Blue monkeys' utilization of five tree species in relation to the abundance of each tree species: *Teclea nobilis*, *Elaeodendron buchananii*, Species 1, *Grewia bicolor* and *Ficus sycamorus*

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Institutionen för husdjurens miljö och hälsa
Avdelningen för etologi och djurskydd

Swedish University of Agricultural Sciences ***Student report 213***
Department of Animal Environment and Health
Section of Ethology and Animal Welfare

ISSN 1652-280X

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Abstract

This paper is a part of a larger study with the purpose of investigating foraging behaviour and feeding preferences of blue monkeys' (*Cercopithecus mitis stuhlmanni*) in the study area. The study took place in the Sabaringo forest just north of the Masai Mara National Reserve, Kenya, where a group of 50 blue monkeys live. In July 2006 the foraging and positioning preferences of lactating and non-lactating females regarding the different tree species in the forest were studied by a group of other Swedish students. To determine if these trees are rejected or preferred, a total inventory of the trees in the area was carried out by me and a fellow student in March 2007. We compared our results with previously collected data of the preferences of the monkeys. My thesis focuses on five of the ten most preferred trees whereas the other five are discussed in the corresponding paper by Kempe. A total of 10 260 trees were counted and 50 different species could be identified. The most common of my focal tree species was *Teclea nobilis* making up 35 % of the total number of trees but used for positioning only 15 % of the observation time. The species that were used for feeding in the highest extent was *Grewia bicolor*, especially by the lactating females who often ate the fruits from it. In relation to the percentage of the forest biomass that this species made up (calculated from its stem area) it was eaten from almost six times more than expected from its abundance. *Ficus sycamorus* had an even higher ratio between occurrence and usage as food, more than 1:30 counted by number of trees or stems. Because it is one of the largest trees, the number was much lower (about seven) counted by area cover. The species only contributed to approximately 0.2 % of the number of trees or stems and a little over 1 % of the total biomass counted by stem area. In addition to these three species *Elaeodendron buchananii* and an unclassified species (Species 1) were also studied in detail and are presented in this paper.

Keywords: *Cercopithecus mitis stuhlmanni*; the Sabaringo forest; foraging; positioning; tree abundance

Sammanfattning

Detta arbete är en del av en större studie med syfte att undersöka den blå markattans (*Cercopithecus mitis stuhlmanni)* beteendemönster och födoval inom studiens område. Studien gjordes i Sabaringoskogen strax norr om Masai Mara National Reserve i Kenya där en flock på omkring 50 blå markattor lever. I juli 2006 har lakterande och icke-lakternade honors val av trädarter, för att äta från eller vistas i, studerats av en grupp svenska studenter. För att avgöra ifall vissa träd valdes bort eller favoriserades gjordes en totalinventering av skogsbeståndet av mig och en annan student i mars 2007. Resultatet jämfördes med data över blå markattans preferenser av trädarter för vistelse och föda. Mitt arbete fokuserar på fem av de mest prefererade trädarterna, medan de andra fem diskuteras i ett motsvarande arbete av Kempe. Totalt räknades 10.260 träd i området och 50 olika arter kunde artbestämmas. Den vanligaste av mina trädarter var *Teclea nobilis* som utgjorde 35 % av totala antalet räknade träd, däremot användes det av aporna för vistelse endast under 15 % av observationstiden. Den art som användes främst för att ätas från var *Grewia bicolor*, särskilt av de lakterande honorna som gärna åt dess frukter. I relation till den del av skogen biomassa som arten utgjorde (beräknat från stamarean) så åts den från nästan sex gånger mer än väntat. *Ficus sycamorus* hade en ännu högre relationskvot mellan förekomst och användning som föda, över 30 räknat på antal träd eller grenar. Då det är ett av de största träden blev det en betydligt lägre siffra (omkring sju ggr) räknat på yta. Trädet utgjorde endast ca 0,2 % av antalet träd och grenar i skogen och lite över 1 % av biomassan räknat på stamyta. Förutom dessa tre arter studerades även *Elaeodendron buchananii* och en oidentifierad art (Species 1) i detalj och tas upp i detta arbete.

Nyckelord: *Cercopithecus mitis stuhlmanni*; Sabaringoskogen; födosök; vistelse; trädförekomst

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1 Introduction

East Africa and Kenya are known for their species richness and varied ecology, with the enormous herds of different grazing and browsing animals on the Mara-Serengeti ecosystem as a good example. Tourism is very important for the Kenyan economy and it is primarily the nature that attracts tourists. Even though the savannah is considered to be the most popular landscape, all the different types of environment such as forests, mountains and water systems are important for the whole picture. One threat to this diversity is the decreasing of forest covered areas, which is due to over-cutting (Fairgrieve & Muhumuza, 2003). Instead, many areas are covered with cropland and other monocultures and we can see an ongoing reduction of plant diversity in remaining forests (Butchart, 1997). Among many other species who are dependent on these forests is the blue monkey (*Cercopithecus mitis stuhlmanni*), an arboreal primate (Kaplin 2001). Although there is no direct threat of extinction to them now, they will have difficulties to survive if too much of their habitat gets destroyed (McDonalds, 1984). Observing their behaviour to find out what they eat and need for life-support help us determine what kind of habitats they need and what forest types and tree species that are important to preserve.

1.1 Blue monkeys

Blue monkeys, *Cercopithecus mitis*, are a member of the genus *Cercopithecus* often referred to as guenon. There are five subspecies found in the world (Internet, IUCN (1), 2006). Some literature refers only to the subspecies *stuhlmanni* when using the name blue monkey while others include all subspecies. The taxonomy within the whole group of Cercopithecus is rather complex and there are several ideas about how they should be divided. Approximately 23 species with more than 70 subspecies are determined. Hybridisation is not uncommon and many subspecies only differ in coloration. (Valste, 1998) *C. mitis stuhlmanni*, the subspecies observed in this study, is dark blue and black. The nose and eye areas are almost hairless but in-framed with long pale-grey whiskers. It is a rather small monkey with a body weight between 4 and 8 kg, the males being significantly heavier than the females, a body length of 40-50 cm and a tail length slightly exceeding that of the body (Anapol et al., 2004). The size is the most obvious sex-dimorphism and they do not develop sexual swellings or other distinct signs of sexual willingness (Pazol, 2003). The blue monkeys have cheek pouches going all the way down in their throat in which they can carry almost as much food as in there stomach. This can be of great help if the monkey detects a danger while foraging. The monkey can then push the food down in the pouches and later push it back up again with his hands and eat it in his own pace. (Mcdonald, 1984; Lambert, 2001)

The species can be found in central, eastern and southern Africa in a variety of habitats with a high range of altitudes and annual rainfall (Fairgrieve & Muhumuza, 2003). They are one of the most widespread forest guenons (Pazol, 2003) and can be seen in many different types of forests; however they seem to prefer mature forests with closed canopies (Kaplin, 2001). Blue monkeys are diurnal and arboreal and can seldom be seen on the ground as they use the trees for moving around, making them dependent on tall trees for food, shelter and as sleeping sites (Kaplin, 2001; Fairgrieve & Muhumuza, 2003).

Blue monkeys are primary considered frugi- and folivorous but they can also eat invertebrates such as molluscs, worms and insects and also fungus etc., making them an

omnivore (McDonald, 1984; Tashiro, 2005). During a day most individuals eat from a number of different tree species and also different items from the trees; such as fruits, flowers, shoots or seeds. They are still very selective in their diet and are considered to eat a high-quality diet with only a number of plant species composing the staple food (Kaplin et al., 1998). All food items are thoroughly investigated, and processed with hands and mouth, so that only the best parts are picked (McDonald, 1984). As is the case with all forest guenons blue monkeys are extremely flexible in there diet; the preferred food items differs between season and habitat quality (Fairgrieve & Muhumuza, 2003). The guenons often show more variation in diet within a group over time and between different individuals in the group than between groups, forests and species (Cords, 1986; Pazol & Cords 2005). However, most studies find that fruits and young leaves are dominant in their diet and that they complement it with other items to supply their total nutritional need (Cords, 1986; Conklin-Brittain et al., 1998; Fairgrieve & Muhumuza, 2003; Pazol & Cords 2005). As a frugivore the blue monkeys probably are important for the dispersal of many trees' seeds, which can create a pattern of negative feedback if one such tree species starts to decline in number. Studies have shown that *Cercopithecus* spit most seeds under the parent canopy (Cordeiro et al., 2004), fruits species that are eaten whole without destroying seeds or fruits stored in the monkeys pouches can however be dispersed quite long distances (Kaplin et al., 1998). There can also be benefits for the tree because of the monkeys' meticulous processing of the fruits, e.g. the cleaning of the seeds (removal of the pulp) have been shown to significantly increase the germination possibility by reducing fungal attacks (Lambert, 2001).

The blue monkey is a social species and often form matriarchal groups with 10-40 individuals in which most often one male at a time take part (McDonald, 1984). They tend to spread out while feeding possibly to avoid competition (Pazol & Cords, 2005). They can also form alliances with other monkeys that they do not compete for resources with. This can lead to a better security-level for both species without decrease in food ability if the species have different feeding preferences. More individuals that can keep an eye out for predators such as leopards or snakes, give each monkey more time for foraging (Treves, 2000; Internet, Animal Diversity Web, 2001). The most likely predator is however larger species of eagle, especially crowned hawk eagle (*Stephanoaetus coronatus*) that is a specialist in hunting tree living monkeys (Cordeiro, 2005). In some areas, hunting by humans (either for the flesh or for protecting their crops) also affects the populations. Another, and probably the largest, threat to the species is habitat destruction, especially the clearing of the rainforest. Studies have shown a significant negative correlation between *C. mitis* group abundance and number of traces of human forest use (Marshall et al. 2005). Considering the speed of clear cutting and agricultural expansion all forest living monkeys can be seen as endangered. According to the IUCN red-list there is however not an immediate risk of the survival of the species*, C. mitis* where year 2000 considered to be in the low risk class (LR). This study is done on the subspecies *stuhlmanni* that only exist in Kenya and Uganda, but the classification is still valid for *C. m. stuhlmanni* (Internet, IUCN (2), 2006).

1.2 Descriptions of focal tree species

Teclea nobilis

Common name: **Small-fruited teclea** (English)

Description: Can grow either as a tree up to 10 m or as a shrub over 2 m in height. It is evergreen. The leaves are 3-folioate and aromatic which can be sensed when they get crushed. The flowers smell sweet and have a creamy yellow-green colour**.** When the fruits (which grow in large clusters) are ripe, they become orange-red (Internet, Flora of Zimbabwe, 2007).
Habitat: Grows mostly in riverine forests, evergreen forests and woodlands (Internet, Flora Zambesiaca (1), 2004).
Range: Ethiopia, East Africa and southwards to Zimbabwe (Internet, Flora of Zimbabwe, 2007).

Elaeodendron buchananii

Common name: **Eleodendron** (English)
Description: Grows as a shrub or tree between 4 and 12 m high**.** The flowers grow in cymes in the axils of the shoots, forming a multiflorous inflorescence. They are white, green or pale yellow with 4-5 petals. The fleshy fruits are 13-20 mm long, ellipsoid and rather smooth. They are first pale yellow and then dries to a red or brown colour, bearing one seed each.
Habitat: Grows at altitudes of 1 000-1 500 m.a.s.l. in evergreen forests and ticket, fringing forests. It can also be found on termite mounds in plateau deciduous woodland.
Range: Angola, eastern Congo, Ghana, Kenya, Sierra Leone, Sudan Republic, Tanzania, Togo, Uganda (Internet, Flora Zambesiaca (2), 2004).

Species 1

One of the ten species mostly used by the Blue monkeys, could not be classified. The species was easily detected but we were unable to determine which actual species this trees belonged to. Earlier studies in this forest (Hansson, in preparation) has referred to this species as *Crabia brownii* but it has now been established that it does not belong to this species. It is a medium high tree, branched to some extent. The fruits are round, a few centimetres in diameter, with a slightly hairy surface. They are green at first, then ripens to yellow-orange.

Grewia bicolor

Common name: ***White Raisin*** *(English),* ***Mkone*** *(Swahili),* ***Ol-Sitete*** *(Maa)*
Description: Grows as a low shrub or small tree, usually greatly branched all the way down to the base of the trunk. Most of the time up to 3 m high but can become as high as 9 m (Dharani, 2002). The inflorescences are axillary, often in great numbers and with bright yellow petals. The basal nectariferous claw on the petals gives it a sweet scent. The fruits are either deeply divided into two globular lobes or just with one lobe, each lobe about 6 mm in diameter. They are first green and hairy and then becoming glossy orange brown or purple-black (Internet, Flora Zambesiaca (3), 2004).
Habitat: Occurs at altitudes up to 2 000 m.a.s.l. in dry Acacia bushland, bushed grassland and woodland. Most often they grow on rocky grounds (Dharani, 2002). They are widespread in deciduous woodland but can also grow in other areas within certain biotopes, such as termite mounds, if the area has an annual rainfall above 60 cm.
Range: Is widespread from S. Africa to Angola, Ethiopia and West Africa. It can also be found in both Arabia and India (Internet, Flora Zambesiaca (3), 2004).
Other: The ripe fruit is sweet and edible by humans and the leaves are used for browsing by domestic stock (Dharani, 2002). The leaves have high levels of many minerals and can therefore act as good mineral phytocentres. It is especially rich in calcium and does also

have high levels of phosphorus, iron and copper compared to many other commonly used browse species (Kabasa et al. 2004).

Ficus sycomorus

Common name: **Sycamore fig** (English), **Ol-gnagboli** (Maa)

Description: This tree can become up to 40 m high, but is more often between 20 and 30 m. The crown is relatively widespread; the diameter often exceeding the height of the tree. (Wahungu, 2001) It has a short trunk of up to 2 meter in diameter. This large tree with its spreading main branches can sometimes use other trees as support, which occasionally can be necessary because of its fast growth rate. The bark is distinctive yellow to creamy brown, first smooth but cracks with age. It has up to 12 cm long leaves with a rough surface. The figs grow in the leaf axils or in dense clusters directly on the main trunk or on branches. Each fig is rounded with a diameter up to 4 cm. They are first greenish and then becoming yellow red when ripe. (Tweheyo & Obua, 2001; Dharani, 2002)

Habitat: It occurs in wooded grassland and in drier wood and bush land up to 2 000 m.a.s.l. It is an important plant in the fringes of rivers.

Range: Grows in a wide range of places such as the Cape Verde Islands, Comoro Islands and Madagascar. It is widespread in sub-Saharan Africa, extending to the Arabian Peninsula in the northeast and to Namibia and South Africa in the south

Other: The fruits are eaten by birds, monkeys, baboons and hyraxes. In Middle East countries it is cultivated because the fruit is considered appetizing (Internet, Flora Zambesiaca (4), 2004). Ficus fruits are produces all year round, a strategy infrequently used by other trees in the tropics. They therefore constitute an important staple food for many frugivores during seasons of low fruit availability (Tweheyo & Obua, 2001).

1.3 Aim

In a previous study, Hansson (in preparation) recorded the blue monkeys' use of the different tree species in the forest around Kichwa Tembo Tented Camp. The aim of my study is to compare these data with the frequency of trees of five of the most used species in the same forest. The hypothesis I am intending to test is that there is a difference between the five tree species in the ratio between the species abundance and its usage. If a difference in the blue monkeys utilization of tree species can be detected this information can be applied when planning preservation arrangements. Another hypothesis is that lactating and non lactating females show different preferences. Lactating females are crucial for the survival of the entire population, it is therefore important to know if they prefer specific species that is not essential for the population as a whole. By looking into the relationship between the tree abundance and how much time the monkeys spent on them, I can determine if they favoured some tree species and avoided others. I have carried out this study together with Vendela Kempe. We show the number, size and spatial distribution of each major tree species in the forest. The entire study focuses on the ten most abundant species in the forest, which represents more than 90 % of the tree-biomass in the area. These trees were also the ten species that were most often used by the blue monkeys. This paper will analyze the result of five of these ten species; *Teclea nobilis, Elaeodendron buchananii*, unidentified Species 1*, Grewia bicolor* and *Ficus sycamorus*. For information about the five other tree species; *Diaspyros abyssinica*, *Ficus lutea, Euclea divinorum*, *Turraea robusta* and *Warburgia ugadensis* see the corresponding paper (Kempe, in press).

2 Materials and methods

2.1 Study site

The Kichwa Tembo Tented Camp and the Bateleur Camp are two lodges situated near the northern border of the Masai Mara National Reserve, a 1 500 km^2 area in the south of Kenya. The Masai Mara National Reserve was established to secure the wildlife and wilderness land in the area in 1961 (Butchart, 1997). Then the largest threat was the decreasing number of animals caused by years of hunting. Today it serves as a good way of securing the income of tourism and at the same time limit the negative effect of human activities on the nature. With it's location on the edge of the Great Rift Valley it constitutes the northern part of the Serengeti-Mara ecosystem and the reserve receives thousands of animals each year during the Big migration. In the area the Maasai people have lived for several hundreds of years with herding cattle, their settlements is now just outside the area borders (Butchart, 1997).

The Kichwa Tembo Tented Camp belongs to Conservation Corporation Africa (CC Africa), a wildlife tourism corporation in Africa. The lodge is located at the base of the wall-like Oloololo escarpment and through it the Sabaringo River flows, on its way to the Mara River. Compared with other parts of the Serengeti-Mara ecosystem, Masai Mara has a high annual average rainfall of 1 000 mm. This is concentrated in two rain seasons; in May-June and October-December. Because of the high altitude of approximately 1 600 m.a.s.l. the temperature is considered rather mild for the latitude (Butchart, 1997).

Our study site was the Sabaringo Forest (1°14'51.00"S and 35° 0'32.92"E) that surrounds the lodge. It is a rather small, evergreen forest that is highly affected by human activities. Roads, buildings, tents and other constructions make the borders of a patchwork of different ecotypes, different vegetation types (including some planted trees) and with a varied degree of human impact. There are tall trees as well as a more or less thick ground cover of smaller trees, shrubs and herbs. The fence that surrounds the lodge keeps many larger animals and predators out of the study area. Also, leftovers from the kitchens are sometimes found in cans and on waste heaps. These are things that make this forest a somewhat different habitat than forests further away from humans.

2.2 Data collection

The monkeys were observed in July of 2006 during 320 observation hours. These hours were evenly distributed over the day between 8:00 and 18:00. Half of the observations were carried out on lactating females and half on non-lactating females. Every minute the behaviour of the monkeys was recorded. The monkeys used the trees either for foraging or for other purposes such as moving, resting etc, here collectively called positioning. The tree species that the monkey was positioned on was recorded, in case of foraging this tree species was also recorded. For details of the methods and more detailed results of the monkeys' behaviour; see Hansson (in preparation) for use of tree species, Ingman (in preparation) for human impact on the monkeys' behaviour and Nilsson (2007) for mother-offspring interactions.

The inventory of the trees surrounding Kichwa Tembo was conducted by two teams during three weeks in March 2007. Each team consisted of one Swedish student collecting the data

and between one and three Maasai field workers who had knowledge about the tree species and could work the GPS-equipment. We made transects and within these defined all the tree species and measured their diameter with a diameter meter at the height of 1.30 m. All trees locations were also marked with a GPS (VENTURE Cx GARMIN). The information was used to make a map in ArcGIS. The borders of the study area were determined by the fence around Kichwa Tembo (July 2006), and made up an area of approximately 0.4 km^2. A small area belonging to a luxury part of the lodge, the Bateleur Camp, was not included since we had no access to this. Another small area was excluded since it was considered as too dangerous to walk in. Fences, borders, roads, and tents were marked with the GPS as well.

A tree was defined as a lignified plant with a diameter of at least 5 cm at a height of 1.30 m. Dead and fallen branches or trees were not included, neither were vines. If a tree was surrounding another tree or if it was hollow, the measured diameter was divided by two to get a more accurate approximation of the tree's biomass. If a tree was divided into several stems below 1.30 m, each stem was measured separately but were all counted as a single tree with the same GPS position.

2.3 Data analysis

The diameter measured of each trunk was used to calculate the surface area with the formula $\pi \times r^2$. We were then able to calculate the trunk surface of each tree, by adding the trunks together, and each tree species in the forest. With these data, we could estimate the percentage of the total tree biomass for each tree species. The number of trees, the number of trunks and the surface area were used as three different measurements for estimating the contribution of each tree species to the total tree biomass in the area. The estimations were compared with data over the use of each tree species by the blue monkeys as collected in July 2006. These data describe the percentage of each tree species in the diet of the monkeys (% of time spent at foraging from the tree species) and the use of each tree species for positioning. All data are presented as means. Since we describe one forest only, we did not perform any statistical test and do not show standard errors (SE).

By using the formula: $\boxed{\frac{A}{B} \times 100}$

A = % of tree-foraging time spent on species X
B = % of forest-biomass that species X made up

we estimated the relation between these two factors. If we would get a value of 100 for all species it would mean that the monkeys chose them randomly and that the use only depends on tree abundance. A number over 100 indicates that they use that species more than would be assumed with a linear relationship.

3. Results

3.1 Proportion of the different tree species

During the inventory 10 260 trees were counted. We identified 50 different species, additionally 18 species could not be classified.

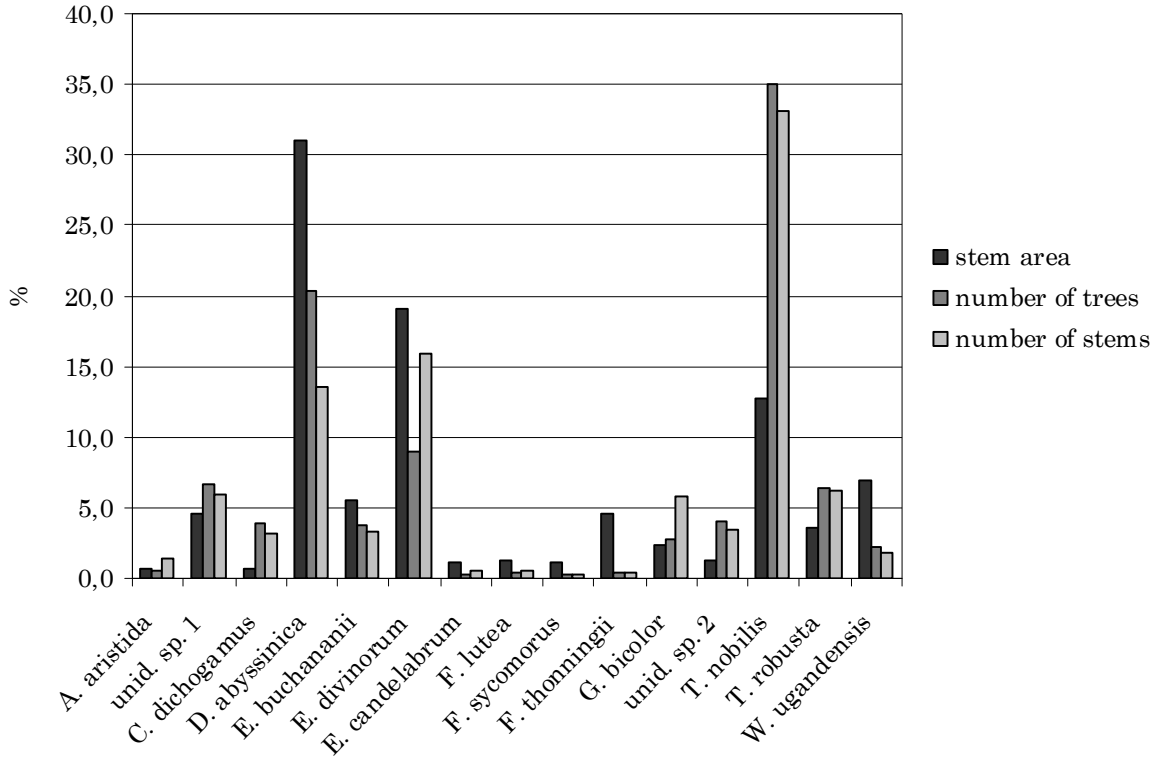


Figure 1. *The relative abundance of the fifteen most common tree species, counted by three different biomass estimations.*

The 15 trees represented in figure 1 were the most abundant species in the forest; they took up more than 96 % of the trees according to all three ways used for estimation of the biomass. Here they are listed alphabetically, with the three staples representing the area of the stems' cross-section, the number of trees and the number of stems. *D. abyssinica* took up more than 30 % of the stem area where as 35 % of the trees were of the species *T. nobilis*. Two of the tree species could not be identified with a scientific or common name, therefore we call them species 1 (sp. 1) and species 2 (sp. 2).

The five species focused on in this paper are Sp. 1, *E. buchananii*, *F sycomorus*, *G. bicolor* and *T. nobilis* (Fig. 3). The last one is the most abundant according to both tree and number of stems. However, the species' stem area percentage is much lower but still higher than the other four's. *G. bicolor* has a quite high tree number percentage but the digit for stem area and number of stems is lower. For *E. buchananii* the relation is the opposite with a higher stem area percentage but low percentage for number of trees and stems. Sp. 1 make up about 5 % of the total tree biomass in the area according to all three estimations. A very low percentage is taken up by *F sycomorus,* especially counted by number of trees or stems. The difference between these estimations and the one done from the stem areas is great but this estimation also makes it only at small part of the forest in the area.

Figure 2 shows the distribution of the ten most abundant tree species in the area. Because of the low resolution some of the GPS points cover each other in the ArcGIS-map, which should be considered when interpreting the figure.

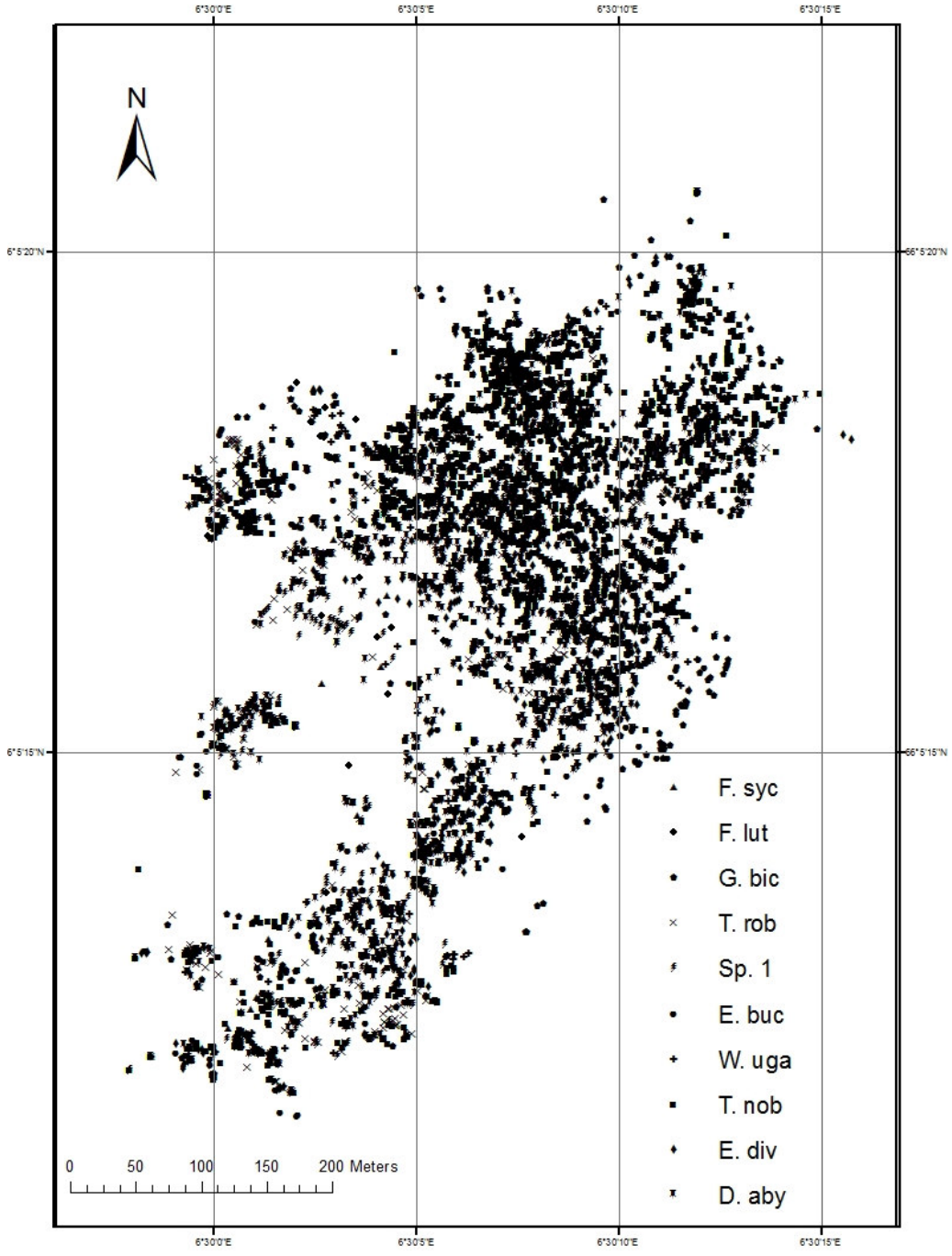


Figure 2. *Schematic map of the study area, the ten species mostly used by the blue monkeys have been visualised. The species shown are* Diaspyros abyssinica*,* Euclea divinorum, Teclea nobilis*,* Warburgia ugadensis, Elaeodendron buchananii, *unidentified Species 1,* Turraea robusta, Grewia bicolour, Ficus lutea *and* Ficus sycamorus.

3.2 Tree species used by the monkeys for foraging and positioning

Figure 3 shows the percentage of each tree species as well as how the monkeys' time of foraging and positioning is distributed between the different tree species respectively.

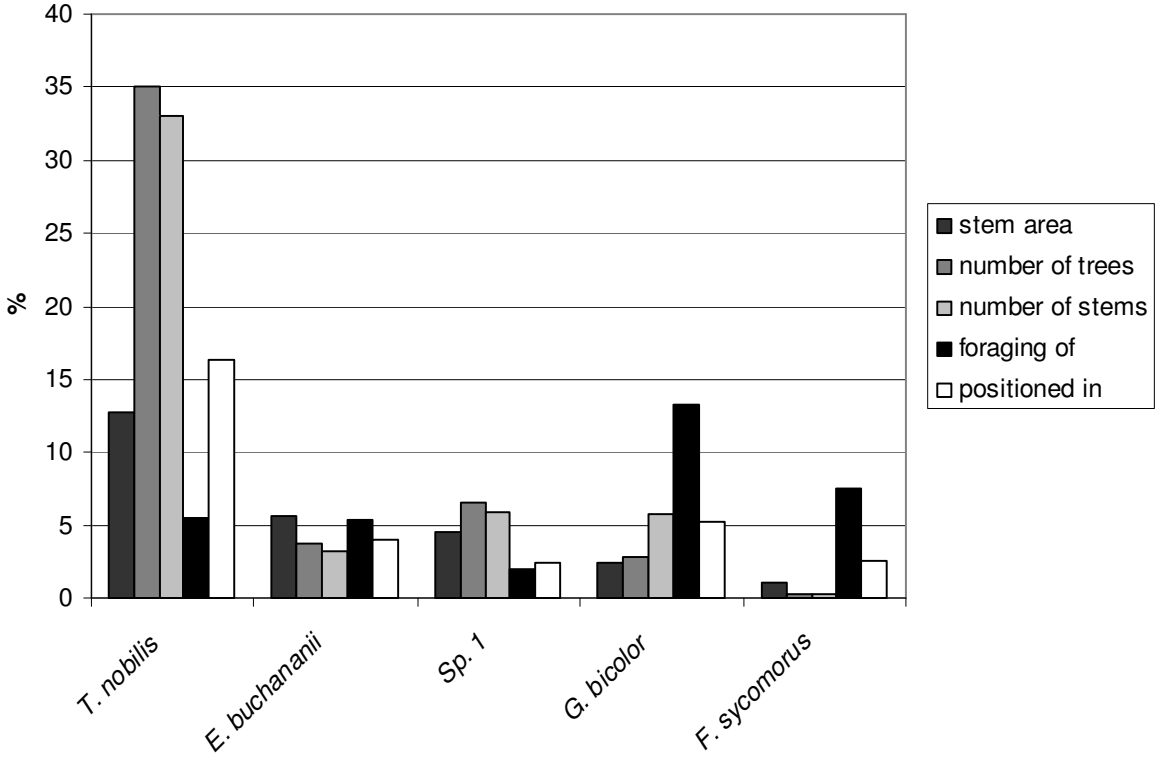


Figure 3. *Proportion of time spent by the monkeys on different tree species for foraging and being positioned in, compared with the data of the three biomass estimations.*

The order of the tree species in the graph is related to their relative area cover in the forest, with *T. nobilis* being the one with highest percentage in stem area and being listed first. The species that, with over 13 % of forging time, was the most used was *G. bicolor. F. sycomorus* was also foraged from in a high extent, especially considering the low frequency of that species, while Sp. 1 was used very limited for foraging. Although *T. nobilis* and *E. buchananii* were used in the same amount of time by foraging monkeys we need to take into consideration that the latter tree species was much less frequent in the area.

T. nobilis was the species mostly used by the monkeys for positioning. In more than 16 % of the events that a monkey was positioned in a tree it was in this species. The differences between the four other trees' occupancy frequencies were not large but *G. bicolor* was used for this purpose a little more than the rest, approximately 5 % of the time.

3.3 Trees used by the lactating and non-lactating females for foraging

A part of the study was to compare the behaviour of lactating females with the non-lactating females, to determine if they used different sources for food. Figure 4 shows the preferences of tree species for foraging for both monkey types.

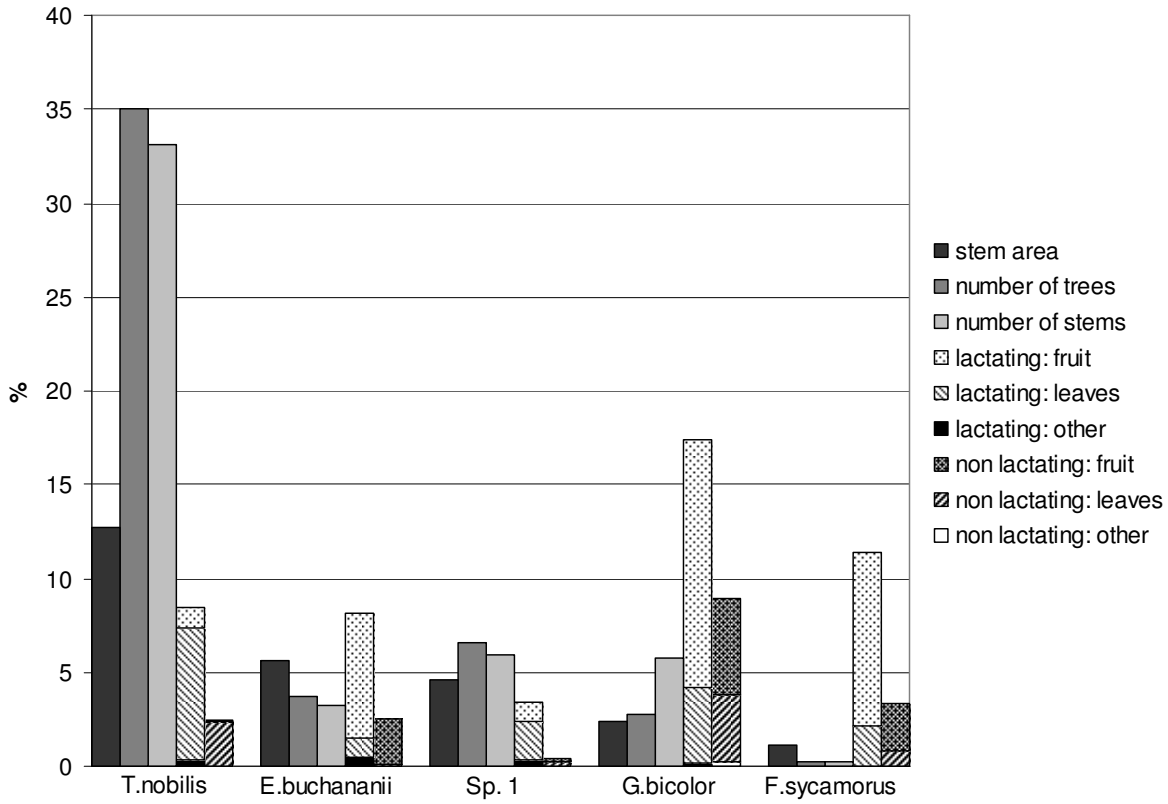


Figure 4. *Relative time spent foraging from the different tree species by lactating and non-lactating monkeys, compared with the data of the three biomass estimations. The foraging time is separated in time spent eating fruits, leaves or something else from the trees.*

Overall the group of lactating females used more of their tree foraging time on these five species than the non-lactating group did. The pattern between the different tree species is approximately the same for both groups but the lactating group had a more than doubled percentage for foraging of all tree species.

Both groups used *G. bicolor* the most, for the lactating group the percentage of time on this species was over 17 and they mostly ate the fruit. Compared with the frequency of *F. sycomorus*, the lactating group used it in a very high extent; especially by eating its fruits. Also the non-lactating group used it but only in approximately the same extent as they used *T. nobilis* and *E. buchananii.* These last two species were used a little less then 10 % each of the tree foraging time by the lactating group. From *T. nobilis* both groups ate the leaves most and from *E. buchananii* the fruits. They used Sp. 1 the least of these five tree species and the non-lactating group did almost not use this tree at all for foraging.

3.4 Tree species used by the lactating and non-lactating for positioning

Figure 5 also shows the preferences of lactating and non-lactating, but this time by looking at the time they spent positioned in each tree species.

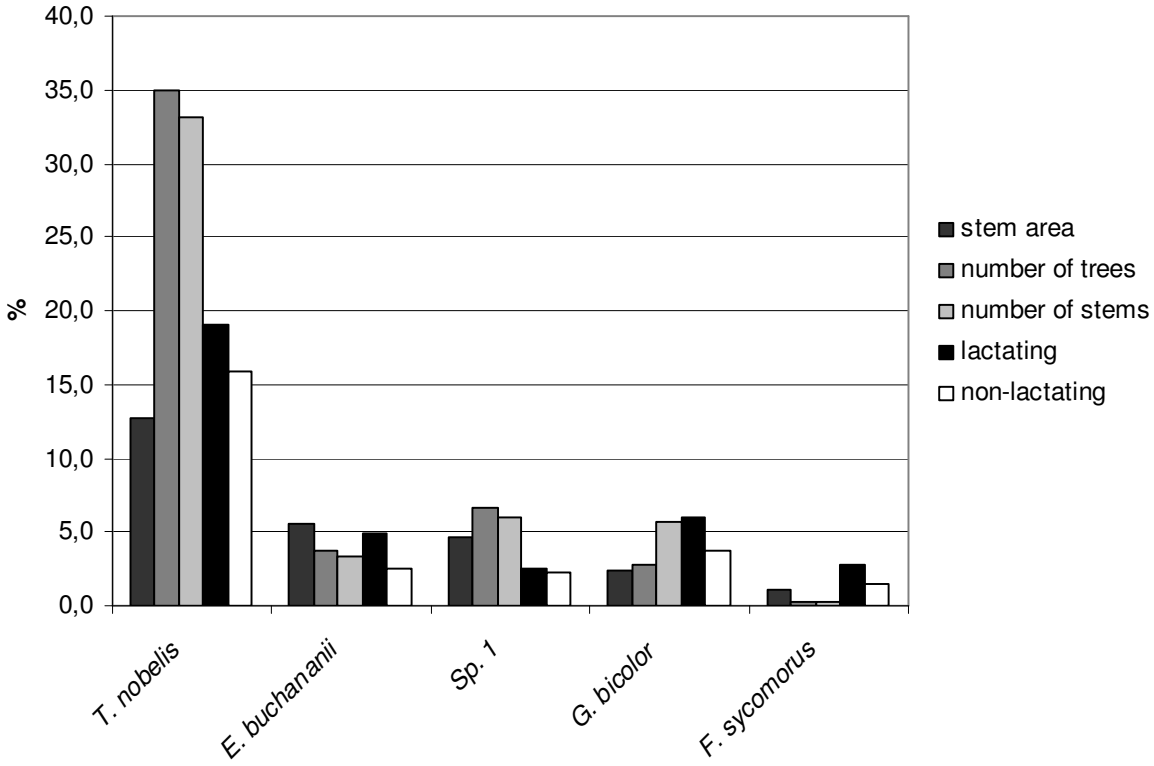


Figure 5. *Relative time spent positioned in the different tree species by lactating and non-lactating females, compared with the data of the three biomass estimations.*

The tree species mostly used for positioning by both groups was *T. nobilis*, the lactating using it the most (almost 20 % of their positioning time was in this species). The only tree species that was used at the same extent by the two groups was Sp. 1, about 2 % of the time. *E. buchananii* was used by lactating monkeys approximately to the trees abundance, by non-lactating slightly less. *G. bicolor* was preferred mostly by the lactating monkeys. The non-lactating on the other hand had a lower positioning percentage. Considering the low frequency of *F. sycomorus* in the area both groups used it a lot for positioning. However, it was still the least used species by both groups of blue monkeys, who used it a little less than 3 % of their time.

3.5 Relation between foraging time and tree species aboundance

Comparing the relative time monkeys spent eating off a tree species with the percentage of the total tree biomass in the area gives figure 6. The percentage on the y-axis gives the relation; a value over 100 means that the monkeys fed off the tree species for a longer time than they would if it was a linear relationship between the two parameters.

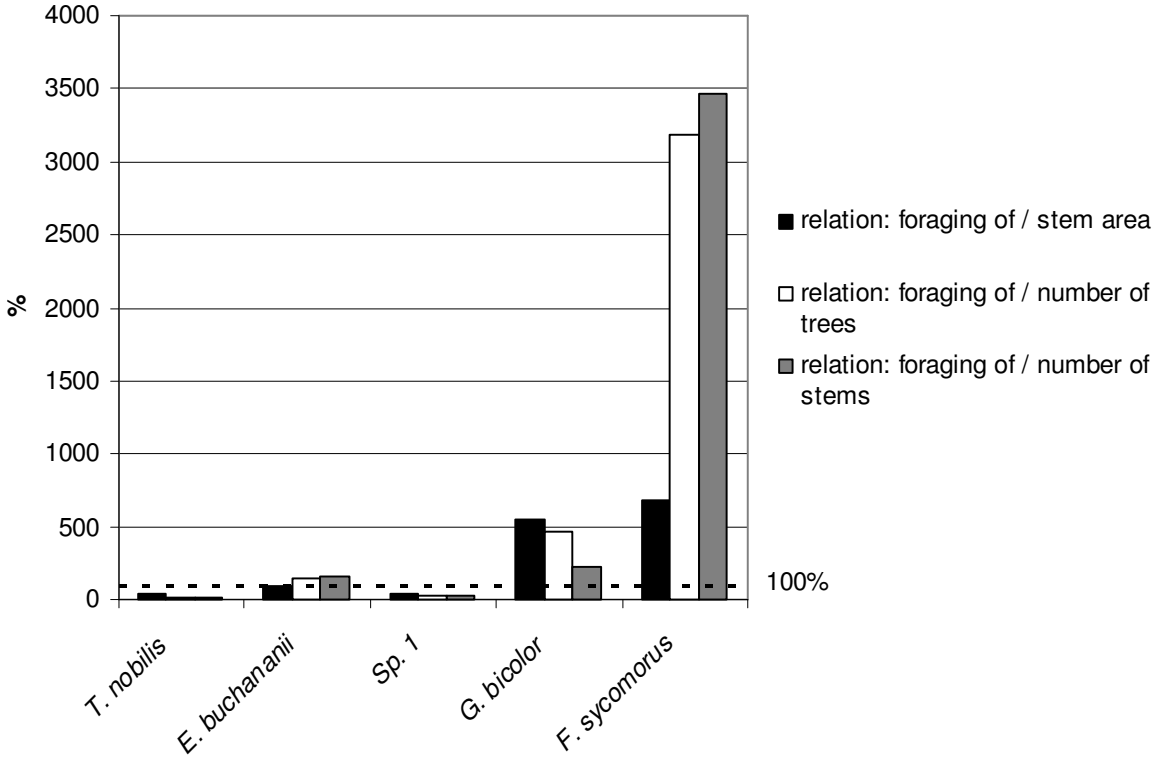


Figure 6. *The relation between the monkeys' utilization of trees for foraging and the tree species biomass, estimated in three different ways.*

The graph does not show a linear relation between the relative tree biomass and the time the monkeys spent foraging off a species, meaning that something else than only tree aboundance affect which tree species the blue monkeys forage off.

According to the biomass estimation from the specie's area cover of the stems' cross-section, *E. buchananii* was foraged off approximately in the same extent that would be expected. Looking at the number of stems and trees instead it was foraged off about 50 % more than would have been thought. *T. nobilis* was used for feeding less than expected, about half of the time expected from the stem area estimation and as low as 10 % of the time expected from the other measurements. Also Sp. 1 was used only 50 % of the time expected, considering all three estimations. Looking at the comparison between foraging and stem area, *G. bicolor* was used almost six times more than expected, the other two estimations also gave several times higher use. The species that seemed to have the highest divergence between abundance and foraging time was *F. sycomorus*, which was foraged off 30-35 times more than expected by the monkeys. These are however calculated when using number of trees or stems as indicators for biomass, stem area gives a more moderate result but still the highest divergence.

3.6 Relation between tree species abundance and time spent positioning

Figure 7 shows the quotient between the relative time the monkeys spent positioned in a tree species and its percental aboundance in the area.

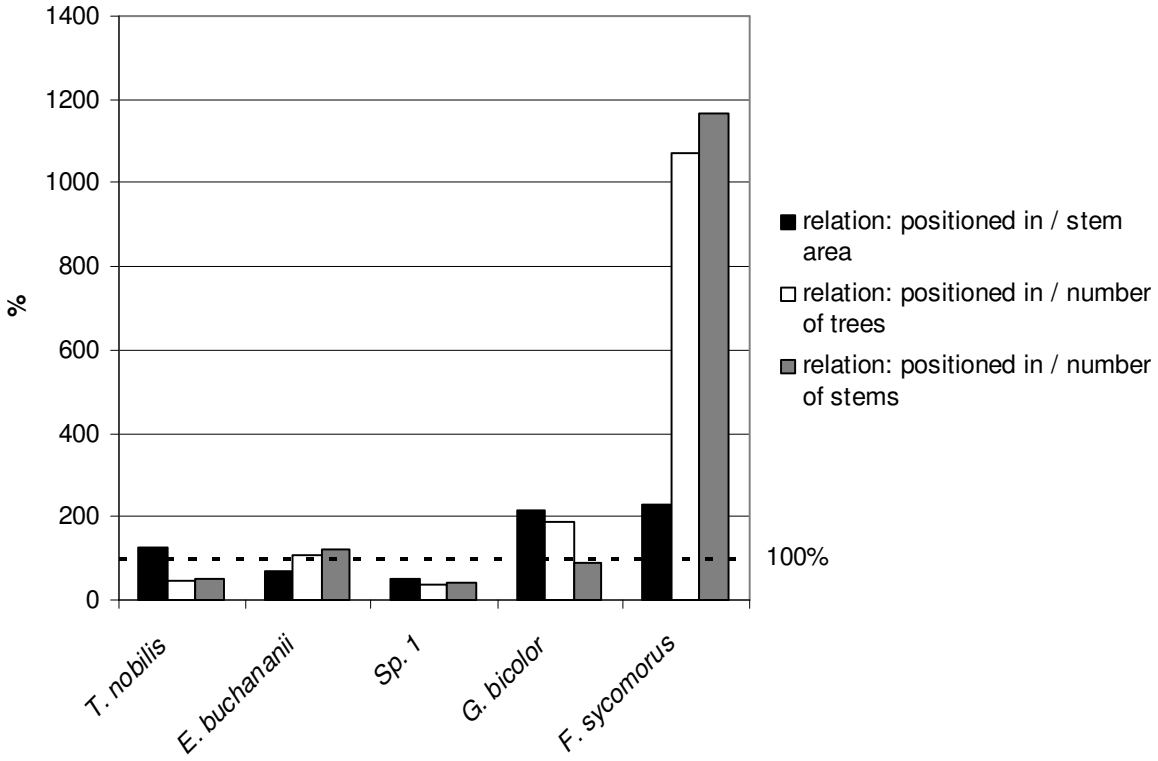


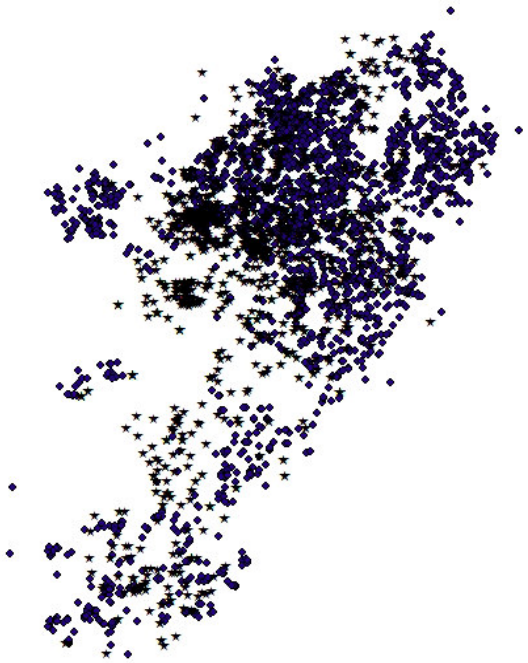
Figure 7. *The relation between the monkeys' utilization of trees for positioning and the species biomass, estimated in three different ways.*

Several of the staples in the graph show a relative close relationship between tree species aboundance and time that the monkeys spent positioned in them. The connection is at least closer than with the time that they used them for foraging. The graph does not show a linear relationship however, and some of the species differ markedly from the 1:1 relation.

In approxematly the same extent of time that would have been estimated from the number of the species *E. buchananii,* it was used for positioning. Compared with its stem area the monkeys used it a little less and with its number of stems a little more than expected. *T. nobilis* was used a few percent more than expected, using the stem area estimation; while it was used only half of the time expected using the number of trees or stems to estimate the biomass. The relation between positioning time and biomass of Sp. 1 was about the same with all three ways of estimation; the monkeys used it about half of the expected amount of time. About twice as much as would be expected from a 1:1 relationship was the relative time monkeys spent positioned in *G. bicolor*, calculated by the biomass estimations from stem area or number of trees. Using the estimation from number of stems instead it was used for positioning in the amount of time expected. Looking at the staple representing the relationship between stem area and relative time used for positioning on *F. sycomorus*, they used it twice as much as expected. The monkeys used the species more then ten times as much as expected estimated from number of trees or stems.

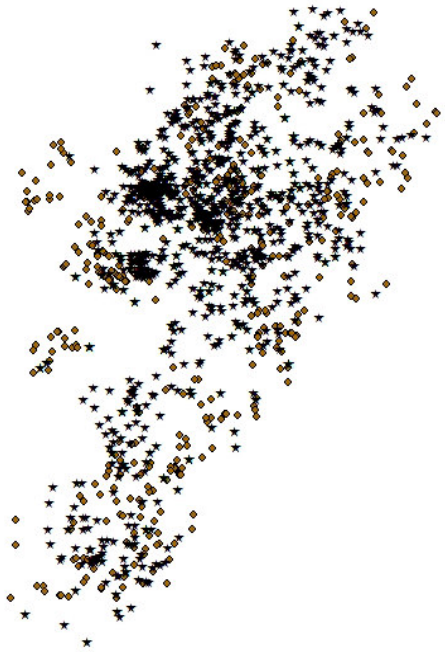
3.7 Tree species distribution compared with monkeys movement pattern

To visualize a correlation between the blue monkeys' movements and the abundance of a particular tree species; each of the five species are shown in a separate map together with the monkeys' movement pattern from July 2006 (Figure 8).

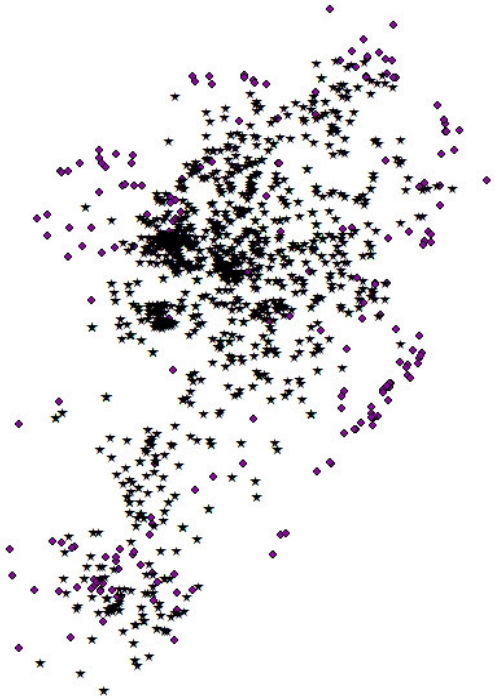


Teclea nobilis

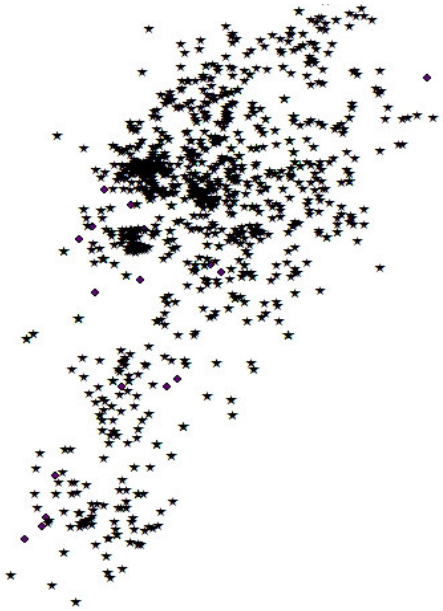
Eleadendron buchananii



Species 1



Grewia bicolor



Ficus sycamores

Figure 8. *The distribution of* Teclea nobilis*,* Elaeodendron buchananii*, Species 1,* Grewia bicolor *and* Ficus sycamorus*. Each compared with the distribution of the blue monkeys, shown as stars. Scale and latitude of the forest is shown in figure 2.*

4 Discussion

4.1 Popularity of the species and why

The hypothesis tested in this study was, that there would be a difference in the ratio between the abundance and the amount of time the tree species would be used (for foraging and positioning). Our results show that this was true for *Ficus sycomorus* and *Grewia bicolor*, which were used for foraging more than they occurred. It was also true for *Teclea nobilis* and Sp. 1 that were used less for foraging than would be expected from their occurrence. The hypothesis is also true for *F. sycomorus* considering its usage for positioning in, for the other four species it is not possible to draw certain conclusions about positioning. The difference between tree abundance and foraging frequency was in several species larger than the difference with positioning frequency. However, even for positioning they preferred some species more than others.

F. sycomorus was the most popular species, especially among the lactating monkeys. There were relatively few individuals of this tree species in the area; some but not all grew near human activities, its usability can therefore not be explained by its position in the landscape. It was to a great extent used for positioning but especially for foraging. If we look at the relationship between the numbers of trees or stems it was used for foraging 30 times more than expected and for being positioned on about ten times more than expected. *F. sycomorus* is a huge tree, often around 30 m in height with an even greater crown spread (Wahungu, 2001) and a trunk diameter of 2 m (Dharani, 2002). Therefore is the relation not as extreme for the stem area estimations, but it is still larger than for the other species. An explanation to why this species were foraged off in such a high extent is that it bore fruit; these are very popular among frugivores, probably because they contain high levels of sugar. (Internet, Flora Zambesiaca (4), 2004) Additionally, the trees develop ripe fruits throughout the year meaning that there is a high possible access. Some studies have stated that figs from different ficus species contribute to more than 75 % of the diet for frugivores in the tropics. As a dry season staple food for many animals, ficus has a very important role in the forest ecosystems (Tweheyo & Obua, 2001). A contributing reason to why this species is preferred could be of its height and widespread crown, giving the monkeys good shelter from predators. It has been shown that arboreal monkeys are safer when positioned within the canopy than at terminal branches (Treves, 2000).

The species that was foraged off in the highest amount of time was *G. bicolor,* which was chosen in 13 % of the foraging events. Compared with the estimation from the stem area biomass it was foraged off about five times more than would be expected. It was also used quite a lot for being positioned in but compared with the number of trees or the stem area it was only used twice as much as expected. Since the species most often grows as a low tree or bush, seldom above 3 m, one could believe that it would have been used even less for positioning. Quite reasonably it can be assumed that they stayed in it more often because they wanted to forage off it. According to Kabasa et al. (2004), *G. bicolor* has a very high mineral content (10.17 % silica free ash) and this could be one explanation to why the monkeys feed from this species. Since that study was done with browsing species for goats, it is possible that the content is only true for the leaves; therefore it can only be used to explain the level of leaf consumption of *G. bicolor* among the blue monkeys. *G. bicolor* seem to have the highest distribution along the boarders of the area. As stated earlier blue monkeys prefer to stay in more centre parts of the forest because of the higher predatory risk when exposed at the boarders. That they still use this species at a very high extent in

this forest could either show that it is a highly favourable tree species, or that the predation risk is so low in this area that they do not need to take protection in the middle of the forest.

Teclea nobilis was used for positioning in a very high extent. It is a rather small tree that occurred at many places and with many but small stems. Hence, the stem area estimation gave much lower biomass estimation than the other two parameters; number of trees and stems. Because of the species being widely spread in the area the chance of the monkeys using it only for passing, is high. This gives the tree species a high representation in the observations data of positioning. However, it was not used in a high extent for foraging. When foraged from it was mainly the leaves that were eaten and fruits contributed only to a very small part. One reason to why the monkeys did not eat the fruits much could be that they prefer juicy or fleshy fruits (Kaplin et al., 1998), *T. nobilis* produce fruits that are only 5-6 mm long (Internet, Flora Zambesiaca (1), 2004) and quite dry. This makes these fruits less attractive compared to fruits of other species present in the area. When the total fruit abundance is lower during other periods of the year, the blue monkeys might switch to a diet composed of more leaves (Pazol & Cords, 2005). This would then probably make *T. nobilis* more important as a foraging species.

A general observation is that the trees from which the monkeys mainly ate fruits were preferred in a higher extent than the ones that they ate leaves from. *T. nobilis* and Species 1 were the only tree species from which the monkeys mostly ate leaves. Fruits are often considered to be preferred for their rich carbohydrate levels, whereas leaves generally have a higher protein level (Conklin-Brittain et al., 1998). A common theory is also that the macronutrient combination in the diet is more important than the amount of any particular nutrient (Conklin-Brittain et al., 1998). Considering this the preferences for the different food items can simply be a product of the monkeys' strive for a mixed diet with an as high nutritional level as possible.

4.2 Differences between lactating and non-lactating females' preferences

Our hypothesis was that lactating and non lactating females would show different preferences. The result support this hypothesis, especially when looking at foraging preferences. All five tree species considered were used in a higher extent by the lactating monkeys than by the non-lactating. However, this is not true if you look at all the trees in the area (see Kempe, in preparation). The lactating monkeys' preference for these five species could be because the monkeys need more of some nutrients when they are lactating. In previous studies (Cords, 1986) pregnant females increased the intake of insects and leaves. This was also true for the females during the five months after delivery when the offspring is depending on the milk from the mother (Cords, 1986). The lactating and non-lactating monkeys in our study still showed similar patterns regarding which species and what parts of these species they preferred. The only of my tree species that was not used in a similar matter by the both groups was *G. bicolor*. Both groups used it in the same extent for feeding of leaves, but the lactating group fed of its fruits in a much higher extent of time than they fed of its leaves; and than the non-lactating group did.

4.3 Reflections

To be able to draw correct conclusions of why the monkeys feed of specific tree species more than others an analysis of the nutrient content of their different parts needs to be done. Since there is very little literature about my focal tree species available, it remains largely

uncertain why the monkeys chose specific food items. It is likely that the nutritional level in the different parts of the species determines the forage pattern, but exactly why a certain part is preferable we do not know. We can not either predict if the patterns we see are maintained throughout each year, because the nutrition levels of both leaves and fruits vary depending on their stage of development. Nutritional components vary among locations, species and time of day (Worman & Chapman, 2005). The study of the monkeys' food choice and movement pattern has only been done once. For statistic relevant data the study requires to be done several times, preferably in different times of the year since many trees flower and bear fruit in specific seasons. The high flexibility of the diet in blue monkeys also makes it hard to draw any conclusions about groups in other habitats (Tashiro, 2005), therefore comparisons with studies in other areas are needed.

I got slightly different results with the different estimations of the trees' biomass. Probably the stem area is the estimator that gives the most correct result of each species' contribution to the forest's total biomass. However, the other two estimations give us important supplementary information. A relation based on the information from the number of trees contrary the number of stems can give different results. A tree with a much higher frequency counted by number of trees than by number of stems is often relatively small. The monkeys are then less likely to use them when moving, since they grow too low and are too unstable. Species that are not as frequently growing but have many stems each, are more likely to be used by moving monkeys. Their leafage often covers a greater area and they are high growing and robust. Several studies have shown that many arboreal monkeys prefer this type of trees and blue monkeys especially prefer the high strata of the canopy (Wahungu, 2001; Tashiro 2003).
Other studies of blue monkeys have shown that each group uses a relatively small amount of plant species for their main diet (Kaplin et al. 1998; Fairgrieve & Muhumaza, 2003). This would make them vulnerable to changes in the composition of the forest and is one reason to why it is important to preserve forests as they are. A recent study has suggested that one major reason for the decline of *C. mitis* populations in a national park in Uganda is the decrease in abundance, richness and diversity of tree species (Teelen, 2007). The blue monkey prefers mature forests and it has been shown that logging affects their choice of food items, in some extent to a less nutritionally rewarding diet (Fairgrieve & Muhumuza, 2003). This suggested tendency makes the maintenance of relatively undisturbed forests an important issue. Looking at the Sabaringo forest this means making efforts of keeping the plant species that the blue monkeys use most in this area. If we would just look at the stem area it would seem as if *G. bicolor* and *F. sycomorus* are similar in importance for the monkeys, but if only a few trees from the later species would disappear there would hardly be any *F. sycomorus* trees left and this could affect the monkeys greatly. In the area there grows many more individuals of *G. bicolor,* making them a little less important to protect from the monkeys point of view. Bearing in mind that *F. sycamorus* can provide the monkeys with ripe fruits all year round and that they probably also are important for shelter and as sleeping sites (Wahungu, 2001; Tweheyo & Obua, 2001) makes them even more worth of consideration in conservatory strategies.

5 Conclusion

The clearest result of this study is that the blue monkeys actually do choose which species of trees to feed off and they seem to prefer some tree species over others for positioning as well. More studies need to be done during different times of the year to give more correct results and to confirm them statistically. Additionally, analyses of the nutrient content of the different parts of the tree species needs to be done to draw conclusions about why the monkeys choose as they do.

The result from the study is that *Ficus sycamorus* and *Grewia bicolor* are favoured by the blue monkeys when feeding. They forage from these two tree species in a considerably higher extent than expected from the proportion that the trees make up of the total tree population in the Sabaringo forest. If conservatory work, to maintain the monkey population, is needed in the future these two species are the ones to focus on. *Teclea nobilis* is the tree species that has the highest number of individuals in the area. Compared to the tree species biomass the blue monkeys are positioned in it more than expected, it can therefore be considered important to maintain as well.

Acknowledgments

I would like to thank Ann-Charlotte Hansson, Emilie Linderoth and Jenny Nilsson for letting me use their behaviour data of the blue monkeys, the latter also for helping with the collection of tree abundance data. I am also grateful to my supervisor during this project, Jens Jung, for all the help during the fieldwork and during the writing of this thesis. Without the help and knowledge of the Maasai field workers my part of the study could not have been done, thank you James, Anthony, Josef, Daniel, Senanga and Jonathan. I would also like to thank Nichlas Ahlm from the Swedish Forest Agency for help and support when setting up the experimental design and for lending us equipment and helping construct the ArcGis maps. Thank you, Vendela Kempe, for a very good collaboration during the fieldwork and for the support when writing this thesis. Finally I would like to express my thanks to the management on Kichwa Tembo Tented Camp for being so helpful and letting us use their surrounding forest for our project.

References

Literature and publications

Anapol, F., Turner, T.R., Mott, C.S. & Jolly, C.J., 2004. Comparative Postcranial Body Shape and Locomotion in Chlorocebus aethiops and Cercopithecus mitis., *American Journal of Physical Anthropology*, 127(2): pp. 231-239, Jun 2005 (ISSN: 0002-9483)

Butchart, D., 1997. *Kichwa Tembo tented camp EcoGuide*

Conklin-Brittain, N. L., Wrangham, R.W. & Hunt, K.D., 1998. Dietary Response of Chimpanzees and Cercopithecines to Seasonal Variation in Fruit Abundance. II. Macronutrients, *International Journal of Primatology,* 19(6): pp. 971-998 ("Seasonality in the Great Apes") 1998, (ISSN: 0164-0291)

Cordeiro, N. J., Patrick, D. A.G., Munisi, B. & Gupta, V., 2004. Role of dispersal in the invasion of an exotic tree in an East African submontane forest., *Journal of Tropical Ecology*, 20(Part 4): pp. 449-457, July 2004 (ISSN: 0266-4674)

Cordeiro, N.J., 2003. Two unsuccessful attacks by crowned eagles (Stephanoaetus coronatus) on white-throated monkeys (Cercopithecus mitis), *African Journal of Ecology*, 41(2): pp. 190-191, June 2003 (ISSN: 0141-6707)

Cords, M., 1986. Interspecific and intraspecific variation in diet of two forest guenons, Cercopithecus ascanius and C. mitis, *Journal of Animal Ecology*, 55(3): pp. 811-827, 1986

Dharani, N., 2002. *Field guide to common trees & shrubs of East Africa*, Struik Publishers, South Africa (ISBN 1 86872 640 1)

Fairgrieve, C. & Muhumuza, G., 2003. Feeding ecology and dietary differences between blue monkey (Cercopithecus mitis stuhlmanni Matschie) groups in logged and unlogged forest, Budongo Forest Reserve, Uganda., *African Journal of Ecology*, 41(2): pp. 141-149, June 2003 (ISSN: 0141-6707)

Hansson, A.C., (in preparation), Foraging Ecology of Lactating and Non-Lactating Blue Monkeys (*Cercopithecus mitis stuhlmanni*), Degree thesis, Swedish University of Agricultural Science (SLU)

Ingman, E., (in preparation), Human impact on food choice and diurnal behaviour in blue monkeys (*Cercopithecus mitis stuhlmanni*), Degree thesis, Swedish University of Agricultural Science (SLU)

Kabasa, J. D., Opuda-asibo, J., Thinggaard, G. & Ter Meulen, U., 2004. The mineral scoring technique and evaluation of indigenous browse species as natural mineral phytocentres for goats in African rangelands., *Tropical Animal Health and Production*, 36(4): pp. 365-80

Kaplin, B. A., 2001. Ranging behavior of two species of guenons (Cercopithecus lhoesti and C. mitis doggetti) in the Nyungwe Forest Reserve, Rwanda., *International Journal of Primatology*, 22(4): pp. 521-548, 2001 (ISSN: 0164-0291)

Kaplin, B.A., Munyaligoga, V. & Moermond, T. C., 1998. The influence of temporal changes infruit availability on diet composition and seed handling in blue monkeys (Cercopithecus mitis doggetti), *Biotropica*, 30(1): pp. 56-71, 1998 (ISSN: 0006-3606)

Kempe, V., (in press) Blue monkeys' utilization of five tree species in relation to the abundance of each tree species: *Diaspyros abyssinica*, *Euclea divinorum*, *Warburgia ugadensis, Turraea robust* and *Ficus lutea,* Degree thesis, Swedish University of Agricultural Science (SLU)

Lambert, J. E., 2001. Red-tailed guenons (Cercopithecus ascanius) and Strychnos mitis: evidence for plant benefits beyond seed dispersal. *International Journal of Primatology*, 22(2):189-201, 2001 (ISSN: 0164-0291)

Macdonald, D.W., Forbes, P., MacKeith B., 1984. *World of Animals: Primates*, Otava Keuruu, Finland (ISBN 91-34-50350-1)

Marshall, A. R., Topp-Jorgensen, J. E., Brink, H. & Fanning, E., 2005. Monkey abundance and social structure in two high-elevation forest reserves in the Udzungwa Mountains of Tanzania., *International Journal of Primatology*, 26(1): pp.127-145, February 2005 (ISSN: 0164-0291)

Nilsson, J., 2007, Mother-young interactions and suckling behaviour in blue monkeys, *Cercopithecus mitis stuhlmanni*, Degree thesis, Swedish University of Agricultural Science (SLU)

Pazol, K. & Cords, M., 2005. Seasonal variation in feeding behavior, competition and female social relationships in a forest dwelling guenon, the blue monkey (Cercopithecus mitis stuhlmanni), in the Kakamega Forest, Kenya., *Behavioral Ecology and Sociobiology*, 58(6): pp. 566-577, October 2005 (ISSN: 0340-5443)

Pazol, K., 2003. Mating in the Kakamega Forest blue monkeys (Cercopithecus mitis): does female sexual behavior function to manipulate paternity assessment?, *Behaviour*, 140(4): pp. 473-499, April 2003 (ISSN: 0005-7959)

Stuart, C. & Stuart, T., 1997. *Field guide to the larger mammals of Africa*, Struik Publishers, Cape Town (ISBN 1 86825 757 6)

Tashiro, Y., 2005. Frequent insectivory by two guenons (Cercopithecus Ihoesti and Cercopithecus mitis) in the Kalinzu Forest, Uganda., *Primates*, 2006:47(2): pp. 170-173, April 2006 (ISSN: 0032-8332)

Teelen, S., 2007. Primate Abundance Along Five Transect Lines at Ngogo, Kibale National Park, Uganda, *American Journal of Primatology*, 69(9): pp. 1030-1044, Sep 2007 (ISSN: 0275-2565)

Treves, A., 2000. Theory and method in studies of vigilance and aggregation., *Animal Behaviour*, 60(6): pp. 711-722, 2000 (ISSN: 0003-3472)

Tweheyo, M., Obua, J., 2001. Feeding habits of chimpanzees (Pan troglodytes), red-tail monkeys (Cercopithecus ascanius schmidti) and blue monkeys (Cercopithecus mitis stuhlmanii) on figs in Budongo Forest Reserve, Uganda. *African Journal of Ecology*, 2001, Vol. 39, Issue 2, 133-139 (ISSN: 0141-6707)

Valste, J., 1998. *Djur I världens natur: Däggdjur 1*, WS Bookwell, Finland 2000 (ISBN 91-73632-0-6)

Wahungu G. M., 2001. Common use of sleeping sites by two primate species in Tana River, Kenya, *African Journal of Ecology*, 2001:39 pp.18-23

Worman, C. O'D. & Chapman, C. A., 2005. Seasonal variation in the quality of a tropical ripe fruit and the response of three frugivores. *Journal of Tropical Ecology,* 21(6): pp. 689-697, November 2005 (ISSN: 0266-4674)

Internet sites

Animal Diversity Web, http://animaldiversity.ummz.umich.edu/site/index.html

1. Cercopithecus mitis*, by Strawder N. 2001, 2007-08-28,* http://animaldiversity.ummz.umich.edu/site/accounts/information/Cercopithecus_mitis.html

Flora of Zimbabwe, http://www.zimbabweflora.co.zw

1. *Teclea nobilis*, 2007-01-09, http://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=133180

Flora Zambesiaca, http://apps.kew.org/efloras/search.do?reset=true

1. *Teclea nobilis*, 2007-01-12, http://www.kew.org.uk/efloras/namedetail.do?qry=namelist&flora=fz&taxon=1275&nameid=3050
2. *Eleadendron buchananii*, 2007-01-08, http://www.kew.org.uk/efloras/namedetail.do;jsessionid=76652C29237FD0E162B079CEC61CCA4A?flora=fz&qry=key&taxon=1535&keyid=405
3. *Grewia bicolor*, 2007-01-12, http://www.kew.org.uk/efloras/namedetail.do?qry=namelist&flora=fz&taxon=1015&nameid=2495
4. *Ficus sycomorus*, 2007-01-09, http://www.kew.org.uk/efloras/namedetail.do?qry=namelist&flora=fz&taxon=56&nameid=239

IUCN (International union for conservation of nature and natural resorses), www.iucnredlist.org

1. Red list of threatened species: *Cercopithecus mitis*, 2007-09-09, http://www.iucnredlist.org/search/search.php?freetext=blue+monkey&modifier=phrase&criteria=wholedb&taxa_species=1&redlistCategory%5B%5D=all&country%5B%5D=all&cty_default=1&aquatic%5B%5D=all&aqu_default=1&regions%5B%5D=all&reg_default=1&habitats%5B%5D=all&threats%5B%5D=all&redlistAssessyear%5B%5D=all&growths%5B%5D=all
2. Red list of threatened species: *Cercopithecus mitis stuhlmanni*, 2007-09-10 http://www.iucnredlist.org/search/details.php/39991/all