



Natural Food Plants and Feeding Behaviors of *Macaca hecki* in the Makarti Jaya Forest, Pohuwato Regency

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Abstract. *Macaca hecki* is an endemic animal on the island of Sulawesi. *Macaca* eats plant parts, such as leaves, flowers, fruit, and seeds of several types of plants, with different feeding behavior. The aim of this research is to identify natural food plant species and describe the feeding behavior of *M. hecki*. The research method used habituation, ad-libitum sampling, and all-occurrence in the *M. hecki* group in the forest of Makarti Jaya Village, Pohuwato Regency, Gorontalo. This research shows eight species of *M. hecki* natural food plants, namely: (1) *Arenga pinnata*; (2) *Pometia pinnata*; (3) *Syzygium cumini*; (4) *Piper aduncum*; (5) *Planchonia valida*; (6) *Musa paradisiaca*; (7) *Pangium edule*; (8) *Palaquium quercifolium*. The feeding behavior of *M. hecki*, namely: (1) taking food directly from the tree with two hands; (2) taking food directly from the tree with one hand; (3) picking up food that falls on the ground; (4) chew calmly; (5) chewing hastily; and (6) store in cheek pouches. The highest frequency of natural food plant species is *Syzygium cumini* (31%), and the highest frequency of feeding behavior was taking food directly from the tree using two hands (39%).

Keywords: *Macaca hecki*, food plants, feeding behaviors

1 Introduction

Macaca hecki, hereafter can be written as *M. hecki* is one of the endemic animals of Sulawesi, living in lowland to mountain forests at an altitude of up to 1,800 m above sea level and is often found on community plantation land. *Macaca hecki*, or in the Gorontalo community it is known as yaki, besides having high adaptability so that it can live in various places, it also plays an important role in the regeneration of forest vegetation because it has the ability to disperse seeds widely in the forest so as to form natural plant vegetation. These endemic animals live in groups consisting of males, females, and their children. Natural

feed of *M. hecki* almost same as some species *Macaca*, namely parts of plant leaves, leaf shoots, flowers, fruits and seeds of various types of plants, due to the ecological role of *M. hecki* as an endemic animal in the regeneration of forests[1][2].

Macaca hecki happy to take as much feed as possible even though they can't afford to spend it. *Macaca hecki* usually takes their food using both hands or directly using their teeth to take food. When in a hurry usually *M. hecki* will put his food into his cheek pouch first[3]. When things are safe, *M. hecki* will bring out his food for chewing and swallowing. Most of the time *M. hecki* interacting with humans can change their feeding behavior[4]. According to Rizaldy [5] that the group *Macaca* indeed, basically they often fight for food when the availability of feed is lacking, but if the availability of feed in their habitat is abundant, the struggle for food will rarely occur.

But nevertheless, it is important *M. hecki* in forest ecosystems, these animals are also considered pests by people who have plantation land around the forest. *Macaca hecki* often enters the community's agricultural land to take cultivated plants which causes the community to experience great losses. Unnoticed by society, the cause *M. hecki* entering agricultural land is due to the increasing area of land clearing in forest areas by the community which is used as a settlement or economic interest. Land clearing causes pressure on forest habitat and vegetation as a natural food source for *M. hecki* so these animals lack natural food and leave their natural habitat. *Macaca hecki* move from their natural habitat is also a threat to the population of *M. hecki* itself because people do various ways to avoid attacks from *Macaca* on plantation commodities, such as shooting, or installing electrified fences around their plantations. Besides threatening the population, often *Macaca* interacting with humans can change the type of food[4].

Makarti Jaya Village has a forest area of approximately 44 hectares, and approximately 15 species of endemic and protected animals live in it, one of which is *M. hecki*. The farming community of Makarti Jaya Village considers the *M. hecki* as pests because they often enter plantations and eat plantation products. Society's view of the *M. hecki* as a pest makes farmers continue to try to avoid attacks from *M. hecki*. However, there are some farmers who do land grants for *M. hecki* to keep the farmland safe, even if this causes a change in eating habits of *Macaca*, types of feed and cause the ability to survive in the wild will be reduced. The reduction in natural feed and the habituation of feed outside the habitat carried out by the community causes *M. hecki* depending on the food provided and the reduced ability to survive in the wild[6]. Pressure on habitat *M. hecki* in the limited production forest area of Mekarti Jaya Village, community plantations are thought to have caused the reduction of natural food vegetation *M. hecki*, and feeding behavior. Therefore, this research is carried out related to the description of natural feed *M. hecki* and feeding behavior in the limited production forest area of Makarti Jaya Village, Pohuwato District.

2 Method

2.1 Study area

The research was conducted in the forest area in Makarti Jaya Village, Pohuwato District, (map on Figure 1). Geographically, the research location is located at four points, namely, the first coordination point 51 N 0357949 UTM 0073522 elevation 132m, the second coordination point 51 N 0367616 UTM 0073758 elevation 79 m, the third coordination point 51 N 0367342 UTM 0073717 elevation 169 m, and the fourth coordination point 51 N 03 67280 UTM 0074146 elevation 96 m. The research was conducted from May to June 2023.

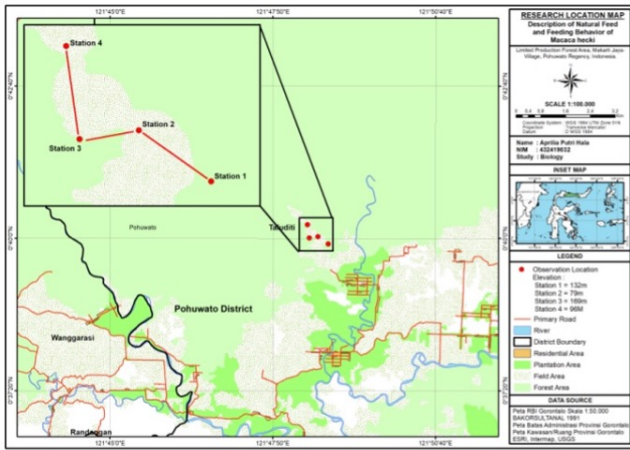


Fig. 1. Map of the study area and data collection points for *Macaca hecki* natural food and feeding behavior

2.2 Procedures

Habituation Habituation is the process of habituation of *M. hecki* to the presence of the observer to prevent changes in behavior when the observation is made. Habituation was carried out for one day starting at 07.00 to 18.00 local time. In addition to preventing changes in eating behavior, this process also identified the number of groups *M. hecki* seen during habituation[3].

Ad-libitum Sampling Ad-libitum sampling is a method that is carried out at the beginning of the activity of observing eating behavior in two groups *M. hecki*. In this method, observations were made in two groups of *M. hecki* who came and recorded feeding behavior that was seen during the observation[3]. Ad-libitum sampling was carried out every day starting at 06.00 – 11.00 local time,

then continued at 13.00 – 17.30. Observations were made at four stations, two stations located on different mountain ridges which have several natural feeds of *M. hecki*. This observation was also carried out in two ways, namely, indirect observation by installing camera traps at each station, and direct observation using binoculars.

All-occurrence All-occurrence was done concurrently through ad-libitum sampling, namely, each feeding behavior performed by the two groups *M. hecki* the frequency of activity that appears the most. In this method, the observations begin in the morning at 06.00 - 11.00 and then continue at 13.00 - 17.30.

Natural Feed Identification Observation of feeding behavior and identification of species of natural feed vegetation carried out directly during the ad-libitum sampling method and all-occurrence method. Any feed eaten by *M. Hecki* first record the local name of the plant and the part eaten, then note the frequency of the type of feed eaten the most. Identification of natural food plant species using the Flora Identification key book by C.G.G.J. Van Steenis in 2013[7]. If there are unknown species, then some parts of the plant such as leaves, flowers, and fruit are taken to be used as a herbarium which will then be identified in the Botany and Plant Systematics Laboratory Universitas Negeri Gorontalo, and supplemented by the results of interviews with forest monitoring community group officials.

2.3 Data Analysis

The results of the identification of forage plant species and feeding behavior are recorded in two Table. Data from these two tables were then analyzed descriptively using a frequency chart and narrative analysis.

An analysis of the feeding patterns of *Macaca hecki* reveals variations in both the types of forage plants consumed and feeding behaviors observed between the two study groups (Group A and Group B).

The natural food presents the frequency of plant species consumed, indicating that *Macaca hecki* utilizes different plant parts as food sources. Differences in dietary preferences can be observed between Group A and Group B, as reflected in their respective average consumption rates.

Meanwhile, the feeding variation describes the frequency of various feeding behaviors exhibited by *Macaca hecki*. The main behaviors observed include using both hands while eating, chewing quietly, storing food in cheek pouches, chewing hastily, and picking up fallen fruit. The variation in feeding behavior frequencies between Group A and Group B suggests potential differences in feeding strategies, which may be influenced by environmental factors or food availability in their habitat.

Overall, this analysis provides insights into the feeding habits of *Macaca hecki*, both in terms of the types of food consumed and their feeding behavior. These findings can serve as a foundation for further research on the ecology and adaptive strategies of this species in its natural habitat.

3 Result and Discussion

3.1 Natural food

The results of the identification of plant species as natural food in two groups *M. hecki* are eight species of forage plants, namely, *Arenga pinnata* (local name: Aren), *Pometia pinnata* (local name: *Matoa forest*), *Piper aduncum* (local name: Betel nut), *Syzygium cumini* (local name: Jamblang), *Planchonia validai* (local name: Putat), *Pangium edule* (local name: Pangi), *Musa paradisiaca* (Banana), and *Palaquium quercifolium* (local name: Nantu). *Edible plant parts M. hecki* namely young leaves, young stems, and fruit, however *M.hecki* prefer the fruit that is ripe. Based on Figure 2, the group eats the most natural foods i.e. *Syzygium cumini* fruit with a percentage of 31%, while the least was young betel leaves (*Piper aduncum*) and young stems of banana (*Musa paradisiacal*) with a percentage of 1%.

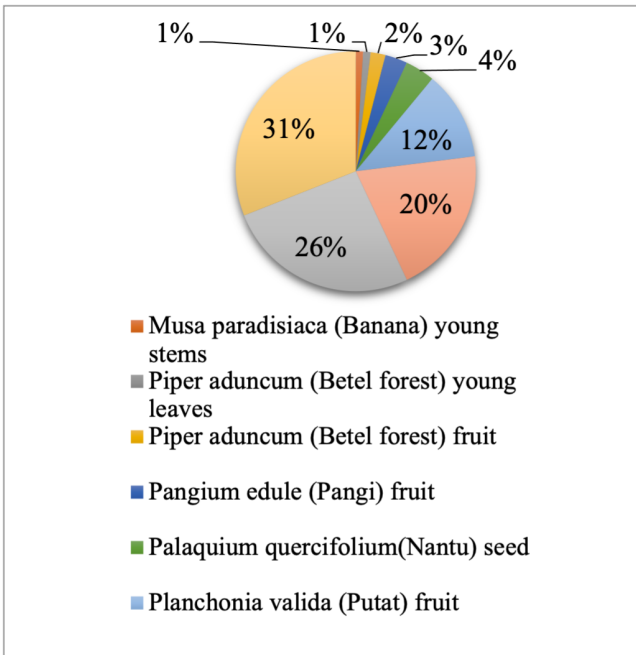


Fig. 2. Natural Feed Consumption Rate (%)

3.2 Feeding Behavior

Feeding behavior *M. hacki* in the forest of Desa Makarti Jaya it is quite varied. There are six categories of eating behavior carried out by *M. hecki*, namely

taking food using two hands, taking food using one hand, picking up food that has fallen or eating food on the ground, chewing quietly, chewing hastily, and storing food in the cheek pouches. Based on Figure 3, the highest percentage of eating behavior *M. hecki* is taking feed using two hands with a percentage of 39%, then the lowest is taking feed using one hand with a percentage of 5%.

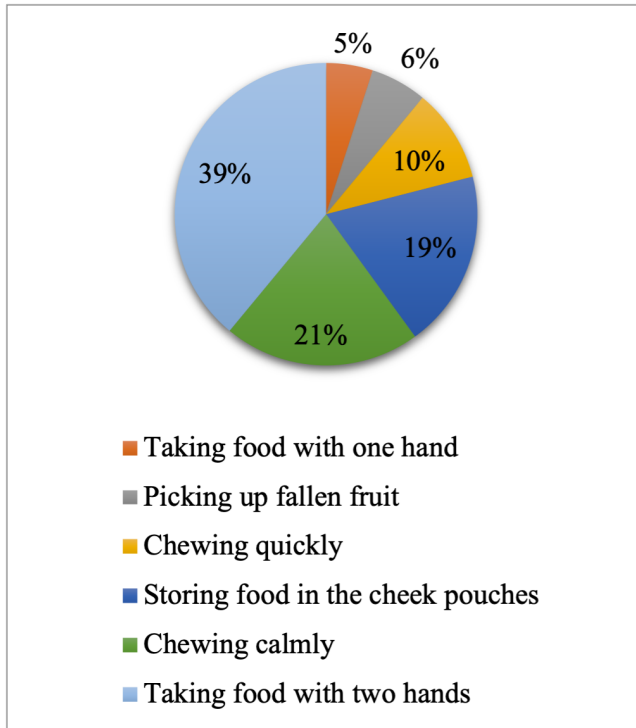


Fig. 3. Feeding Behavior Rate (%)

3.3 Discussion

Based on observations, there are eight species of natural food *M. hecki* in the limited production forest of Desa Makarti Jaya, namely *Palaquium quercifolium*, *Musa paradisiacal*, *pangium edule*, *planchonia validai*, *Syzygium cumini*, *Piper aduncum*, *Pometia pinnata*, and *Arenga pinnata*. The fruit are favorite part of the plant to *M. hacki*, but some members also like young leaves and young stems. At the time of observation, the most consumed feed by *M. hecki* is *Syzygium cumini*, or what is known as “jamblang” fruit with a percentage of 31%. Group *M. hecki* usually start looking for food at 05.00 - 10.00 local time, then continue at 14.00 - 17.00. According to Rizaldy[6], in the morning, *M. hecki* will immediately look for food, this is because at night *Macaca* does not do other activities

besides resting, then in the afternoon will look for food again because at night there is no activity foraging.

Syzygium cumini or “jamblang” fruit is elliptical or oval in shape, has a length of about 2 – 3 cm, is black in color, has white flesh, and has a sweet, slightly astringent taste[8]. The color is not too flashy and the sweet taste of the fruit *Syzygium cumini* led the group *M. hecki* like this fruit. Feeding behavior *M. hecki* for this feed namely the group that usually takes this fruit directly from the tree using two hands, but sometimes also use one hand, and some keep the fruit in their cheek pouches to be stored when it is time to rest, or feel threatened. The position *M. hecki* when taking food using two hands, sitting on a large tree branch with one leg clamping the branch to support its body weight, then both hands take the fruit to be eaten. When picking up food using one hand *M. hecki* hold its weight using one hand and the other hand takes the feed.

Based on observations, when chewing fruit *Syzygium cumini* *M. hecki* chews hastily and quietly, to see bystanders thus feeling threatened, at the same time *M. hecki* chews hurriedly while making loud continuous noises, with hasty glances, moving faster than usual, then depositing some of his food in his cheek pouches. When it got used to the presence of observers *M. hecki* starts chewing quietly, doesn't make a sound, and focused on the food it was eating.

Arenga pinnata, or palm fruit is one of the feeds that is also preferred by the group *M. hecki*, based on the results of observations of group frequency percentage values *M. hecki* eats fruit at 26%. *Arenga pinnata* is a plant that has many benefits, from its roots which can be used for woven materials, young dried leaves used by residents as a substitute for cigarette paper, midrib fibers for palm fiber, male flower bunches contain sugar so that the liquid can be tapped and made sugar palm, stems palm contain starch or palm flour, and the fruit which is bullet-shaped and has three seeds inside can be made candied[7]. Group *M. hecki* usually eat the fruit *Arenga pinnata*, and only one bite and then throw it away, this is suspected because the fruit *Arenga pinnata* has sap that can make it itchy, so avoid the sap *M. hecki* don't eat it. The *M. hecki* heckling usually takes and eats palm fruit directly from the tree using two hands and occasionally using one hand. When picking up food using two hands, *M. hecki* usually sits on the fronds of a palm tree and then takes the feed using two hands, whereas when taking it with one hand usually *M. hecki* pulling the palm bunches using one hand, and the other hand is used to pick the palm fruit and put it in the mouth.

Pometia pinnata or forest “matoa” is also food for *M. hecki* with the percentage of the group eating fruit that is 20%. *Pometia pinnata* fruit is oval in shape with a fruit length of 5-6 cm. The color of unripe fruit is usually green while those that are ripe are dark red. Forest “matoa” fruit flesh tends to be thinner and sweeter than general matoa fruit[9]. The sweet taste of the *Pometia pinnata* made *M. hecki* like the fruit. Observations showed that the *M. hecki* group ate young forest “matoa” fruit that fell to the ground. The male and strong *M. hecki* usually climbs the *Pometia pinnata* tree and then drops the fruit, then the

group members below pick up and eat the fruit. *Macaca hecki* also stores forest “matoa” fruit in its cheek pouches to eat during the day’s rest.

Planchonia valida is also a natural food for *M. hecki*. The frequency percentage of the *Macaca* group eating the fruit of *Planchonia valida* was 12%. *Planchonia valida* fruit is round, green in color, the flesh is white. The *M. hecki* group ate ripe *Planchonia valida* fruit but sometimes ate young fruit. Based on the results of observations, it appears that *M. hecki* ate the fruit under the tree, or waited for the fallen fruit to be dropped by another *M.hecki* from the top of the tree. When eating fallen fruit by using two hands.

Another natural feed is *Palaquium quercifolium*, or local name called “nantu”. The frequency percentage of the *M. hecki* group eating *Palaquium quercifolium* seeds was 5%. The part eaten by *Macaca* is the seeds contained in the ripe fruit. *Palaquium quercifolium* fruit seeds are oval, slightly flattened, and brown in color. Similar to the “matoa” fruit, the *M. hecki* group ate “putat” and “nantu” fruits that had been dropped by another *M. hecki*. However, the treatment of the *M. hecki* group on the “nantu” fruit was slightly different because the part eaten was not the flesh but the seeds, so *M. hecki* had to peel the fruit flesh to extract the seeds using two hands.

Pangium edule, the local people call “pangi” a natural food of *M. hecki*. The part eaten is the fruit. The percentage frequency of the *Macaca* group eating “pangi” fruit is quite small, namely 3%, because, at the time of observation, the fruit was not ripe enough to eat. Group *M. hecki* usually only eat ripe fruit that is still on the tree. This fruit that has fallen, or has been hollowed out by squirrels is not eaten. When picking and eating “pangi” fruit, *Macaca* usually uses two hands, because the fruit is considered the largest fruit among natural food *M. hecki* found at the time of observation. The *M. hecki* take the “pangi” fruit in a sitting position on a large branch, wrap one leg around the branch of the tree you are sitting on to support your body weight and both hands take the fruit to eat.

Apart from eating the fruit, the *M. hecki* also eats the young stems of *Musa paradisiaca*, or forest bananas, that are still budding or young. However, the *M. hecki* did not consume much of the feed because during the observation the availability of forest fruit was abundant so the percentage. only 1%. *Macaca hecki* eats young banana tree trunks by peeling or tearing the stems using both hands. The part eaten is the innermost stem.

Pepper aduncum, or forest betel is also a natural feed of *M. hecki*. *Pepper aduncum* leaves with a length of 10 to 14 cm, and a width of 5-6 cm, the color of young leaves tends to be bright green compared to old leaves. Forest betel fruit, also called “buni”, has a short stalk with a grain length of 12-14 cm, green in color. The *M. hecki* is heckling to eat the fruit and young leaves, taking straight from the forest betel tree, using both hands.

Based on observations on feeding behavior during the study, it appears that the *M. hecki* group more often took food directly from the tree than eating under the tree or waiting for the fruit to fall. Because when in the tree, *M. hecki* easily takes as much food as he wants. In general, in a confined environment,

M. hecki feeding behavior tends to be competitive and agonistic to get feed[2]. The feeding behavior of the *M. hecki* group in the limited production forest of Makarti Jaya Village during the observation process did not show agonistic and aggressive behavior. This is because the availability of feed in its natural habitat is still abundant, so the *M. hecki* group is not aggressive in obtaining feed. In addition, the abundance of natural feed *M. hecki* in its natural habitat does not make one Macaca have to wait for another Macaca to finish eating in order to get the desired feed[4], *M. hecki* male will be aggressive towards others Macaca to take the feed first. This condition rarely occurs in natural habitats *M. hecki* in the limited production forest of Makarti Jaya Village. The abundant availability of natural food makes the group Macaca rarely come down to community land to look for food.

4 Conclusion

Macaca hecki in the limited production forest of Makarti Jaya Village consumes eight species of natural food, with *Syzygium cumini* being the most preferred (31%) and *Piper aduncum* leaves and *Musa paradisiaca* stems the least (1%). The most common feeding behavior is using both hands (39%), while the least is using one hand (5%).

The abundance of food reduces competition, leading to minimal aggressive behavior. *M. hecki* prefers ripe fruit and stores food in cheek pouches as an adaptive strategy. Overall, the rich food availability supports stable feeding behavior and minimizes conflict in their natural habitat.

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