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Antipredator Behavior by the Red-tailed Guenon, *Cercopithecus ascanius*

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ABSTRACT

The study was carried out in the Sabaringo forest in the north-western part of Masai Mara National Reserve in Kenya. Two species of monkeys inhabit this area; the red-tailed monkey (*Cercopithecus ascanius*) and the blue monkey (*Cercopithecus mitis stuhlmanni*). The blue monkey has been the focus of attention in previous behavioral studies in this forest. The principal aim of this study was to evaluate if similar studies also could be applied to the red-tailed monkey. My study focuses on general anti-predator behavior to compare lactating and non-lactating red-tailed monkeys.

Data were collected from the 16th of March to the 21st of March 2009 on foot by students and field assistants. Every minute a focal animal's foraging and social behaviors were recorded together with location and posture. A total of 66 hours of data were obtained. A hotel is situated in the forest which makes the monkeys habituated to human presence. The area is also surrounded by a fence to keep the forest protected from larger animals. In addition, this fence makes it more difficult for predators like felines to enter the forest. Raptors are therefore likely to be the most important predator to the red-tailed monkey in this area.

My results confirmed that the red-tailed guenon is a tree living monkey. However, a significant difference regarding time spent on the ground was observed between lactating and non-lactating monkeys. Lactating females were hardly seen on the ground. There was also a distinct difference between the two groups in the possibility to follow and observe them. The average observation time for lactating monkeys was half of the time for non-lactating monkeys (60 and 120 minutes respectively). Recordings were also made concerning daily activities. Periods of peak activity were destined to morning and afternoon hours. The dominating activity was sitting followed by eating and moving. During lunch hours foraging decreased while sitting increased. Finally, the methods previously used in studies of blue monkeys proved to be applicable even to the red-tailed monkeys but required more time and more observation hours.

SAMMANFATTNING

Min studie genomfördes i Sabaringoskogen i den nordvästra delen av Masai Mara nationalreservat i Kenya. Två arter av apor bebor detta område, nämligen rödsvansmarkattan (*Cercopithecus ascanius*) och den blåa markattan (*Cercopithecus mitis stuhlmanni*). Vid tidigare beteendestudier i den här skogen har den blåa markattan stått i centrum. Huvudsyftet nu var att utvärdera om det var möjligt att använda sig av liknande metoder i studier av rödsvansmarkattan. Fokus lades också på antipredationsbeteende samt skillnader i beteende mellan lakterande och icke lakterande rödsvansmarkattor avseende antipredation.

Data samlades in till fots mellan den 16 och 21 mars 2009 av studenter och fältassistenter. Varje minut antecknades en apas åt- och sociala beteenden tillsammans med dess lokalisation och hållning. Totalt erhöles 66 observationstimmar. I skogen ligger ett hotell, vilket har bidragit till att aporna har vant sig vid människor. För att skydda området från stora djur omges skogen av ett staket. Detta gör det svårare för predatorer, såsom kattdjur, att komma in i området. I denna skog är därför rovfåglar antagligen den viktigaste predatorn.

Mina resultat bekräftade att rödsvansmarkattan är en trädlevande apa. Däremot kunde en tydlig skillnad ses mellan lakterande och icke-lakterande individer avseende den tid aporna tillbringade på marken. Lakterande sågs mycket sällan på marken. En klar skillnad mellan grupperna i möjligheten att följa efter och observera aporna kunde också fastställas. För lakterande honor var medelobservationstiden hälften så länge jämfört med icke lakterande apor (60 respektive 120 minuter). I studien registrerades också djurens dagliga aktiviteter. Aporna var som mest aktiva under för- och eftermiddagen. De dominerande aktiviteterna var att sitta följt av att äta och röra på sig. Mitt på dagen ägnade de mindre tid åt att äta, medan de satt i större utsträckning. Slutligen visade det sig att de beteendestudier som tidigare utförts på den blå markattan även är applicerbara på rödsvansmarkattan, dock var studierna mer tidskrävande.

1. INTRODUCTION

1.1. Species description

The red-tailed guenon, *Cercopithecus ascanius*, is one of totally twenty guenons, all living in Africa (Groves, 2005). They belong to the family Cercopithecidae and subfamily Cercopithecinae (Estes, 1991). *C. ascanius* is a colorful monkey with a speckled yellow-brown fur and blue areas around the eyes. Their cheeks and under-parts are white and the end of the tail is red. There is also a white spot on their nose, shaped as a heart (Footitt, 2004). They are small and agile and weigh between 2 and 6 kg (Estes, 1991).

The species inhabits central Africa from southern Sudan as the northern boundary, through the Central African Republic and Congo, to northern Zambia as the southern limit. They also occur in Angola in the west to Kenya in the east (Wolfheim, 1983). Their preferred habitat is a dense lowland rainforest with a tangle of undergrowth, but they also inhabit lakeshore and marsh areas. They are additionally found in dry evergreen forest, mountain forest and acacia woodland (Wolfheim, 1983).

C. ascanius has typically a uni-male social system and live in groups of about 25 individuals (Butynski, 2002). The females remain in the same group for her entire life, in contrary to the males who have a propensity to leave the group when sexually mature (Cords, 1987). They can thereafter live as residents in a mixed group or as nonresident males outside groups (Jones and Bush, 1987). The females give birth to one infant a year, typically between April and November (BBC, 2009).

The diet usually consists of fruits but includes also leaves and animal prey. An interesting detail that distinguishes red-tailed monkeys and Cercopithecidae species from other primates is their use of cheek pouches. They use them as temporary food storage (Smith et al, 2008), allowing them to gather food at more dangerous areas but chew them in safer places. They are diurnal, which means that they perform their activities during daylight hours (Butynski, 2002). In general, diurnal primates have a peak in activity during dawn and dusk and a period of rest during midday (James and Phyllis, 1984).

The Red-tailed guenon is not on the IUCN red-list of threatened species (IUCN, 2009) but the number of individuals is decreasing in Kenya. This is mainly because the forest is replaced by farms and plantations. In other countries the monkeys are hunted for the meat and fur. The government in Kenya has, however, tried to protect the species by creating forest reserves such as Kakamega forest reserve and Mount Elgon Game reserve (Wolfheim, 1983).

1.2. Anti-predator strategies

According to Oxford Advanced Learner's Dictionary (2000), the definition of a predator is "an animal that kills and eats other animals" (p. 992). Anti-predator strategies are therefore an animal's defenses to avoid being caught, hunted, killed or eaten by another animal. As far as red-tailed monkeys are concerned the most important predator is the crowned hawk-eagle (Mitani *et al*, 2001), but also other large birds, chimpanzees, felines, snakes and humans (Struhsaker and Leaky, 1990). Which predator is the most dangerous threat to the individual

animal depends on how common the predator is in the area, but also on the prey's body size and behaviour. The larger the animal is the larger the predator has to be, since large predators tend to hunt large individuals (Garber *et al*, 2008).

1.2.1. RECOGNITION

The first step to avoid being captured by a predator is to recognize it. Young animals have not developed their skills and are therefore more susceptible to an attack by a predator (Caro, 2005). An important activity to discover a predator already at some distance is scanning the environment. Scanning has, however, an impact on other activities such as foraging, sleeping etc. (Caro, 2005).

1.2.2. PROTECTION

1.2.2.1. APPEARANCE

The importance of a protective coloration to obviate the risk of predation has been discussed. The color and pattern of the fur are not only for protective purposes, but also an adaptation to attracting mates, finding food and regulating body temperature (Caro, 2005).

Protective coloration can be divided into three different strategies (Caro, 2005). The first strategy is background matching, where the animal has a certain color, stripes or dots that match the surroundings. Animals with an arboreal lifestyle tend to have a spotted coat to match the speckled surroundings made by the sun passing through leaves. Crypsis is even more effective if the animal remains immobile or "freezes" (Caro, 2005).

The second strategy (Caro, 2005) is to minimize the shadow on its own body, because it accentuates its outline. This is made by counter-shading, which means that the dorsal surface of the body is dark and the ventral is light. When light comes from above, the animal's contour is partially concealed (Caro, 2005).

The third strategy (Caro, 2005) is a disruptive coloration. The predator becomes confused of all contrasting colors and misunderstands it for several objects (Caro, 2005).

All three strategies could be applied to the red-tailed monkeys, who have a speckled fur and a dark dorsal surface compared to the white ventral surface. Different colours also outline the eyes, cheeks and nose.

1.2.2.2. HABITAT CHOICE

Only the fact that red-tailed monkeys are arboreal (Butynski, 2002) give them protection to reduce predation risk. The canopy provides shelter and the three-dimensional appearance offers many escape routes and hiding places (Garber *et al*, 2008). In addition, an approaching threat will soon be discovered by the vibrating branches (Garber *et al*, 2008). Studies of the closely related blue monkey show that they prefer living and travelling in a dense and continuous canopy on a height over twelve meters and that they are rarely seen on the ground (Kaplin, 2001). For protection during nighttime, primates generally choose a sleeping site in

tall trees with branches starting high (Caro, 2005). They also prefer to sit on terminal branches, which cannot hold the weight of a predator (Caro, 2005).

Sex differences do occur in terms of food preference and consequently also habitat choice (Cords, 1986). Studies show that lactating and pregnant females forage mainly on leaves and other protein-rich food items. Comparatively, the males focus on eating a more energy-rich diet consisting of assorted fruits (Cords, 1986), especially during mating time (Nakagava, 2000). Moreover, females are particular about their choice of feeding place which cannot be too close to another female (Pazol and Cords, 2005). Studies of blue monkeys indicate that they can be hundreds of meters away from each other while feeding. This has possibly to do with intra-group competition and rank.

1.2.2.3. GROUP SIZE

To be a group-living species has both advantages and disadvantages. Benefits are gained in terms of a dilution effect, where the risk of any individual of being targeted by a predator is lower (Stanford, 2000). The group also stands a good chance to discourage the predator and thwart a coming attack. At the same time disadvantages such as food competition and mating competition increase with larger group size and also the group itself may attract predators (Stanford, 2000).

1.2.2.4. POLYSPECIFIC GROUPS

The definition of a polyspecific group is that different species of monkeys associate with each other. This commonly occurs among primates in Africa (Clifford, 2006). The groups may stay together for hours or days to travel and feed. The advantages of living in a group are obtained and furthermore, if the species have different diets or feeding tactics the competition for food and mating is decreased in polyspecific groups (Clifford, 2006). In the forest of my focal animals, red-tailed guenons mix with blue monkeys (*Cercopithecus mitis stuhlmanni*); there are even hybrids of these two species.

1.2.3. RESPONDS TO PREDATORS

1.2.3.1. WARNING CALLS

The use of warning signals is probably both costly and beneficial. The predator can localize the individual caller better, but the whole group's chance to escape the threat increases (Caro, 2005). The calls have to be accustomed to the preferred habitat of the species. Arboreal monkeys use with advantage low-pitched, frequency-modulated pure sounds in a sequence since these sounds travel the farthest through the canopy (Estes, 1991).

As a response to a disturbance such as a predator or another approaching group, red-tailed monkeys use a hack sound (Estes, 1991). This is different from other similar species. Alerting signals, on the other hand, can be difficult to distinguish between monkeys. The calls progressively intensify and tend to be contagious to other group members (Estes, 1991). Alarm calls are usually rapid and of short duration. The guenons typically use a chirping

sound (Estes, 1991). Most forest living monkeys have at least two types of alarm calls (Seyfarth, 1980). Vervet monkeys for example have mammalian carnivore alarms, avian predator alarms, snake alarms and baboon alarms and respond differently to the sounds (Seyfarth, 1980). Aggression calls towards predators is more like “chutter” among guenons (Estes, 1991). If a predator is close and the group wants to bring out a call of defense or distress, the sound is similar among most primate species. The calls are usually high-frequency, shrill screams or screeches.

1.3. Aim of the study

The main purpose of the study was to investigate whether previous observation methods of the blue monkey in Sabarigo forest also could be applied to the red-tailed monkey. In particular, I investigated if lactating females were more difficult to observe and to follow. I focused on describing their daily rhythm concerning foraging and resting patterns. I also compared anti-predator behavior and habitat preferences in non-lactating monkeys with lactating monkeys.

2. MATERIALS AND METHODS

2.1. Study Area and Subjects

The study of the red-tailed guenon took place in the Sabaringo forest in the north-western part of the Masai Mara National Reserve (MMNR) in Kenya. MMNR was established in 1961 and is connected with the Serengeti National Park in Tanzania (Williams, 1967). Together they form an important ecosystem. In comparison with Serengeti, MMNR is smaller but invaluable to the animals on the savanna due to its high rainfall (Sinclair & Arcese, 1995). There are two rainy seasons, one longer period ranging from March to May and one shorter episode in November and December. The average rainfall in MMNR is 1200 mm per year. During the longer dry season between mid-July and mid-October, especially wildebeest and zebras migrate from Serengeti to the area for water and green pasture.

The Sabaringo forest covers an area of 24 ha and is transversed by the Sabaringo River (Bryant & Lomba, 2004). It is an evergreen forest and contains a diverse wildlife. The largest mammal that inhabits the area is the warthog (& Beyond, 2009). Except for the red-tailed guenon, other mammals to be found are the blue monkey (*Ceropithecus ascanius*), banded mungo (*Mungos mungos*), tree hyrax (*Dendrohyrax dorsalis*), together with a large number of bird species (Nilsson, 2008). An electric fence is surrounding the forest and the trees are therefore protected from being pushed over by larger herbivores such as elephants and hippopotamus. Predators like hyenas, leopards and snakes can however still cross the fence.

The forest consists of tall trees with the canopy height reaching approximately 20 m as well as of tangled undergrowth with shrubs, herbs and vines. The most common tree species are *Teclea nobilis*, *Diospyros abyssinica* and *Euclea divinorum* (Kempe, 2008). There are also gaps in the forest due to trails, lawn and buildings of various sizes.

Parts of the forest are also a built-up area with two lodges, the Kichwa Tembo Masai Mara Tented Camp and the Bateleur Camp. The lodges consist of 40 safari tents and 18 suites, respectively. The area also has a restaurant, a reception, a tourist shop, a main office, management houses, a staff quarter with a football field and a swimming pool (& Beyond, 2009). Some parts of the forest and consequently also the monkeys are undoubtedly affected by the presence of tourists and staff members. The monkeys are to an ever increasing extent habituated to humans and seize the opportunity to eat garbage from restaurant leftovers in open trash bins.

2.2. Data Collection

During the research, members of a group of approximately 30 individuals of red-tailed monkeys were studied. Individual identification was not possible. A rough estimate however suggests three lactating females with one offspring each, about ten non-lactating females, one dominating male and several juveniles. The behavior observations were conducted from the 16th to 21st of the March 2009. Recordings were made on foot and began generally at 8:00 and ended at 18:00. The starting and ending time varied slightly from day to day mainly because

of difficulties in travelling to the forest and sometimes also due to heavy rainfall and thunderstorms.

Two parallel teams with two or three observers collected the data. In case a lactating female with an offspring were followed, one observer surveyed the mother and one the offspring. A third person was also always responsible to record the data on a paper sheet. The preferred focal animal for this study was a female with an offspring. If there were no such animals available when the study started, a non-lactating female was chosen. If the observers came across a lactating female, while observing a non-lactating individual, the animals were exchanged. If a focal animal was out of sight for more than five continuous minutes that particular observation was stopped and a different animal was chosen. During the lunch hours between 12:30 to 14:30 the monkeys had a tendency to move to Bateleur Camp area. This is a private area where no studies could be made due to possible disturbance of tourists. Therefore the study occasionally had to stop during these hours. The observations lasted in average 1:42 hours and a total amount of 66 hours were obtained; 54 of these recordings were of adults and the remaining 12 recordings of offsprings. We decided not use the offspring data in the results of my theses.

Recordings of each focal animal were made every minute. The behaviors were foraging, carried on mother, trying to suckle, suckling, standing, lying, sitting, moving, playing, self-grooming, grooming others, receiving grooming, other social behavior or missing observation. When a monkey was observed foraging, data was also collected concerning food type, i.e. leaves, buds, flowers, fruits, seeds, bark, invertebrates or unidentified food. In case of playing also the partner was recorded as mother, offspring, other adult, other infant, juvenile or playing could also be with the monkey itself. In case of grooming and receiving grooming the partner was recorded as mother, other adult, juvenile, offspring or other infant. I do not present the results of social behaviour in my thesis; the reason I carried out these observations was to test if they were feasible in red monkeys.

Table 1: Behavior definitions

Behavior	Definition
Foraging	Chewing, gathering or manipulating potential food.
Carried on mother	Offspring carried by mother with or without suckling.
Trying to suckle	Offspring trying to put its mother's nipple in its mouth without suckling taking place.
Suckling	Offspring holding its mother's nipple in its mouth for the duration longer than 10 seconds.
Standing	Standing up on four limbs alternatively upright on its rear limbs.
Lying	The monkey's abdomen leaning against an object.
Sitting	Sitting on its bottom.
Moving	Walking, running or jumping in a certain direction with

	all four limbs in motion.
Playing	Undirected movements with another individual or by itself.
Self-grooming	Manipulating own fur with hands, such as scratching and picking.
Grooming other	Manipulating other monkey's fur by mouth or hands.
Receiving grooming	Manipulation of the focal animal's fur by other monkey's mouth or hands.
Other social behavior	Antagonistic or sexual behavior.
Missing observation	Behavior was not able to identify or monkey was out of sight.

2.3. Data Analysis

For statistical analysis, we calculated the percentage of the recorded behaviours. An observation bout was an uninterrupted observation of one particular monkey. When the monkey was lost, the next monkey found was treated as a new animal although we could not exclude that some individuals were observed several times. Observations less than 15 minutes in length were excluded from the data analyses.

I tested if the data were normally distributed with the Anderson-Darling Normality Test. If they were normally distributed, I used Anova GLM to test statistical significance. Otherwise, I used the non-parametric Kruskal-Wallis Test. All results are presented as means plus/minus standard errors of the mean (SE).

3. RESULTS

3.1. Habitat Preference

Both lactating and non-lactating monkeys obviously prefer trees and shrubs as a habitat. There is, however, a distinct difference between the two groups regarding the percentage spent on the ground ($P = 0.001$). Lactating females were hardly ever on the ground and were consequently seen more frequently in the trees ($P=0.005$) compared to non-lactating individuals. No difference concerning time spent on man-made items (tents, houses etc.) and vines was observed between the two groups.

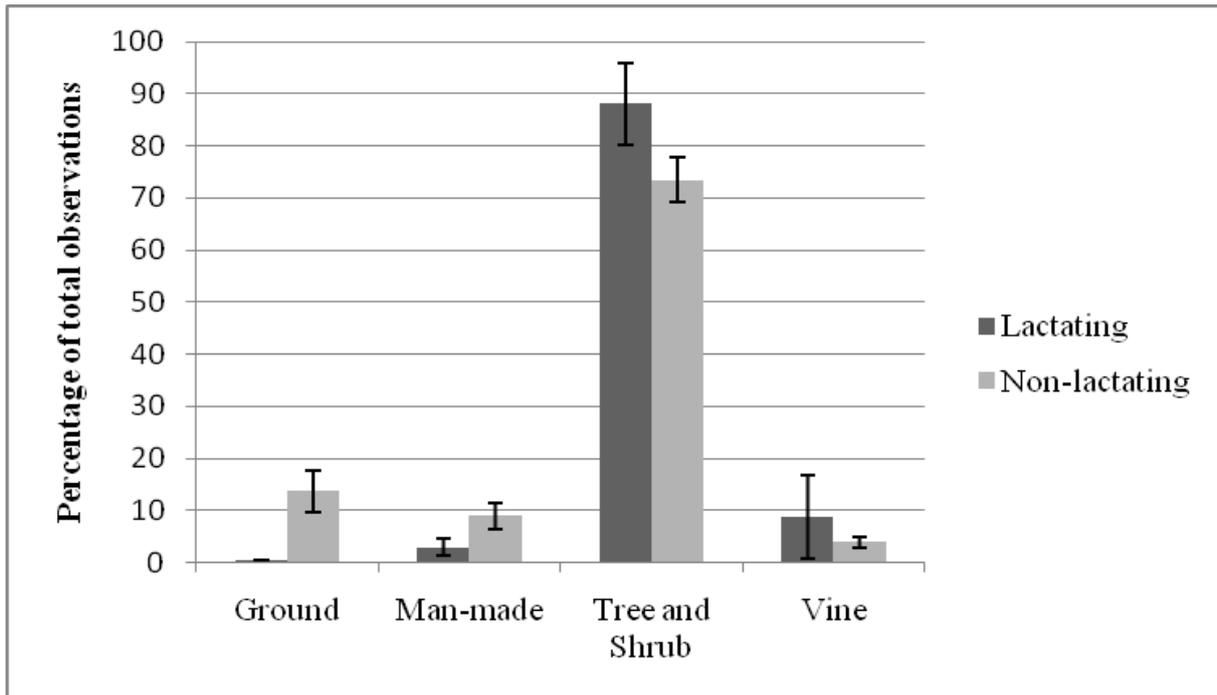


Figure 1: Habitat choice of lactating and non-lactating monkeys as percentage of time spent on the ground, on man-made items, in trees and shrubs or on vines.

3.2. Duration of Observation

There is a clear difference between lactating and non-lactating individuals in the feasibility to follow and observe them. Non-lactating females could be followed for a longer time ($F=10.26$, $P=0.003$, Anova GLM).

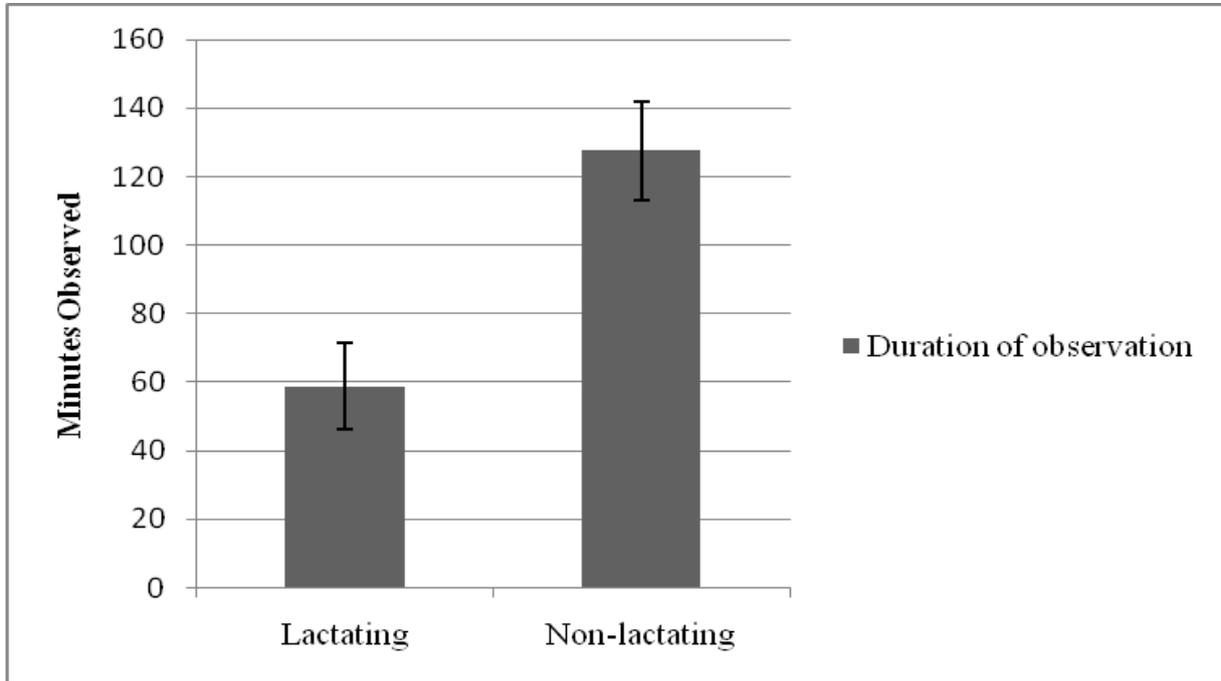


Figure 2: Duration of observation (minutes) in lactating and non-lactating females.

3.3. Daily Activities

Daily activities differed throughout the day. Eating was more common in the morning (P=0.008) and afternoon compared to lunch hours. Sitting was on the contrary more common during lunchtime (P=0.079) than during morning and afternoon hours. There were no differences in standing, lying and moving patterns over the day. Lying was a very rare activity.

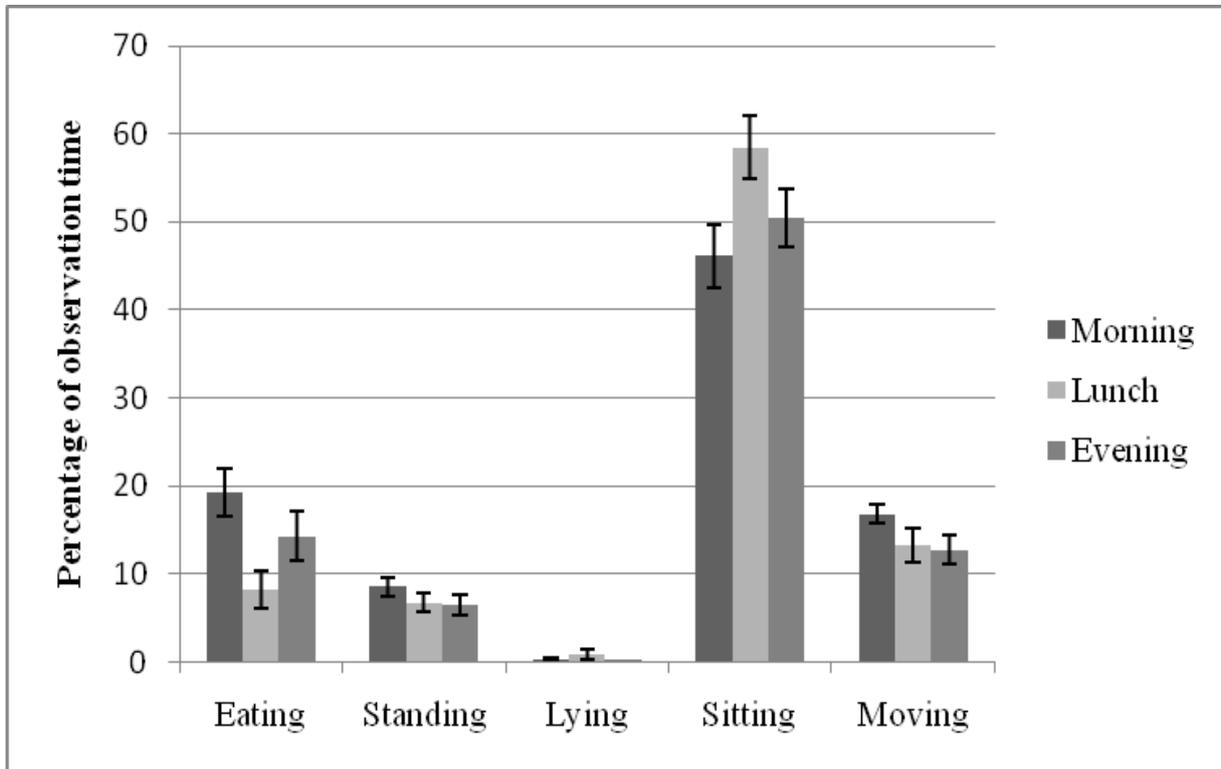


Figure 3. Percentage of observation time of different behaviours divided into morning, lunch and afternoon. Morning hours were from 8:00 to 10:59, lunch hours from 11:00 to 14:59, and afternoon from 15:00 to 17:59.

4. DISCUSSION

In African forests raptors and felids together represent a clear majority of primate predator attacks (Gursky, 2007). Since the area is surrounded by a fence other possible predators like felines cannot easily enter the forest. Hence, the most important predator to the red-tailed monkey in the Sabaringo forest is most likely the African hawk-eagle and other large raptors. Chimpanzees are of major importance concerning predation in other areas such as Ngogo, Kibale National Park in Uganda (Teelen 2005). This species is however not present in the Sabaringo forest.

The red-tailed monkeys utilize several anti-predator strategies. It is impossible to conclude which strategy is the most important in this specific species. Different behaviors can be of decisive importance on different occasions, depending on predator, location, time of the day etc.

4.1. Habitat Preference and Group Formation

The fact that they are arboreal gives them advantages in the form of shelter and escape routes. My result confirmed in accordance with another study (Butynski, 2002) that red-tailed monkeys spend most of their time in the trees. However, a significant difference regarding time spent on the ground was observed between lactating and non-lactating monkeys. Lactating females were seldom seen on the ground. This could be a precautionary measure where they may feel too vulnerable and exposed for predators on the open ground. The remaining individuals of the group spent most of their time on the ground foraging ripe fruit (own observations). According to Cords (1986), lactating and pregnant animals prefer to eat relatively more protein-rich leaves rather than energy-rich fruits to cover their daily intake of nutrients, which also could explain why they do not want to spend unnecessary time on the ground. Furthermore, arboreal-living monkeys are vastly superior predators like felines and raptors in terms of liveness and speed when moving in and between trees. On the ground they are not superior and definitely not while carrying a baby.

Another interesting issue is the importance of the red-tailed monkey's use of cheek pouches. Smith *et al* (2008) concluded that the monkeys use their cheek pouches to reduce exposure to aerial predators. They filled them up in a more exposed area than where they emptied them. In addition, studies show that the use increases when they forage on fruits (Lambert, 2005). Furthermore, females tend to use their cheek pouches more often than males (Lambert and Whitham, 2001).

In addition, while foraging on the ground, red-tailed monkeys abundantly formed polyspecific groups with the blue monkey (own observations). Studies in Kibale National Park, Uganda, showed that red colobus monkeys spent over 50% of the observations with red-tailed monkeys (Teelen, 2005). These associations were both established and ended by the red-tailed monkeys. The conclusion from that study is that the predation of red-tailed monkeys by eagles is the important part of the association and that the predation of red colobus by chimpanzees is of less importance in the formation of polyspecific groups in Kibale National Park (Teelen,

2005). Other studies, however, showed that the formation of polyspecific groups result in an increased vigilance. As an example from Kibale forest, the time spent scanning increased when red-tailed monkeys associated with red colobus (Capman and Chapman, 1996).

Explanations to these contradictory results can be many. Individuals in small original groups show a greater personal reduction in vigilance compared to individuals in a greater primary group when forming polyspecific groups. There could also be a difference in predator risk between the species. The number of possible predators (chimpanzees and eagles) could differ between the different observation periods. Aerial predators could for example be more common than ground threats. In addition predators could also prefer one species to another (Caro, 2005). During the studies in Sabaringo forest no recordings were made regarding polyspecific associations. This is, however, an interesting area for further investigation.

4.2. Duration of Observation Bouts

The average duration of each observation occasion was in lactating females less than half of the time for non-lactating individuals. The true time difference is most likely even larger since we during our studies prioritized to find and observe lactating females. If this was impossible at the time we followed a non-lactating monkey. Consequently, while observing this monkey we kept looking for a lactating individual and if we succeeded we changed the focal animal. This means that the observation duration for non-lactating monkeys could have been longer in some cases and hence also the difference in observation length between the two groups.

In my study, lactating females were both more difficult to find and also more difficult to follow. The easiest way for the observers to find the monkeys was to listen for the sound that originated from the shaking branches when the monkeys moved from canopy to canopy. Lactating and pregnant females prefer eating leaves to fruit. Considering this, they might be more inactive and more silent compared to males and consequently more difficult to find. Studies also show that females generally forage with gaps between them, which also could explain the fact that it was more time-consuming to find lactating females. The group of red-tailed monkeys as a whole was well habituated to humans, but on several occasions lactating individuals seemed disturbed by our presence. Since the trees were the absolutely dominating habitat for lactating females, they always had many escape routes. It was therefore difficult for the observers to predict the direction of a moving monkey and the observers were consequently left behind. Sometimes we even got the impression of chasing the monkeys even though we kept the distance. This is possibly an anti-predator behavior, where lactating animals are more alert and agile and on their guard compared to non-lactating individuals.

4.3. Daily Activities

My results also show that the monkeys are most active during morning and afternoon with a decrease in activity during the warmest hours of the day. This is also supported in a long-term field study of rhesus monkeys in India. They concluded that social activities, resting and foraging were the dominating activities between 09:00 and 12:00. During the warmest hours of the day, in this case between 12:00 and 15:00, the monkeys were mainly resting and

grooming. The duration of the siesta increased with increased daily temperature. The greater part of the afternoon was dedicated to foraging (Else, 1986). A similar study of rhesus monkeys also confirms that the day starts and ends with foraging and that there is a period of rest between 11:00 and 15:00 that lasts for about one hour (Roonwal and Mohnot, 1977).

The fact that red monkeys are diurnal gives them both advantages and disadvantages. They get a better view of food resources, group members, competitors and also predators. An additional advantage for tree living species is that it is safer to move and forage in the trees during daylight (Feldhammer *et al*, 2007). On the other hand, diurnal species suffer from heat stress and are easier to be caught by a predator since also the predators have a better view. The African hawk-eagle usually accomplishes its hunts during daytime. The large bird species is however also dependant of creating thermals to be able to fly high and far (Olsen, 2009) which demands high temperatures. The African hawk eagle is an ambush hunter, which means that attack and capture take place almost simultaneously. First they search for a group of monkeys, which they stalk for some time. Thereafter they try to land on a branch as close to the monkeys as possible where they quietly sit and wait for the monkeys' approach before they attack the surprised prey (McGraw *et al.*, 2006). If they have time, the monkeys usually respond with alarm calls to warn other group members or to deter the predator. Adult male monkeys can also even attack the raptor (McGraw and Zuberbühler, 2008). An interesting observation is that the group seldom travels in a straight line to a specific fruit tree. Instead they thread their way through the forest, even though the location is well known. This could be a way of confusing the raptor and perhaps avoiding an approaching attack (Gursky, 2007).

The fact that the monkeys are inactive during the eagle's peak hours around lunch could be another adjustment to avoid predation. However, another explanation could be that they want to avoid heat stress during midday. A reason why they are more active foraging during morning and afternoon could also be that they are hungry after a night's sleep and need to fill the stomach before they go to sleep again. In addition, foraging in the morning could be explained by the presence of dew on the leaves in the morning. Additionally, leaves contain relatively more water when the temperature is lower and when the relative humidity is increased (Feldhammer *et al*, 2007).

Campbell (2008) describes a daily variation in diet by spider monkeys. They have a diverse diet that mainly consists of fruit, but also leaves, flowers, seeds, invertebrates etc. which is comparable with the diet of red-tailed monkeys. Their peak consumption of fruit is during morning and afternoon with a decrease during midday and the consumption of leaves at maximum during the afternoon. Leaves are the monkeys' primary resource of protein and are therefore an important part of their diet. However, they are also hard to digest which can explain the peak consumption in the evening when other activities decrease.

5. CONCLUSIONS

The work presented in this thesis has generated in three conclusions. First, lactating females are hardly ever on the ground, in contrast to non-lactating monkeys. Second, lactating monkeys were much more difficult to find and to follow, which resulted in shorter observation time than for non-lactating individuals. Third, in accordance with other studies, red-tailed monkeys were most active during morning and afternoon hours with a period of decreased activity during midday. All three of these conclusions might be an adaptation to avoid predation. Even though the red-tailed guenon is an agile monkey and sometimes adopts an attitude of reserve towards observers, I consider it practically possible to use similar methods in a more large-scale study.

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