuous focal sampling to monitor food types and a selectivity index to analyze food type preferences. The results showed that the female *Macaca nigra* pattern was influenced by the reproductive phase, female parity and environmental conditions. Females at the end of the pregnancy and lactation phases had a high proportion of feeding and eat more arthropods. Primiparous females mostly performed resting activities. Food preference was influenced by reproductive factors and food availability. The choice of fruit could be affected by fruit availability, and their favorite food was *D. mangiferum* and *Euginia* sp.

Keywords: daily activity, fruits availability, fruits preferences, *Macaca nigra*, reproductive phase

INTRODUCTION

Sulawesi black crested macaque (*Macaca nigra*) is one of the seven macaques species endemic to Sulawesi Island. Female *M. Nigra* has three phases of reproduction, namely oestrous, pregnant and lactation. Several studies have shown that the reproductive phase requires a large energy cost (Pond 1977; Altmann & Samuels 1992; Garber & Leigh 1997). Pregnancy and lactation are essential stages for females, especially lactation, which is the reproductive phase with the highest energy costs (Pond 1977; Garber & Leigh 1997). During lactation, females need foods with higher protein and calories for milk production and baby care, such as infant transport and thermoregulation (Altmann & Samuels 1992; Guedes *et al.* 2008). The gestation period of *M. nigra* lasted about 180 days (Engelhardt & Perwitasari-Farajallah 2008) and was characterized by discoloration around the urogenital area from red to dark purple (Gholib 2017). The lactation period was characterized by a discoloration of the urogenital skin from dark red-purple to pale pink (Gholib 2017). The lactation lasts approximately one year (Pasetha 2018, unpublished data).

Females allocate time to optimize reproductive success (McCabe & Fedigan 2007). The reproductive phase affects the behavior and proportion of female daily activities. Females change feeding strategies to meet nutritional

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needs (Dunbar & Dunbar 2002). In addition to internal factors such as reproduction and birth experience (parity), external factors such as environmental conditions (availability of food and seasons) can affect individual nutritional intake, thus triggering changes in activity and selection of food types (Murray *et al.* 2006; Cui *et al.* 2019). Selected foods are generally high quality, easy to process and eaten more often than expected based on their estimated availability (Leighton 1993). The study of food preference focused on the type of fruit eaten by *M. nigra*, because *M. nigra* is a frugivorous monkey. Fruits are expected to be the food resource that most restricts the feeding places of this species.

Sulawesi black crested monkeys spend 59% of their time for locomotion and eating, while the other 41% are for resting and socializing (O'Brien & Kinnaird 1997). During the reproductive phase, females of *M. nigra* have a different proportion of activity, i.e., higher feeding activity during the pregnancy and higher resting during the lactation phase (Pasetha *et al.* 2019). The activity changes in each lactation period are not known, as well as the fruit preference during the pregnancy and lactation phases. The purpose of this study was to investigate the daily proportion of female *M. nigra* behavior in pregnancy (B1, B2, B3) and lactation (L1, L2, L3) phases, as well as their fruit preferences during those two phases. Analysis of the influence of female parity and environmental conditions was also carried out on the behavior and food preferences of female *M. nigra*.

MATERIALS AND METHODS

Research Subjects and Locations

Two groups of habituated *M. nigra* in Pantai Batu 1B (PB1B) and Rambo (R1) were observed in their natural habitats. Sixteen individuals in the pregnancy phase and 23 individuals in the lactation phases of *M. nigra* were observed from August 2018 to July 2019. Data collection was conducted in the Macaca Nigra Project (MNP) Research Station, at the Conservation Forest Management Unit (KPHK) area of Tangkoko, North Sulawesi, Indonesia (10 32'39"N, 1250 12'42"E). This area covers 8,867 ha and consists of primary and secondary lowland rainforests with an altitude of 1,350 meters above sea level (O'Brien & Kinnaird 1997).

Research Tools

Data were collected using the 10-inch ODYS Tablet, Samsung Smartphone J3 (2016) with the CYBER TRACKER application, counters, cameras, books, pencils, markers, Ziplock plastics, Garmin GPS, binocular, obrometer, thermometer maximum-minimum and portable scales.

Demographics and Daily Behavior Data Collection

The group was followed from 05:00 to 17:00, five days a week. Demographic data collected were females' reproductive status and the day of parturition (as an indicator of the end of the gestation phase). The oestrus cycle was observed qualitatively with visual observations. The observation was based on the size of swelling and skin color around the urogenital area (0 = deflating, 1 = inflating, 1-2 = medium swelling, 2 = maximum swelling) (Higham *et al.* 2012). Pregnancy was divided into three periods, namely B1, B2, and B3 (one period equals to two months). Lactation was divided into three periods, namely L1, L2, and L3 (one period equals to four months). Behavioral data were collected with focal animal sampling and instantaneous sampling for 30 min with a one-minute interval (Altmann 1974). Food intake was recorded by continuous focal sampling, while data on the consumed food species were recorded (Rothman *et al.* 2011). Daily activities recorded were feeding, foraging, locomotion, resting and socializing. Observation time was divided into three periods: morning (06:00-09:00), noon (10:00-13:00), and afternoon (14:00-17:00) (Pasetha *et al.* 2019).

Identification of Fruit Species

Fruit species identification was carried out based on MNP database. Unknown fruit species were sampled, made into herbarium specimens and identified in the Biology Research Center, Indonesian Science Institute (LIPI). Collected fruits were stored in Ziplock plastic bags and labeled with a local name, scientific name, date, location and part-eaten (Rothman *et al.* 2011).

Environmental Data Collection

Environmental data taken were the air temperature and the rainfall around the MNP Research Station area. The air temperature and rainfall were measured every morning during the study period at 07:00 or 08:00 micro temperature (around the MNP Research station), and the numbers on the obrometer boundary were recorded. The data were tabulated monthly.

Food Availability Index

Fruit availability was calculated by observing the parts of the trees eaten by *M. nigra*, from which the Food Availability Index (FAI) was then calculated. Measurements were taken on the second week of every month. The calculation of food availability index was carried out by making 20 plots sized 100 x 100 m covering 6.9% of the total group area. All the tree species were recorded and identified. The number of tree parts counted, such as leaves (young leaves, old leaves and leaf buds), flowers (flowers and flower buds) and fruit (raw fruit, ripe fruit and old fruit). We used two types of measurements. The 1st type was logarithmic scale for measuring leaves: 0 = 0-9 leaves; 1 = 10-99; 2 = 100-999 and so on. The 2nd type was rank scale for measuring fruits: 0 = almost nothing; 1 = multiples; 2 = many but not full; 3 = full or almost full. The diameter (DBH) of tree trunks was measured for all the trees with DBH of more than 10 cm and propagated more than 5 cm (Sari 2013). The data was analyzed by using the Food Availability Index (FAI) formula (1).

$$FAI = \sum_{i}^{n} (Ai x Di) \quad \text{.........................} (1)$$

where:

FAI = total food availability index for species *n*

Ai = average value of food availability for species *i* (logarithmic scale)

Di = average density of species *i* per hectare (based on 20 plots).

Behavioral Data Analysis

Data on daily activities were tabulated using Pivot tables. The daily behavior proportions were grouped and calculated based on pregnancy phase differences (B1, B2, and B3) and lactation (L1, L2 and L3) phase differences. The frequency of daily activities was calculated by using formula (2):

$$\text{Activity frequency } i\ (\%) = \frac{activity\ i}{total\ all\ activity} \times 100 \quad \text{....} (2)$$

Analysis of Food Type Frequency and Fruit Preference

All types of food eaten were tabulated using Pivot tables. The frequency of food and fruit types was analyzed to see the relationship between reproductive conditions and seasons. The frequency of food types was calculated by using formula (3):

$$\text{Food } i \text{ frequency } (\%) = \frac{food\ i}{total\ all\ food} \times 100 \quad \text{......} (3)$$

Food preferences were calculated by food selection index method (Krebs 1999; Manly *et al.* 2002). The FAI values were used to determine a proportion of fruit availability in habitats. Each type of eaten food was calculated as the ratio of food selection. The resulting value can be interpreted as the probability of food desired choice by primates. The null hypothesis test using the G-test indicates that an animal randomly chooses food resources based on food availability at a confidence interval of 95%. The Food Selection Index was calculated by using formula (4):

$$w = \frac{oi}{pi} \quad \text{..................................} (4)$$

where:

w = forage ratio

oi = proportion of fruit species eaten

pi = proportion of fruit species i in the habitat (FAI).

Statistical Analysis

Statistical analyses were run using a Non-Parametric Multivariate analyses. Shappiro-Wilk test for normality test and Kruskal-Wallis for testing the significance of reproductive phase differences were performed. G-test was used for selectivity analysis of selected fruit. Pairwise-Wilcoxon test was performed to know which variables influence the behavior. The statistical analyses were run using program R alpha level 0.05.

RESULTS AND DISCUSSION

Female Behavior during Reproduction

Reproductive phase is an important phase for females, which affects changes in daily activities and types of food eaten (Muruthi *et al.* 1991; White *et al.* 2007). Energy required by female mammals during pregnancy and lactation phases are generally higher than those of non-productive females (Lee 1997). Energy costs for reproduction in primates can be achieved by implementing several strategies such as increasing energy intake, reducing energy excretion, using up body tissue reserves and reducing energy output from physical activity (Bercovitch 1993; Dufour & Sauther 2002; National Research Council 2003).

Based on the observations, females during reproductive phase had higher feeding and social activities compared to other activities. Locomotion was the least activity performed by pregnant and lactating females. Lactating females had feeding (31%, P = 0.01) and foraging (16%, P = 0.21) activities higher than pregnant females. Other activities such as resting (19%, P = 0.7), locomotion (12%, P = 0.81) and social (25%, P = 0.6) were performed more by pregnant females than lactating females (Fig. 1).

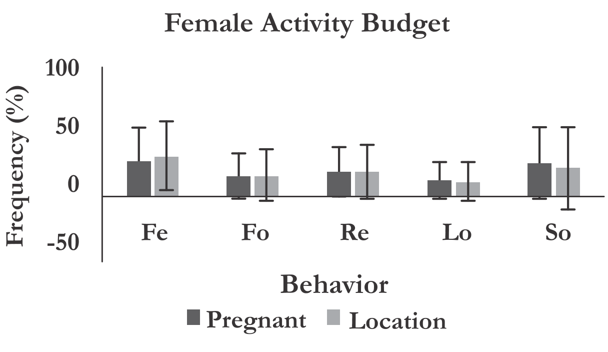


Figure 1 The behavior frequency of female *M. nigra* during pregnancy and lactation phases
Notes: Observed behaviors were feeding (Fe); foraging (Fo); resting (Re); locomotion (Lo) and socializing (So).

Based on this study, females in the pregnant and lactating phases had significantly higher feeding activity, especially the lactating females. The increased energy intake shown by the increasing feeding frequency is an adaptation done by females to meet the energy needs (Dufour & Sauther 2002). Social activities were also highly performed by the pregnant and lactating females, although activity was not significantly different between pregnant and lactating females. These results align with a study done on *Macaca thibetana*, where females with infants receive more grooming and affection from other members than females without infants. This phenomenon can be explained by the biological market theory, which states that grooming is a form of a commodity that can be exchanged for other individuals' infant caring (Jiang 2019).

Females in the pregnancy period generally had high feeding activity at B1 (28%) and B3 (29%) period with P = 0.35 (Fig. 2) because at that time, the female needed more nutrition for fetal development and energy reserves after parturition. Foraging activity decreased as the gestation period progressed (P = 0.57), similar to locomotion behavior (P = 0.07) which also reduced toward the end of pregnancy. In contrast to foraging behavior, females in the final period had the highest resting percentage (21%, P = 0.046) which was significantly different compared to other periods. Social activity of pregnant females was more performed on the B1 and B2 levels of pregnancy (P = 0.5) than B3 in the last pregnancy period. In general, the social activity among levels of pregnancy were not significantly different. Ruivo *et al.* (2017) and Gould *et al.* (2011) stated that due to the high energy and nutritional needs during pregnancy, females in the early gestation period will spend a lot of time eating. This behavior aims to compensate for the nutrition shared with the fetus. The behavior was also shown by a study conducted by Pasetha *et al.* (2019) that *M. nigra* females had the highest feeding activity during the pregnancy period. This pattern is also shown in baboon (*Papio cynocephalus*), which compensate for their energy needs by having longer mealtime (Altmann & Altmann 1970; Dunbar 1977).

This result is in contrast with a study on green monkeys (*Cercopithecus sabaeus*). Green monkeys adapt their dietary patterns by eating better quality foods but shorter meal time to save energy (Harrison 1983). Our study showed that the foraging, social and locomotion activities of *M. nigra* females decreased with the gestation period progressed, while the resting activity was significantly rising. Pregnant females specifically reduce their activity to save energy lost, including social activities, especially before parturition. This behavior is also done to avoid other members' aggression (Pusey *et al.* 2008; Murray 2009).

Females in lactation period had the highest feeding activity compared to other activities (Fig. 2). Feeding (34%, P = 0.002) and foraging (23%, P < 2.2e-16) activities were higher as the lactation period progressed. Along with the lactation period, the infants will be more independent, so that the movement of females is more flexible to eat and prepare for the next reproductive cycle. Resting activity was most often performed by females in L1 (25%, P = 1.5e-14) and continues to decrease by females in L2 and L3, similar to locomotion activity (15%, P = 5.98e-11). In contrast, social activity was stable around lactation period (23%, P = 0.19).

Our finding indicated a similar result to previous studies done in other primate species. In baboons and vervet monkeys, the feeding activity of lactating females are less efficient when the infant is still dependent on the mother's body. At the beginning of infant age, female often spends longer time foraging than other females (Whitten 1982; Koenig *et al.* 1997; Sauther 1994). As the infants get older, the dependence of infants on their mother will be reduced so that the female can increase the proportion of forage for subsequent reproductive needs (Koenig 1997; Dunbar & Dunbar 2002). Usually, lactating females raise food intake (Tarnaud 2006), forage efficiently (MacCabe & Fedigan 2007), or eat nutrient-rich foods such as protein and carbohydrates (Herrera & Heymann 2004; MacCabe & Fedigan 2007; Muruthi *et al.* 1991; Serio-Silva 1999).

Resting activity and locomotion in lactating females *M. nigra* significantly decreased along with the age of infants. The results of our study were in contrast to a study conducted by Pasetha *et al.* (2019) showing that lactating female *M. nigra* had the highest resting behavior a few days after parturition based on only taking data on lactating females in the early period during the postpartum period. Female *M. nigra* increased their social activity at the end of the lactation period. Lactating females spend a lot of time socializing with other females as a strategy to share the burden of infant care, grooming access and foraging access (Henzi & Barrett 2002; Jiang *et al.* 2019).

Effect of Parity on Female Behavior

We observed 13 primiparous females and 24 multiparous females of *M. nigra*. Multiparous pregnant females performed more feeding (28%, P = 0.65), social (26%, P = 0.3) and locomotion (12%, P = 0.93) activities compared to primiparous females. Besides, foraging activity (17%, P = 0.47) and resting (22%, P = 0.029) activities performed by primiparous females were higher than multiparous females (Fig. 3). Only resting activity showed a significantly different proportion between females in two parity types.

Multiparous females in lactation phase had feeding (31%, P = 0.69), foraging (15%, P = 0.51) and locomotion (12%, P = 0.52) activities higher than primiparous females (Fig. 3). Primiparous females performed more resting (21%, P = 0.03) and social (23%, P = 0.30) activities.

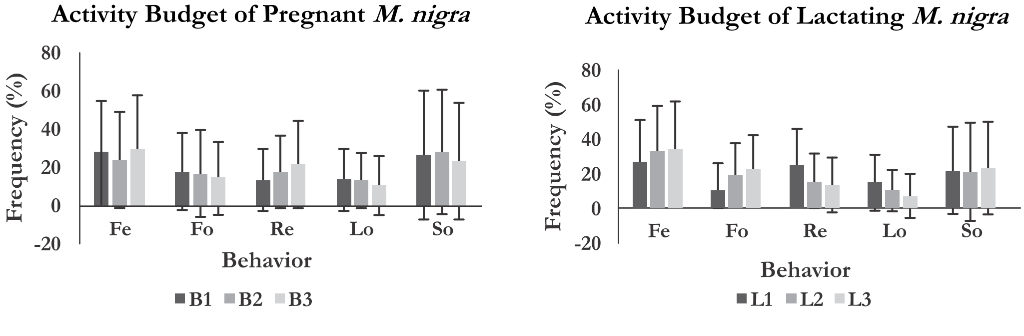


Figure 2 The behavior frequency of pregnant and lactating females *M. nigra*
Notes: B1, B2 and B3 indicate the pregnancy period; L1, L2, and L3 indicate the lactation period.

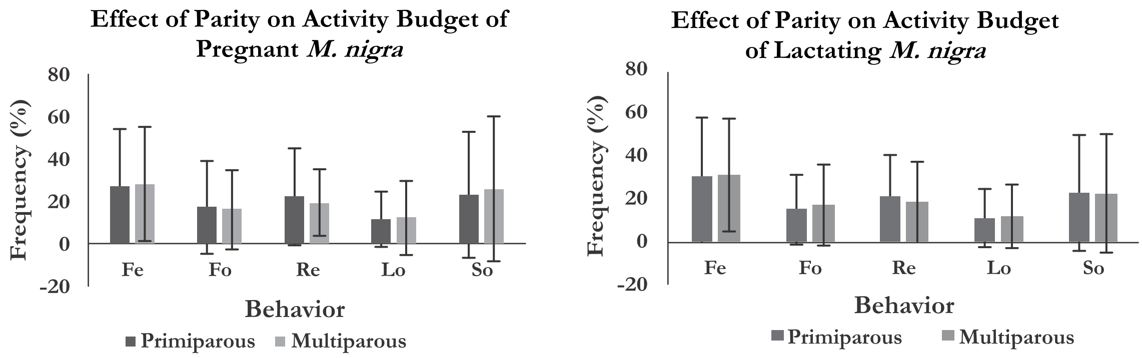


Figure 3 The behavior of females *M. nigra* with different parity types in pregnancy and lactation phases

Parity or experience in having children can be one of the individuals' characteristics that can influence their behavior patterns. A part from resting, there were no significant differences between primiparous and multiparous female behavior. Primiparous females tend to increase alertness and resting activity, in exchange, they decrease feeding activity to compensate for time (Barrett *et al.* 2006). In contrast to Muruthi *et al.* (1991), primiparous females need more time to eat because primiparous females are not fully mature. They still need more energy to increase body weight and adequate calorie intake for reproduction.

Environmental Influence on Female Behavior

Based on the phenological analysis, the abundance of fruit was directly proportional to rainfall. From October to February, the rainfall was high with low micro-temperatures (Fig. 4). Feeding activities were directly proportional to the high rainfall.

Pregnant females did a lot of social (P = 0.31) and resting (P = 0.02) activities when the rainfall was high, but the feeding activity was relatively not much different each month (P = 0.31). Locomotion activity was increased during dry season (P = 1.25e-06). They walked more often during the low rainfall season from August to October to search for more food. During the lactation period, females had the highest feeding activity when the rainfall was high (P = 0.002). Resting activity was also higher in the rainy season (P < 2.2e-16) (Fig. 5).

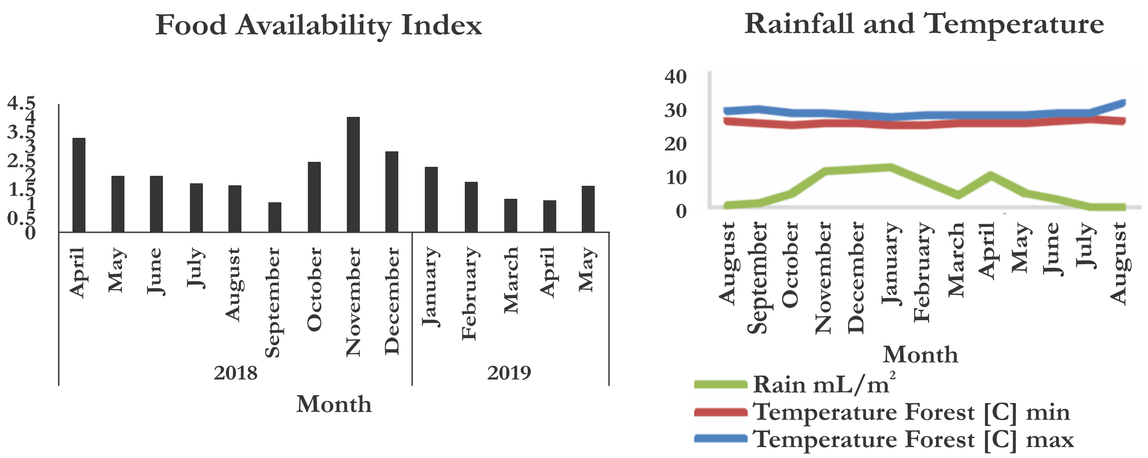
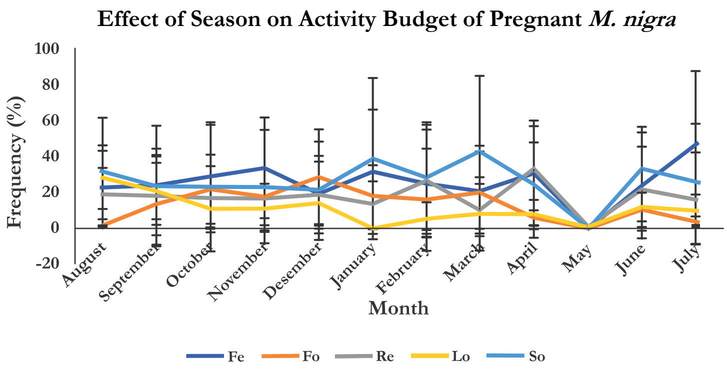


Figure 4 Phenology of fruit trees and environmental conditions (rainfall and temperature) in KPHK Tangkoko



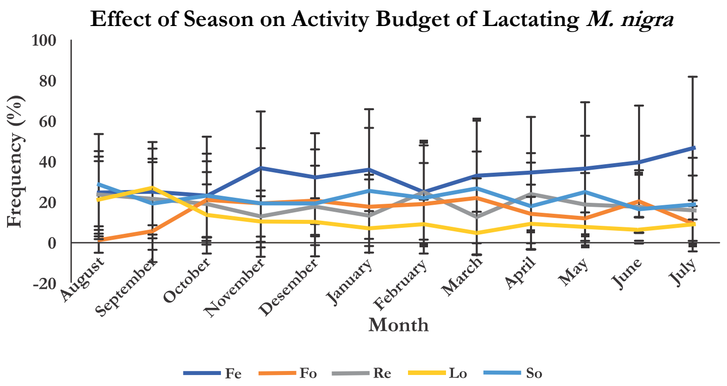


Figure 5 The effect of different seasons on female daily activity

The intensity of rainfall was high from October 2018 to February 2019. Our study showed that during the rainy season, the feeding activity of female *M. nigra* rose. In lactation period, females had significantly higher feeding ($P = 0.002$) and resting ($P < 2.2e\text{-}16$) activities during the peak of rainy season. The proportion of these activities fluctuated until it increased in July 2018 when the rainfall was low. Locomotion activities were significantly higher during the dry season. The increasing proportion of locomotion activity also occurs in baboon (*Papio cynocephalus*), which during the dry season and less food availability, baboons walk more and look for alternative food (Altmann & Samuel 1992).

Frequency and Preference of Female Food during Reproduction

Reproductive period can affect the females on selecting food (McCabe & Fedigan 2007). Due to high energy needs, the females are required to consume food that suits their needs (Serio-Silva *et al.* 1999; Herrera & Heymann 2004). Based on the observations in our study, females *M. nigra* during reproduction period ate more arthropods such as ants, termites, grasshoppers, crickets, spiders and larvae. Arthropods contain many proteins and lipids that are important for females during the reproductive phase (Rothman *et al.* 2014). Pregnant and lactating females ate arthropods up to 45% and 40% ($P = 0.003$), respectively. The proportion of fruit eaten by pregnant and lactating females was 20% and 13% ($P = 0.36$), respectively (Fig. 6). In addition, females also ate mushroom (1%, $P = 0.34$), stems (1.1%, $P = 0.43$), leaves (1-2%, $P = 0.25$), buds (0.07%, $P = 0.26$), sap (0.008%, $P = 0.57$), and flowers (0.1%, $P = 0.08$). Calorie consumption and crude protein are critical during pregnancy and lactation phases so that females will choose certain foods during that period (Lee 1997; Dufour & Sauther 2002). Sulawesi black crested macaques are fruit-eating monkeys. The main foods eaten are fruit and insects as companion food (O'Brien & Kinnaird 1997; Sari 2013). Our study indicated that arthropods and fruits are the dominant food for the pregnant and lactating females.

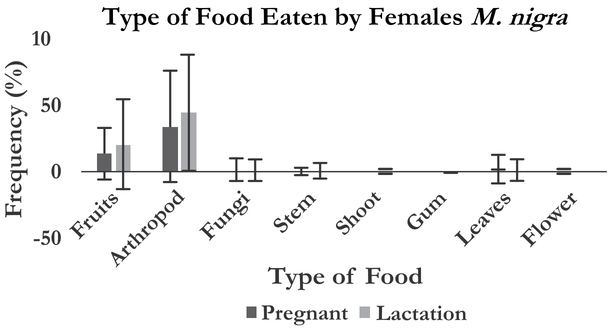


Figure 6 Frequency of the type of food eaten by females *M. nigra*

In contrast to a previous study that stated *M. nigra* in the pregnant and lactating phase eats more fruit (Pasetha *et al.* 2019) because *M. nigra* is a frugivore macaque that needs glucose as the primary source of energy. Arthropods are a widely available food source containing high concentration of fat and protein in nature. Protein and fat are essential nutrients for females during the reproductive phase (Gould 2011). Besides, lactating females significantly ate more insects and have more variety of food types than pregnant females.

We recorded 71 fruit species eaten by females during their reproductive period. The four most-eaten fruit species were i.e., *Koosiodendron pinnatum* (P = 0.17), *Ficus variegate* (P = 0.26), *Dracontomelon dao* (P = 0.8) and *Morinda citrifolia* (P = 0.22). Based on the period of lactation, female of L1, L2, and L3 mostly consumed *K. pinnatum*, *F. variegata* and *D. dao,* respectively. Based on the period of pregnancy, females of B1, B2, and B3 mostly consumed *M. citrifolia*, *F. variegata* and *K. pinnatum*, respectively. The differences in fruit types eaten by pregnant and lactating females in different periods did not show statistical significance. These fruits were consumed due to the abundant availability throughout the season except for *K. pinnatum. M. citrifolia* and *D. rao* has carbohydrate content of 93.23% and 93.12%, respectively, which is quite high.

Fruits are essential sources of nutrition for *M. nigra,* especially carbohydrates, vitamins and minerals (National Research Council 2003). Based on previous research by O'brien and Kinnaird (1997), there are 145 types of fruit eaten by *M. nigra*. According to Pasetha *et al.* (2019), there are 34 types of fruit eaten by females during reproduction. Similar to our findings, these previous studies stated that *Dracontomelon dao*, *Spondias* sp*.,* and *Ficus* sp. are the most eaten species (O'Brien & Kinnaird 1997; Pasetha *et al.* 2019). Those fruits have a high carbohydrate, fiber and protein content among fruits they consume, respectively. The vegetation analysis results support this finding because both fruit types have the highest Important Value Index (IVI) (Pasetha *et al.* 2019, unpublished).

Pregnant and Lactating Female Diet Preferences

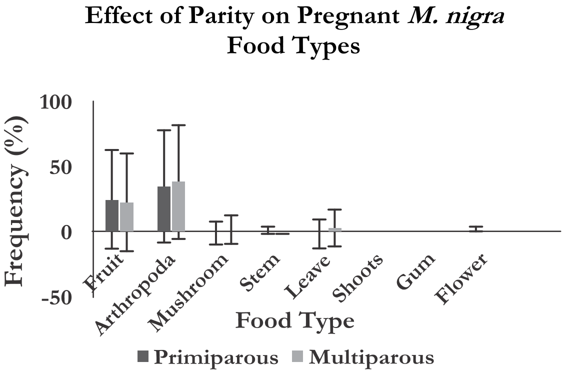
A selectivity index was conducted to indicate which food types are the favorite choice of animal species. The results showed that *Dracontomelon mangiferum* (35.13%) and *Eugenia* sp. (42.38%) was the most preferred fruit types by females during reproduction period. Based on the proximate analysis, *D. mangiferum* has a relatively high carbohydrate content (93.28%), and *Eugenia* sp. has a high-fat content (5.4%) compared to other fruit types. Based on fruits availability analysis, *Arenga pinnata, Ficus variegate, Caryota mytis, Garcinia tetranda, Morinda citrifolia, Morinda bracheata* and *Piper aduncum* are species that bear fruit throughout the year and are included in fruit species having a high consumed frequency.

Environmental condition is a limiting factor causing variations in the primate's diet (Agetsuma 1995; Agetsuma & Nakagawa 1998; Jaman & Huffman 2008; Yeager *et al.* 1996). The availability of fruit increases in the months during high rainfall, resulting in the increased of feeding activity. Based on the G-test, which rejected the hypothesis, pregnant and lactating *M. nigra* did not randomly select the food type.

Effect of Female Parity with Food Type

Based on their parity, pregnant females ate more arthropods (Fig. 7). Primiparous female ate fruits (25%) more than multiparous females (23%, P = 0.48). On the contrary, arthropods consumption was mostly done by multiparous females (38%, P = 0.47). Lactating females also ate more arthropods. Multiparous lactating females consumed more insects (49%) than primiparous females (43%, P = 0.07).

Fruit consumption in primiparous and multiparous lactation females was quite similar (P = 0.56). Species of fruit eaten by pregnant primiparous and multiparous were *K. pinnatum* (P = 0.86), *F. variegate* (P = 0.006) *D. dao* (P = 0.28), *T. cattapa* (P = 0.16) and *M. citrifolia* (P = 0.37). Species of fruit eaten by primiparous and multiparous lactating females were *K. pinnatum* (P = 0.82), *F. variegate* (P = 0.63) *D. dao* (P = 0.03), *T. cattapa* (P = 0.0005) and *M. citrifolia* (P = 0.5).



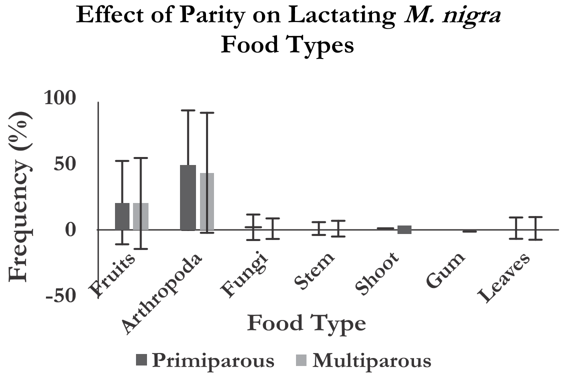


Figure 7 Effect of parity on the frequency of food types

Based on parity, both primiparous and multiparous females in the reproductive period ate more arthropods. Primiparous females consumed more arthropods such as crickets, grasshoppers, spiders and larvae than multiparous females. Arthropods contain high protein and fat concentrations compared to other types of food such as fruits and other plants part. In small quantities, arthropods can also be a supplement for primates due to their content of vitamins and fatty acids (Clutton-Brock *et al.* 1989; Rothman *et al.* 2014). Those nutrients are essential during pregnancy and lactation periods. Our finding has a similar result to previous studies. Female orangutans, titi monkeys and capuchins tend to increase arthropods' consumption during pregnancy and lactation (Fox *et al.* 2004; Herrera & Heymann 2004; McCabe & Fedigan 2007). Fruit consumption in primiparous and multiparous lactating females had a similar proportion. Most fruit eaten by pregnant and lactating females was *K. pinnatum, F. variegata, D. dao, T. Cattapa* and *M. citrifolia*. Intraspecific variability in primate feeding behavior is closely related to several factors, e.g., reproduction conditions and favorite foods (Post *et al.* 1982).

CONCLUSION

The behavior pattern of female *Macaca nigra* can be influenced by the reproductive phase, female parity and environmental conditions. Females in the 3rd period of pregnancy and lactation had high percentage of feeding. Resting had significant changes in behavior proportion. Feeding activity was done more often by multiparous females compared to primiparous female. Food preference was influenced by the female reproductive phase and food availability. The selectivity in choosing food was not random. During the pregnancy and lactation periods, females preferred to eat arthropods and fruits. Their favorite fruits were *D. mangiferum* and *Euginia* sp. More comprehensive and in-depth research on behavioral and feeding ecology needs to be done. Research with more individual samples of female in the reproduction phase is recommended, as they may have different strategies to adapt to ecological changes in the future.

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