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De viktigaste födoträden för den angolanska svartvita colobusapan (Colobus angolensis palliatus) i Diani Forest, Kenya

Camilla Jansson

Etologi och djurskyddsprogrammet

Photo: Maria André

Sveriges lantbruksuniversitet
Institutionen för husdjurens miljö och hälsa
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Camilla Jansson

Studentarbete 365, Skara 2011

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Handledare: Jens Jung, Institutionen för husdjurens miljö och hälsa, SLU, Box 234, 532 23 Skara
Examinator: Carina Palmgren-Karlsson, Institutionen för husdjurens miljö och hälsa, SLU, Box 234, 532 23 Skara

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Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Avdelningen för etologi och djurskydd
Box 234, 532 23 SKARA
E-post: hmh@slu.se, **Hemsida:** www.hmh.slu.se

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SUMMARY

The Angola black-and-white colobus (*Colobus angolensis palliatus*) is a subspecies of *Colobus angolensis* inhabiting fragmented forests in coastal Kenya and Tanzania. *C. angolensis* is regarded as Least Concern in the red list of IUCN because its populations are abundant. However, the populations of *C. a. palliatus* are relatively isolated from each other and their habitats are constantly undergoing deforestation which makes this subspecies vulnerable to extinction. In 2001, the estimated number of Angola black-and-white colobus in Kenya was 3100 to 5000 individuals confined to the forests of the Kwale District. The Diani Forest is an unprotected forest in the district and has been highlighted as a key habitat for future Angola black-and-white colobus conservation. There are few observations on *C. a. palliatus* and to conserve this subspecies more information is needed.

The aim of this study was to investigate which tree species that the Angola black-and-white colobus forages from in the Diani Forest. Observations were carried out on four troops during eight days between 25th of March and 2nd of April 2011. The recording method being used was instantaneous sampling with an interval of one minute. In each study session, two focal animals were observed and registrations were made on the monkey´s behaviour and position as well as utilized tree species. When the monkey was feeding, the food tree species and the food item were also recorded.

In total, the Angola black-and-white colobus foraged from 42 tree species in the observed sites of the Diani Forest. The major food trees were *Adansonia digitata, Adenanthera pavonina, Bougainville spectabilis, Delonix regia, Hunteria zeylanica, Lecaniodiscus fraxinifolius, Lannae welwitschii, Pithecellobium dulce, Trichilia emetica,* and *Zanthoxylum chalybeum*. The subspecies ate a high proportion of mature leaves (35.4 %) followed by flowers (27.6 %), young leaves (21.1 %), fruits (9.5 %), unidentified leaves (4.1 %) and other food items (2.3 %).

The results from this study show that the Angola black-and-white colobus is primarily folivorous since more than 50 % of its diet is composed of leaves. However, previous studies have shown that the dietary composition of Colobines varies between habitats, seasons and years and it is therefore difficult to draw any conclusions from this minor study. Future observations on the feeding ecology of *Colobus angolensis palliatus* should be performed on more troops of monkeys in different forest habitats during long time periods to achieve more accurate information on monkey diets and thereby better conserve the subspecies and its habitats in Diani Forest. In addition, the nutritional quality of consumed plant parts should be examined. The results of this study are based on few observations during a short time period and should therefore be interpreted cautiously.

SAMMANFATTNING

Den angolanska svartvita colobusapan (*Colobus angolensis palliatus*) är en underart till *Colobus angolensis* och lever i fragmenterade skogar längs Kenyas och Tanzanias kuster. *C. angolensis* är klassad som Livskraftig på IUCN:s rödlista eftersom populationerna är stora. Populationer av *C. a. palliatus* är dock isolerade från varandra och habitaten skövlas ständigt vilket gör underarten sårbar. År 2001 var antalet angolanska svartvita colobusapor i Kenya mellan 3100 och 5000 individer vilka lever i skogarna i Kwale District. Diani Forest är en oskyddad skog i distriktet och anses vara ett nyckelhabitat för framtida bevarandeinsatser för underarten. Det finns dock bara ett fåtal studier på *C. a. palliatus* och för att kunna bevara denna underart behövs mer information.

Syftet med denna studie var att undersöka vilka trädarter som äts av den angolanska svartvita colobusapan i Diani Forest. Observationer utfördes på fyra trupper under åtta dagar mellan den 25:e mars och 2:a april 2011. Den registreringsmetod som användes var momentanregistrering med ett intervall på en minut. I varje observationspass studerades två fokaldjur och registreringar utfördes på apornas beteende, position och vilken trädart som användes. När aporna åt registrerades även födoträd och äten växtdel.

Aporna åt från totalt 42 trädarter i det studerade området av Diani Forest. De tio viktigaste födoträden var *Adansonia digitata, Adenanthera pavonina, Bougainville spectabilis, Delonix regia, Hunteria zeylanica, Lecaniodiscus fraxinifolius, Lannae welwitschii, Pithecellobium dulce, Trichilia emetica* och *Zanthoxylum chalybeum.* Aporna åt en hög andel mogna blad (35.4 %) följt av blommor (27.6 %), unga blad (21.1 %), frukt (9.5 %), oidentifierade blad (4.1 %) och andra växtdelar (2.3 %).

Min studie visar att den angolanska svartvita colobusapan huvudsakligen är en bladätare eftersom mer än 50 procent av dieten utgörs av blad. Tidigare studier har dock visat att dieten hos colobusapor varierar mellan habitat, årstid och år och det är därför svårt att dra några slutsatser från denna enkla studie. Framtida observationer på födobeteende hos *C. a. palliatus* bör genomföras på flera trupper i olika skogshabitat under långa tidsperioder för att få fram mer tillförlitlig information om apans diet och därmed på ett bättre sätt kunna bevara underarten och dess habitat i Diani Forest. Därtill bör näringsinnehållet i ätna växtdelar undersökas. Resultatet från denna studie är baserat på ett fåtal observationer under en kort tidsperiod och bör därför beaktas med försiktighet.

1. INTRODUCTION

1.1. Background

The Angola black-and-white colobus (*Colobus angolensis palliatus*) is a subspecies of *Colobus angolensis* which lives in ranges from Angola to Kenya (McDonald & Hamilton, 2010). Before 1900, the Angola black-and-white colobus was found in a continuous vegetation mosaic of unique forest, thicket, woodland, bushland, and grassland, which extended from the Kenya-Somalia border to the Tanzania-Mozambique border (Anderson et al., 2007b; Clarke, 2000). The growing human population in parts of this region led to an increase in deforestation and hunting pressure, which reduced colobus populations and habitats (Anderson et al., 2007b). Today, the subspecies is confined to fragmented forests in coastal Kenya and Tanzania (Rodgers, 1981; Kanga & Heidi, 2000; Anderson et al., 2007b). *Colobus angolensis* is considered as Least Concern in the red list of the International Union for Conservation of Nature (IUCN; Kingdon et al., 2008) since its populations are abundant. However, the populations of *Colobus angolensis palliatus* are relatively isolated from each other and according to McDonald and Hamilton (2010) there is a large genetic diversity both within Kenyan populations and between Kenyan and Tanzanian populations. This pattern of isolated populations in combination with ongoing deforestation makes the subspecies vulnerable to extinction (Anderson et al., 2007a).

In 2001, the estimated number of Angola black-and-white colobus in Kenya was 3100 to 5000 individuals (Anderson et al., 2007b). These individuals represent a total of 55 populations (Anderson et al., 2007b) restricted to the southern coastal forests of the Kwale District (Anderson et al., 2007a). The largest population was found in the Shimba Hills National Reserve which also protects the largest proportion of remnant coastal forest within the district. Forest reserves protect another six of the ten largest colobus populations outside the National Reserve, but the number of individuals in these reserves is smaller than those individuals (17 % of the Kenyan *Colobus angolensis palliatus* population) inhabiting the more than 3000 ha of unprotected coastal forest. The Diani and Shimoni Forests are two unprotected forests that provide habitats for two of the largest colobus populations. These forests are considered as key habitats for future Angola black-and-white colobus conservation (Anderson et al., 2007b).

1.2. The Angola black-and-white colobus

1.2.1. Morphology

The Angola black-and-white colobus is an old world monkey of the genus Colobus. It is a medium-sized black-coloured monkey with white hairs on the cheek and throat, a white brow band, long-haired white epaulettes on the shoulders and white hairs on the tail (Groves, 2007). Like other old world monkeys, the Angola black-and-white colobus has longer hind legs than fore legs, pads on its buttock, and flattened nails (The Colobus Trust, 2011). Males are slightly larger than females (Thompson, 2002) and have a white band on the buttock whereas females have a white patch (Groves, 2007). The Angola black-and-white colobus is highly arboreal (Anderson et al., 2007a; Anderson et al., 2007c) and with its reduced thumbs it ñhooks onò to tree branches (Groves, 2007).

1.2.2. Social behaviour and organization

The Angola black-and-white colobus is active during the day (Anderson et al., 2007a). In the Kwale District, the monkey lives in troops of two to thirteen individuals with a mean group size of six individuals (Kanga & Heidi, 2000; Anderson et al., 2007a). The small troops of *Colobus angolensis* species are often comprised of one adult male and two to six adult females with their young. Larger troops generally have more than one resident male. The troops defend a relatively small core home range from other troops of colobus monkeys. The dominant male controls reproductive access to the females within his troop and defends the troop from predators whereas the dominant female leads the troop. Males reach sexual maturity at an age of four years and females at an age of two years. The colobus monkeys reproduce throughout the year and a single offspring is born but twins are also possible. The young are cared for by their mothers and other members of the troop and are weaned at an age of about 15 months (Thompson, 2002).

1.2.3. Feeding behaviour, digestive tract and habitat

The Angola black-and-white colobus is primarily folivorous (Anderson et al., 2007b), however there are little dietary data on *Colobus angolensis* species (Lowe & Sturrock, 1998). Colobines generally prefer to consume foliage rich in protein and poor in fibre (Fashing et al., 2007a) and therefore select young leaves prior to mature leaves (Maisels et al., 1994).

Despite their tendency to select more easily fermentable foliage (Maisels et al., 1994), Colobines are adapted to digest low quality forage (Fashing et al., 2007a). The digestive system of Colobines is unique among primates because of its anatomical complexity. Colobines have a relatively large stomach which is divided into four chambers (Chivers & Hladik, 1980). The two first chambers constitute the forestomach where most of the food is fermented and digested with the help from specific bacteria, protozoa, and fungi (Fashing et al., 2007a; Groves, 2007). These microorganisms allow Colobines to extract nutrients from the fibrous cell walls of plants and also to detoxify some plant secondary compounds (Lambert, 1998). However, the cost of ingesting food items rich in fibre or secondary compounds is longer stomach retention times and thereby longer periods of feeding associated resting to effectively digest and detoxify ingested plant matter (Decker, 1994; Lambert, 1998; Fashing et al., 2007a). Colobines avoid this cost by being relatively selective in their choice of food items (Fashing et al., 2007a) and some species are also known to eat soil, clay, and charcoal which are thought to assist in the digestion of toxic leaves (The Colobus Trust, 2011).

The Angola black-and-white colobus inhabits fragmented forests in coastal Kenya and Tanzania (Rodgers, 1981; Kanga & Heidi, 2000; Anderson et al., 2007b). In their study of the ranging patterns of *Colobus angolensis palliatus* populations in the Kwale District, Anderson et al. (2007c) found that the subspecies frequently travels and forages in vegetation such as mangrove, wooded shrubland, shrubland, and perennial plantation. The researchers showed that a high proportion of vegetation cover and food tree cover in these vegetation types correlate with a high abundance of colobus monkeys, and that monkey abundance declines with distance from forest habitat.

1.2.4. Threats

The growing human population and its need of forest resources and space for husbandry practices have had a negative impact on East African forests (Anderson et al., 2007a). The major threats to the Angola black-and-white colobus are habitat loss and fragmentation (Kanga & Heidi, 2000; Anderson et al., 2007b). Clear-logging of forests in Kenya gives space to agriculture, local settlements, coral-black mining, and tourism development (Anderson et al., 2007b).

Deforestation results in a mosaic of isolated forest fragments in varied stages of succession (Decker, 1994). The fragments impede or prevent gene flow between colobus populations occupying different areas (Decker, 1994; Kanga & Heidi, 2000). McDonald and Hamilton (2010) revealed a large genetic diversity both within Kenyan *Colobus angolensis palliatus* populations and between Kenyan and Tanzanian populations. They concluded that the Kenyan *Colobus angolensis palliatus* populations need to be better protected, and in accordance with Anderson et al. (2007c) they also highlighted the importance of habitat connectivity to enhance gene flow between Kenyan populations.

1.3. The Diani Forest

The Kenyan *Colobus angolensis palliatus* populations are restricted to the southern coastal forests of the Kwale District (Anderson et al., 2007b). The Kwale District covers 8322 km^2 of land, and is mainly an agro-ecological zone that has been shaped by a growing human population. Today, only 3 % of the district is covered by closed-canopy indigenous coastal forest. The Kwale District comprises a mosaic of forest patches including indigenous coastal forest vegetation, mangrove, coastal shrubland, shrub grassland, wooded grassland, perennial plantation, timber plantation, cropland, and areas of human settlement (Anderson et al., 2007c).

The Diani Forest is one of three remaining patches of coral forest within the Kwale District (Kanga & Heidi, 2000; The Colobus Trust, 2011). The forest is mainly threatened by deforestation to give space for agriculture and development (Anderson et al., 2007b). In the last 25 years, the Diani Forest has diminished with almost 75 % (Kanga & Heidi, 2000). Today, the forest covers 455 ha of land (Anderson et al., 2007b) and is highly fragmented by roads, resorts, and commercial development (McDonald & Hamilton, 2010). This fragmentation makes the Angola black-and-white colobus and other monkeys susceptible to vehicular death and electrocution when travelling between fragments (Kanga & Heidi, 2000; McDonald & Hamilton, 2010). From the year 2004 to 2006, the *Colobus angolensis palliatus* population in Diani Forest declined from about 400 to about 200 individuals (The Colobus Trust, 2011). The exploitation of Diani Forest is reduced by the work of The Colobus Trust, which is a primate conservation centre located in the area (Anderson et al., 2007b).

1.4. Aim

The aim of this bachelor thesis is to investigate which tree species that the Angola black-and-white colobus forages from in the Diani Forest. The Colobus Trust has previously performed research on the feeding ecology of this subspecies. However, the most recent study was conducted in 2003, and the Diani Forest has been modified since that time. It is

therefore relevant to perform new observations on the feeding ecology of the Angola black-and-white colobus.

The questions are as follows:

1. Which are the major food trees of *Colobus angolensis palliatus* in Diani Forest?
2. Which food items is *Colobus angolensis palliatus* eating from these trees?

2. MATERIAL AND METHOD

The practical part of this work has been conducted in collaboration with three other university students. Two of these students were working with their respective bachelor thesis and the third one was preparing his master thesis. Since the aim of the study diverged among the students, the study design was shaped from several questions.

2.1. Study area and subjects

The study was performed in the Diani Forest which is located in the southern coastal province of Kenya. The Diani Forest contains both native and exotic tree species (The Colobus Trust, 2011). Two *Colobus angolensis palliatus* habitats were selected in the forest. The first habitat was named Colobus Trust (CT) because it is located around the conservation centre of The Colobus Trust. The second habitat was called Baobab (BB) because it is positioned around the Baobab Beach Resort. The Colobus Trust site constitutes patches of degraded forest whereas the Baobab site composes patches of pristine forest. The sites are positioned near the Diani Beach Highway which traverses through the Baobab site. The two habitats are located a few kilometres from one another and both are highly fragmented by roads and buildings.

In each habitat, two *Colobus angolensis palliatus* troops were selected. The four troops were named CT1, CT2, BB1, and BB2, respectively. The CT1 troop resides close to The Colobus Trust conservation centre and constitutes of nine individuals (two adult males, four adult females, one sub-adult, and two juveniles). This troop has been observed several times before, and is regarded as the most habituated to humans of the troops studied. The CT2 troop lives close to the CT1 troop and constitutes of nine individuals (three adult males, four adult females, one sub-adult, and one juvenile). Both troops live near the beach in forest patches fragmented by roads and buildings. The BB1 troop resides close to the beach in the Baobab Beach Resort property and constitutes of five individuals (one adult male, two adult females, one sub-adult, and one juvenile). In contrast to the other troops, the BB2 troop lives on the other side of the Diani Beach Highway and therefore not by the beach. This troop occupies forest patches fragmented by some buildings and constitutes of eight individuals (one adult male, five adult females, one sub-adult, and one juvenile). Each troop was used to people, however, the BB2 troop seemed to be slightly more vigilant to humans than the other troops.

2.2. Study design and registrations

Before the observations began, a pilot study was performed during two days to control the ethogram. After some modifications, the study was then conducted for eight days between

25th of March and 2nd of April 2011. The study spanned from the end of the dry season to the beginning of the wet season. In the wet season it was raining mostly during night-time.

The monkeys were studied during their most active time of the day. The observations were carried out in the morning from 6.20 to 9.00 and in the afternoon from 16.00 to 18.00 since these are regarded as feeding bout periods. The monkeys were expected to mostly rest during the remaining daytime since that has been shown in previous studies.

The observations were made in two teams of two students and one field assistant, respectively. One of the students was observing the monkeys and keeping track of time, by using a stopwatch, while telling the other student what to write down in the data sheet. The observing student was also marking GPS points of the troop with a GARMIN Oregon 550t. The field assistant informed the students of the name of the tree species being used by the monkeys. When the monkeys were feeding from a tree the field assistant also provided information about food items. After the first half of each study period, the observer and writer were switched so that each of the students performed both types of work each day. The students were also rotating among teams so that different groups of persons were working together in different days.

The study periods were divided into study sessions of fifteen minutes each and after one study session there was a pause of five minutes before the next session began. The recording method being used was instantaneous sampling (Martin & Bateson, 2010) and the behaviours of the monkeys were recorded on the minute for every minute in the study session. The recordings started on the same minute as the study session began which means that a total of sixteen registrations were made during each session. In each study session, two focal animals were observed and these individuals were changed after the session. The focal animals of one study session were randomly selected and normally not chosen for the subsequent session. However, in occasions when some individuals were hard to see from the observer point the same focal animal was chosen as in the previous session.

For every study period, the troop being observed and the names of the observers were noted as well as the current weather conditions. For each study session, the age (e.g. adult, sub-adult, juvenile) and gender (only of adults) of the focal animal were also noted. The gender of sub-adults and juveniles was not noted because of difficulties in gendering these age groups. The behaviours that were registered during the observations are defined in the ethogram (Tab. 1). Besides registrations on monkey behaviour, the position of the monkey (Tab. 2) and the tree species being used were recorded. When the monkey was feeding, the food tree species and the food item (Tab. 3) were also recorded. In the first and the last minute of each study session, the GPS points of the monkeys were also marked by standing as close as possible to the troop. The teams attempted to influence the monkeys as little as possible during observations.

Table 1. Ethogram with the codes and definitions of recorded monkey behaviours.

Code	**Behaviour**
FE	Feeding ï individual is placing leaves, flowers, fruits etc., into the mouth or chews them. Includes searching for food using visual scanning in combination with grasping or searching with arms.
R	Resting ï individual is lying or sitting when not doing other activities. Includes vigilance.

GAU	Auto-grooming ï individual is picking through its own fur. Includes scratching.
GAL	Allo-grooming ï individual is picking through the fur of another individual.
CL	Clinging ï infant/juvenile clinging to another individual.
II	Inter-species interactions ï individual interacts with another monkey species.
SO+	Positive social interaction ï individual interacts physically with one or more individuals of the same species with no distress or moving away. Includes copulation.
SO-	Negative social interaction ï individual interacts physically with one or more individuals of the same species. One or more individuals show alarmed or distressed behaviour by the contact.
C	Calling ï individual is vocalizing.
M	Moving ï individual is using its limbs to move from one point to another.
P	Playing ï individual is chasing or being chased by another individual or two or more individuals are wrestling in a playful manner.
D	Drinking ï individual is ingesting water.
O	Other ï individual is performing a behaviour that is not defined in the ethogram.
T/O	Time out ï individual is out of sight or lost.
D/D	Data deficient ï troop is not found.

Table 2. The codes and definitions of recorded monkey positions.

Code	**Position**
TC	Top canopy ï 10 m and above.
MC	Mid canopy ï between 5 and 10 m.
LC	Low canopy ï 5 m and below, but above ground level.
MS	Manmade structure ï wall, roof, bridge etc.
GR	Ground.

Table 3. The codes and definitions of recorded monkey food items.

Code	**Food item**
FL	Flower, including flower bud.
FR	Fruit.
SE	Seed.
FC	Fossil coral.
ML	Mature leaf.
YL	Young leaf, including leaf bud.
UL	Unidentified leaf ï either young or mature.
O	Other ï bark, soil, lichen, insect etc., or unidentified food item.

The teams observed one troop each during the whole day and each troop was studied every second day. The CT1 troop was always studied on the same day as the BB1 troop and the CT2 troop was always observed on the same day as the BB2 troop. Since the monkeys normally stayed in the same tree from evening to next morning, the troops that were to be observed during the following day were located in the evening. Each student observed the same troop for a total of two days and every troop was studied for a total of four days. The teams were permitted to enter most of the private properties in the study area. The total observation time of the whole study was 103 hours and eight minutes.

2.3. Data analysis

Data were collected from a total of 30 observation periods of which 14 were mornings and 16 were afternoons. In two scheduled mornings one of the teams could not locate its troop. Of 42 tree species used for foraging, only the ten major food trees were presented in the results. The data of food trees were pooled by observation periods in Microsoft Office Excel 2007. The proportions of feeding registrations from different food trees were calculated for each observation period and the mean ± standard error of mean (SEM) of feeding registrations from each major food tree was calculated in Minitab 15. Since the data were not normally distributed, the P value, H value and degrees of freedom were attained by the non-parametric Kruskal-Wallis Test. The level of significance was $P<0.05$. The food items being eaten from the major food trees were only presented descriptively. Since the consumption of seeds was low, it was included to other food items. Fossil coral was excluded from the analysis since it is not a plant part.

3. RESULTS

3.1. The major food trees of the Angola black-and-white colobus

In total, the Angola black-and-white colobus in Diani Forest foraged from 42 tree species. The ten major food trees are presented in Figure 1. These trees are *Adansonia digitata*, *Adenanthera pavonina*, *Bougainville spectabilis*, *Delonix regia*, *Hunteria zeylanica*, *Lecaniodiscus fraxinifolius*, *Lannae welwitschii*, *Pithecellobium dulce*, *Trichilia emetica*, and *Zanthoxylum chalybeum*. There was a significant difference in the utilization of different food trees ($H = 26.72$, $P = 0.002$, $DF = 9$; Kruskal-Wallis Test adjusted for ties). *Bougainville spectabilis* and *Delonix regia* are consumed more often than *Adenanthera pavonina*, *Hunteria zeylanica*, *Pithecellobium dulce*, and *Zanthoxylum chalybeum*. *Adansonia digitata*, *Lecaniodiscus fraxinifolius*, *Lannae welwitschii*, and *Trichilia emetica* are also eaten more often than *Pithecellobium dulce*.

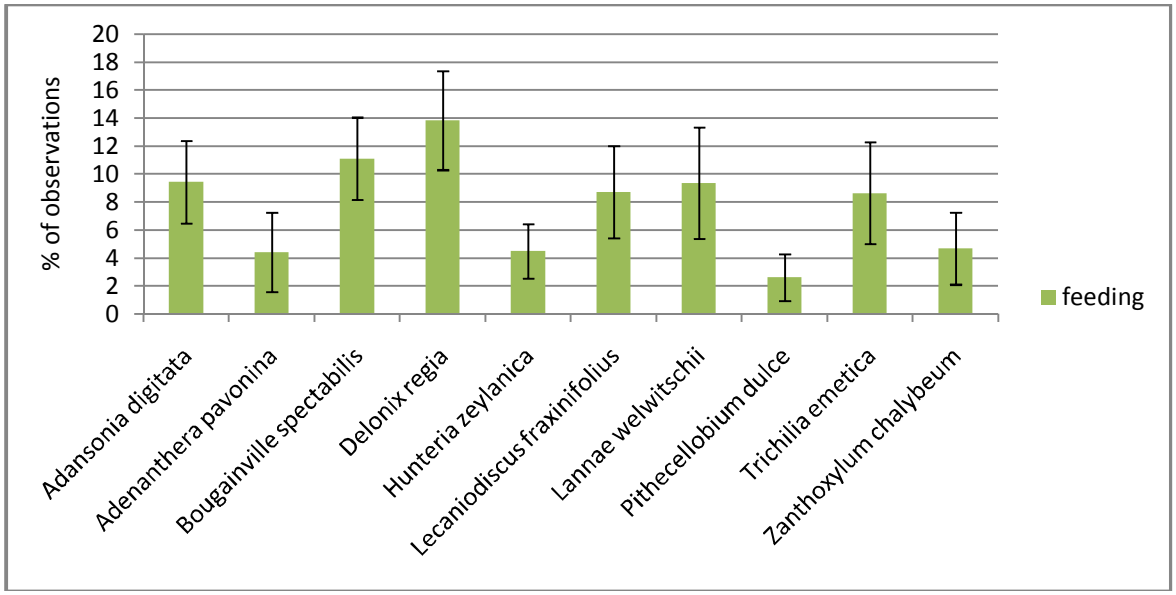

Figure 1. The ten major food trees of the Angola black-and-white colobus in Diani Forest, Kenya. The mean proportion ± standard error of mean of feeding registrations from each tree species is illustrated.

3.2. Food items eaten by the Angola black-and-white colobus

The total proportions of different food items that the Angola black-and-white colobus ate from the major food trees are presented in Figure 2. Leaves and flowers provided the vast majority of ingested food items. The monkeys ate high proportions of mature leaves (35.4 %), flowers (27.6 %), and young leaves (21.1 %). The consumption of fruits (9.5 %), unidentified leaves (4.1 %), and other food items (2.3 %) were smaller.

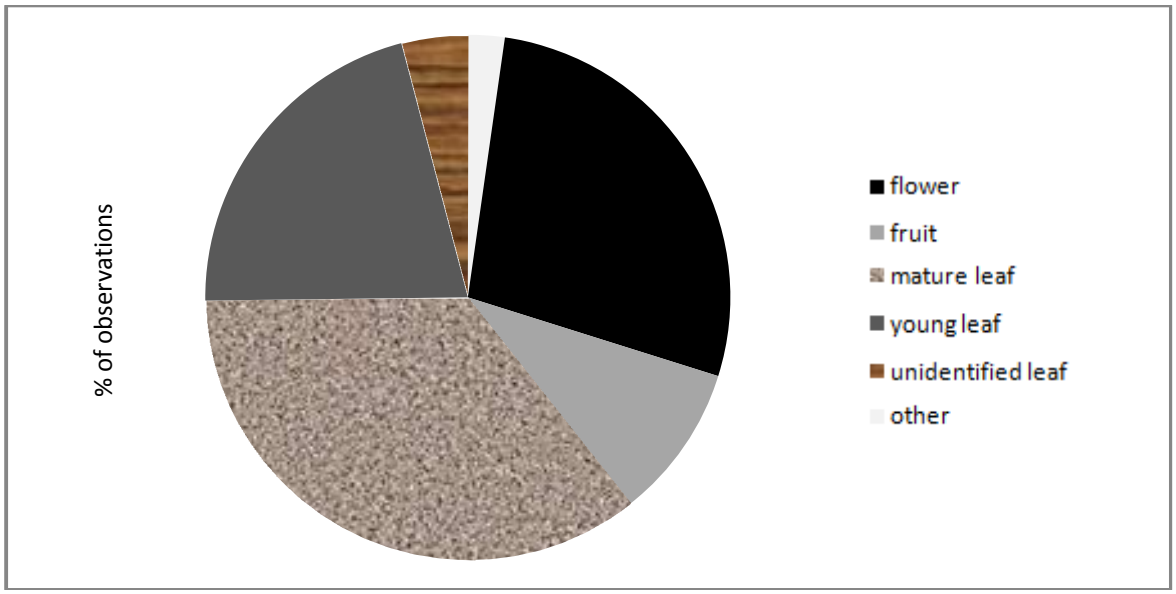

Figure 2. The food items eaten from the ten major food trees of the Angola black-and-white colobus in Diani Forest, Kenya. The total proportions of different food items are illustrated.

The proportions of different food items that the Angola black-and-white colobus ate from the respective major food trees are presented in Figure 3.

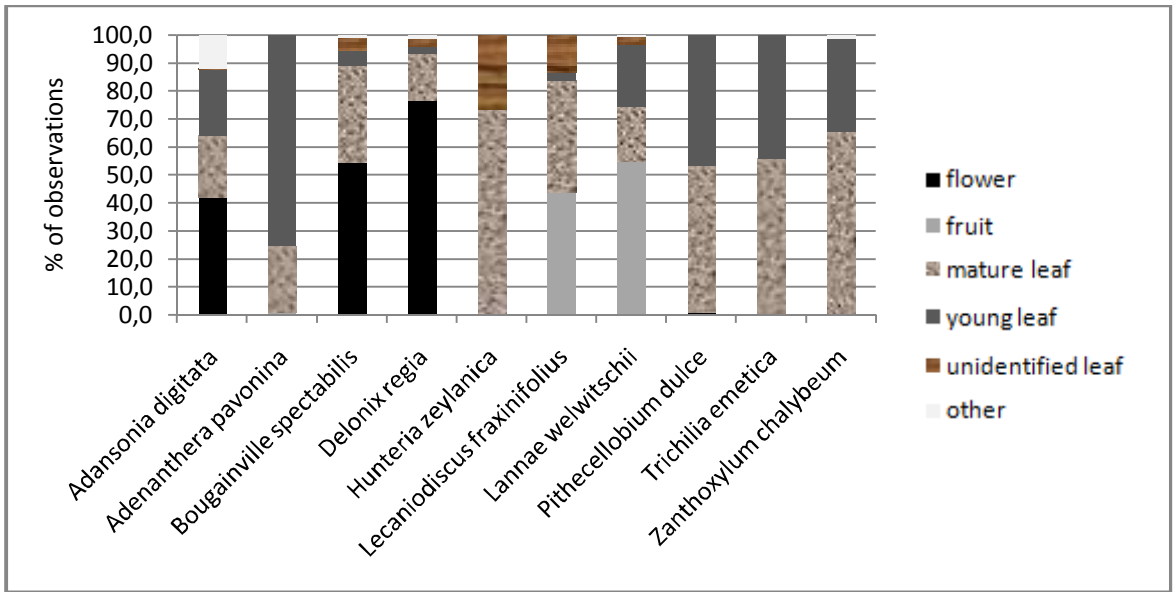

Figure 3. The food items eaten from the ten major food trees of the Angola black-and-white colobus in Diani Forest, Kenya. The proportions of different food items from each tree species are illustrated.

The monkeys consumed a high proportion of flowers from *Adansonia digitata*, *Bougainville spectabilis*, and *Delonix regia*, whereas fruits were eaten from *Lecaniodiscus fraxinifolius* and *Lannae welwitschii*. From *Pithecellobium dulce*, *Trichilia emetica*, and *Zanthoxylum chalybeum* the monkeys consumed high proportions of both young and mature leaves, whereas mostly mature leaves were eaten from *Hunteria zeylanica*. The monkeys also consumed a relatively high proportion of other food items from *Adansonia digitata*.

4. DISCUSSION

4.1. The major food trees of the Angola black-and-white colobus

The results from this study show that the Angola black-and-white colobus in Diani Forest forages from at least 42 tree species. The ten major food trees are *Adansonia digitata*, *Adenanthera pavonina*, *Bougainville spectabilis*, *Delonix regia*, *Hunteria zeylanica*, *Lecaniodiscus fraxinifolius*, *Lannae welwitschii*, *Pithecellobium dulce*, *Trichilia emetica*, and *Zanthoxylum chalybeum*. Five of these species, namely *Adansonia digitata*, *Lecaniodiscus fraxinifolius*, *Lannae welwitschii*, *Trichilia emetica*, and *Zanthoxylum chalybeum* are also presented as major food trees in an unpublished study performed by The Colobus Trust. In their study, it was found that the Angola black-and-white colobus forages from 116 tree species in the Kwale District. Fourteen of these 116 species make up more than 75 % of the colobus diet in Diani Forest (Anderson et al., 2007a). Although there is little information about the method being used in the observations by The Colobus Trust, the differences in our results might be explained in many ways. One explanation is that The Colobus Trust observed the monkeys during the whole day (Anderson et al., 2007a) while I only observed them during feeding bout periods. Furthermore, The Colobus Trust probably observed more troops of monkeys in the Diani Forest and thus more habitats. It is also possible that The Colobus Trust observed the monkeys in another season and over a longer time period.

Other studies have shown that Colobines adapt to variations in food supply by changing their dietary compositions and ranging patterns (Decker, 1994; Lowe & Sturrock, 1998; Anderson et al., 2007c; Harris et al., 2010). In their study of *Colobus angolensis palliatus* in Tanzania, Lowe and Sturrock (1998) found differences in colobus behaviour and diet in relation to seasonality. At the end of the dry season, the monkeys spent more time feeding, showed a higher dietary variety, and ranged over a much larger area than at the beginning of the wet season (Lowe & Sturrock, 1998). The seasonal differences in colobus behaviour and diet can probably be explained due to monkeys having difficulties in finding food items of high nutritional quality at the end of the dry season. Lowe and Sturrock (1998) only studied one troop of eight individuals, but the seasonal differences in colobus behaviour and diet have been confirmed by other studies. Harris et al. (2010) revealed that *Colobus guereza* increases its dietary diversity when its major food trees are scarce, and Decker (1994) and Fashing et al. (2007a) state that other food items than the preferred ones might be selected in times of food scarcity.

In the present study, observations were done during the end of March to the beginning of April which is the switch from dry to wet season. Trees and other vegetation generally undergo changes in nutritional composition during this period (Baranga, 1983). It was raining during night-time in the last observation days and although I could not observe any

major differences in the vegetation during this short period it is possible that the nutritional quality of some plant parts had increased which influenced the choice of food tree species and food items. Furthermore, it is not impossible that the feeding bout periods had changed over the study period, since Lowe and Sturrock (1998) showed differences in the feeding bouts of *Colobus angolensis palliatus* between seasons. At the end of the dry season, feeding bouts were from 6 to 9 hrs and around 13 and 17 hrs, whereas at the beginning of the wet season, feeding bouts were around 6 and 13 hrs (Lowe & Sturrock, 1998).

The results from the present study show that there is a difference in the utilization of the ten major food trees. *Adansonia digitata*, *Bougainville spectabilis* and *Delonix regia* were consumed more often than nearly all of the other food trees. However, the utilization of different food trees most certainly differs between seasons. It is difficult to discuss why one of the ten major food trees is used more or less than another. The more interesting thing to discuss is why a specific tree species is one of the major food trees.

The study performed by The Colobus Trust showed that the Angola black-and-white colobus in Diani Forest eats young and mature leaves, petioles, flowers, fruits, seeds, and bark (Anderson et al., 2007a). These food items were also consumed by the monkeys in the present study were the most eaten food item were mature leaves followed by flowers, young leaves, fruits, unidentified leaves and other food items. These proportions differ from the results of Maisels et al. (1994) and Decker (1994). Maisels et al. (1994) observed *Colobus angolensis angolensis* in Zaire during eight months and found that the subspecies ate a high proportion of seeds (49.9 %) followed by young leaves (21.2 %), fruits (16.8 %), mature leaves (6.4 %), and flowers (5.9 %). However, Maisels et al. (1994) performed their observations during a period when the availability of fruits was high which somewhat explains the high consumption of fruits and seeds. Decker (1994) observed the red colobus (*Colobus badius rufomitratus*) for five days a month during two years and found that nearly 50 % of its diet composed of young leaves and 25 % each of fruits and flowers. The differences in colobus diets are not surprising since studies have shown that colobus monkeys have different dietary compositions in different forest habitats (Chapman et al., 2002) and even that troops of red colobus monkeys and *Colobus angolensis* species living in the same site have different diets (Chapman et al., 2002; Fashing et al., 2007b). Chapman et al. (2002) also revealed that the diet of one troop of red colobus monkeys varied over a period of four years. One explanation to these dietary differences is that the distribution and nutritional quality of food tree species can differ both within and between habitats and also between years (Chapman et al., 2003).

Although the literature states that Colobines rarely eat mature leaves because these contain high amounts of fibre (Decker, 1994) and therefore are harder to digest than young leaves (Lambert, 1998), the Angola black-and-white colobus in my study in Diani Forest during the end of March to the beginning of April consumed a high proportion of mature leaves. One explanation to the high consumption of mature leaves is that this food item probably was one of the best foods available during this season. Decker (1994), Fashing et al. (2007a) and Anderson et al. (2007a) have shown that other food items than the preferred ones can be chosen in times of food scarcity. The results from my study show that the Angola black-and-white colobus ate a high proportion of leaves from *Adansonia digitata*, *Adenanthera pavonina*, *Hunteria zeylanica*, *Lecaniodiscus fraxinifolius*, *Lannae welwitschii*, *Pithecellobium dulce*, *Trichilia emetica*, and *Zanthoxylum chalybeum*. *Adansonia digitata*, *Adenanthera pavonina*, and *Pithecellobium dulce* are all deciduous tree species (Sobrado, 1993; Gebauer et al., 2002; World Agroforestry Centre, 2011),

whereas *Trichilia emetica* and *Zanthoxylum chalybeum* are evergreen (Beentje et al., 1994; Hughes, 1988).

Since the seasonal variations in nutritional quality are more distinct in deciduous tree species than in evergreen species (Baranga, 1983) it can be assumed that the Angola black-and-white colobus relies on evergreen food trees to a greater extent than on deciduous food trees. Furthermore, evergreen species contain leaves in varied stages of maturation and thus of different nutritional quality (Baranga, 1983) which probably is a good characteristic of a food tree species. In general, young leaves have higher protein and water contents than mature leaves (Decker, 1994) and the nutritional quality of the leaves declines with maturation (Baranga, 1983). The leaves of *Adansonia digitata* have high protein and mineral contents (Gebauer et al., 2002) whereas the leaves of *Adenanthera pavonina* are rich in proteins but poor in minerals (World Agroforestry Centre, 2011). In my study, the monkeys spent much of their time resting during observations which can be explained by the high temperature and humidity of the season but also by the high consumption of mature leaves. It is possible that these were feeding associated resting periods during which the monkeys digested fibre from the mature leaves (Decker, 1994; Lambert, 1998; Fashing et al., 2007a). Another explanation to the high consumption of mature leaves could be that the Angola black-and-white colobus actually prefers to eat these leaves. Although this theory is very doubtful, Colobines are adapted to digest low quality forage (Fashing et al., 2007a; Lambert, 1998) and observations on the feeding ecology of *Colobus angolensis palliatus* are too few to draw any definitive conclusions.

In the present study, the Angola black-and-white colobus consumed a high proportion of flowers from *Adansonia digitata*, *Bougainville spectabilis*, and *Delonix regia*. The study performed by The Colobus Trust also revealed that the subspecies eats flowers from *Adansonia digitata* (Anderson et al., 2007a). It is quite interesting that the subspecies forages from *Bougainville spectabilis* and *Delonix regia* because these are ornamental trees exotic to Kenya (Endress, 1996; World Agroforestry Centre, 2011). Both are deciduous species that are blooming at the end of the dry season (Endress, 1996; World Agroforestry Centre, 2011) and thus probably not used as major food trees in other times of the year. The brightly coloured flowers of *Bougainville spectabilis* and *Delonix regia* probably attract the monkeys that act as pollinators (Fleming & Sosa, 1994). In general, flowers have higher water and fibre contents but lower protein contents than leaves (Milton, 1999). However, the nutrients of flowers are often more accessible than those of leaves (Milton, 1999) which somewhat explains why the monkeys ate a high proportion of flowers when young leaves were scarce. The trees of *Bougainville spectabilis* and *Delonix regia* were privately owned, but although Anderson et al. (2007c) reported that *Colobus angolensis palliatus* frequently travels and forages in perennial plantation, the monkey is not regarded as a pest species. Thus, hunting is not a big threat to the Angola black-and-white colobus (Anderson et al., 2007a). However, Anderson et al. (2007b) point out that the ongoing deforestation with the resultant habitat loss can lead to an increase in plant-raiding behaviour which in turn increases the hunting pressure.

In my study the Angola black-and-white colobus ate a relatively low proportion of fruits. The fruits were eaten from *Lecaniodiscus fraxinifolius* and *Lannae welwitschii* which have also been seen in the observations by The Colobus Trust (Anderson et al., 2007a). The monkeys in the present study were probably eating ripe fruits or only the skins of unripe fruits (Anderson et al., 2007c) since research has shown that Colobines get acidosis by ingesting the pulp of unripe fruits (Fashing et al., 2007a). However, because of difficulties

in finding information about the utilized tree species it is hard to decide whether the fruits were unripe or ripe. Not unlike flowers, fruits generally contain higher amounts of fibre and water but lower amounts of protein than leaves. Fruits also have more accessible nutrients than leaves (Milton, 1999). In the study performed by Maisels et al. (1994) it was shown that almost half of the diet of *Colobus angolensis angolensis* was composed of seeds. Their results are not comparable with the results from my study because *Colobus angolensis palliatus* only consumed small amounts of seeds and this food item was therefore included to other food items. Furthermore, the Angola black-and-white colobus was never observed to eat seeds from any of the ten major food trees. Koyabu and Endo (2008) suggest that *Colobus angolensis* species are adapted to seed-eating because of their flat molars and strong jaw musculature. In their study, Maisels et al. (1994) have differed between fruit pulp and seeds which I have not done in this study. If the monkeys were eating fruit I considered that their main goal was to eat fruit pulp and not seeds. Even though monkeys were seen to throw fruits on the ground after eating the fruit skin or pulp it is possible that seeds were ingested. Furthermore, there are differences in chewing and only swallowing seeds because if the monkey is chewing seeds it is probably more accurate to consider this behaviour to be seed-eating than if the monkey is only swallowing seeds when eating fruits. In summation, it is not impossible that my study has underestimated the consumption of seeds whereas Maisels et al. (1994) have overestimated the consumption.

In this study it was very rare that the Angola black-and-white colobus ate something that I had to record as other food items. However, it occurred in some occasions and especially when the monkeys were feeding on *Adansonia digitata*. Although I could not exactly see what the monkeys were eating it looked like they were grasping along the bark of the tree so possibly they were eating bark. The study performed by The Colobus Trust also revealed that the Angola black-and-white colobus consumes bark from this tree species (Anderson et al., 2007a). The bark of *Adansonia digitata* has high fibre and water contents (Gebauer et al., 2002) and is chewed by wild and domestic animals in times of water scarcity (World Agroforestry Centre, 2011).

4.2. Reflections

There are some possible sources of error in this study. First, observations were performed on only four troops of monkeys during a short time period and the results of this study should therefore be interpreted cautiously. In the future it is important to perform observations on more troops of monkeys during longer time periods to achieve more accurate information on monkey diets. Second, the data from two scheduled mornings were missed because one of the teams could not locate its troop. In both times it was one troop in the Baobab site and tree species in this pristine habitat may therefore be underrepresented in the results. Third, it is not impossible that one troop of monkeys was foraging more often than the other troops. Tree species in one habitat may therefore be more or less represented than tree species in another habitat. Fourth, although all troops were habituated to humans and there are no observations of certain individuals being more vigilant to humans than other individuals, one troop was more timid than the others which might have influenced the observations. Fifth, sometimes the field assistant could not identify the tree species being used. However, despite the fewer registrations of some food tree species the results still show the major food trees. Sixth, it is not impossible that the field assistants sometimes were unsure about the maturation of leaves which explains why the monkeys have been eating both young and mature leaves from the same deciduous tree

species. Seventh, the feeding bout in the morning started at least twenty minutes earlier than our observations. However, since it was too dark to see what the monkeys were eating it would have been pointless to start the observations earlier in the morning. Furthermore, the monkeys were only observed during feeding bout periods and it is therefore possible that I have missed some feeding registrations during the day.

The method that was used in this study can be useful also for future observations of the Angola black-and-white colobus. By observing only two focal animals at a time instead of the whole troop it is easier to follow the monkeys. Some individuals of the troop can otherwise be hard to see on the minute in the dense tree canopy. Since the monkeys of a troop always travelled together it is unlikely that some tree species were missed by observing only two focal animals at a time. Furthermore, since the monkeys moved relatively slowly between trees it is not likely that some tree species were missed by using instantaneous sampling with one-minute intervals instead of continuous sampling.

As stated by Chapman et al. (2002), a study of one troop of monkeys inhabiting a specific site at one point in time may not adequately represent the species. In this study I observed four troops of the Angola black-and-white colobus in two habitats that somewhat differed in the distribution of different tree species. Studies have shown that food choice differs between troops inhabiting different sites (Chapman et al., 2002) and also between troops inhabiting the same site (Chapman et al., 2003). Since food choice to a great extent depends on the distribution of tree species (Chapman et al., 2003) it is important to investigate the distribution of trees in future observations. In the future it is also important to observe more troops of monkeys in different habitats of the forest to better conserve the trees.

In this study I did not investigate the nutritional quality of eaten tree species and plant parts. There are not only differences in the nutritional quality of plant parts from different individuals of the same tree species (Harris et al., 2010) but also differences in the nutritional quality among leaves of the same individual deciduous tree (Chapman et al., 2003). Chapman et al. (2003) even saw that the differences in the nutritional quality of mature leaves from the same tree species can be greater between sites than between different tree species. In addition, the researchers showed that the nutritional quality of the same plant parts differs from year to year. To explain why some tree species and plant parts are selected instead of others it is necessary to examine the nutritional quality of consumed plant parts which have been done in studies by Maisels et al. (1994), Chapman et al. (2003), Chapman et al. (2004) and many others. However, it is complex and time-consuming to investigate the nutritional quality of eaten plant parts and Chapman et al. (2005) have therefore studied the possibility of using the protein content of colobus faecal samples as an indicator of the protein content in consumed plant parts. Chapman et al. (2005) examined the faecal samples of *Colobus angolensis*, *Colobus guereza*, and red colobus, and found that the method is applicable only when there are large differences in the protein content of consumed plant parts. The researchers concluded that the digestive system of Colobines probably respond to low protein contents of eaten plant parts by synthesizing more microbial protein that improves the digestion of fibre and increases the microorganism load which result in higher contents of microbial protein in the faeces. Thus, to date there are no other reliable method to investigate the nutritional quality of plant parts eaten by Colobines than to examine these plant parts. Furthermore, since the nutritional quality of trees and plant parts differ between sites and years it is necessary to perform observations during long time periods in different forest habitats.

5. CONCLUSIONS

This study has shown that *Colobus angolensis palliatus* forages from 42 tree species in the observed sites of Diani Forest. The most utilized food trees were *Adansonia digitata, Bougainville spectabilis, Delonix regia,* and *Lannae welwitschii*. The monkeys in the study were primarily folivorous since more than 50 % of the diet was composed of leaves followed by flowers, fruits and other food items. The highest consumption was of mature leaves which differs from other studies were the monkeys ate rather young leaves. Hence, since the dietary composition of Colobines varies between sites, seasons and years, it is difficult to draw any conclusions from this minor study. Future observations on the feeding ecology of *Colobus angolensis palliatus* should be performed on more troops of monkeys in different forest habitats during long time periods to achieve more accurate information on monkey diets and thereby better conserve the subspecies and its habitats in Diani Forest. In addition, the nutritional quality of eaten plant parts should be investigated. The results of this study help to identify tree species and thus habitats that are especially useful for the monkey´s survival.

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REFERENCES

Anderson, J., Cowlishaw, G. & Rowcliffe, J.M. 2007a. Effects of Forest Fragmentation on the Abundance of *Colobus angolensis palliatus* in Kenya´s Coastal Forests. International Journal of Primatology. 28, 637-655.

Anderson, J., Rowcliffe, J.M. & Cowlishaw, G. 2007b. The Angola Black-and-White Colobus (*Colobus angolensis palliatus*) in Kenya: Historical Range Contraction and Current Conservation Status. American Journal of Primatology. 69, 664-680.

Anderson, J., Rowcliffe, J.M. & Cowlishaw, G. 2007c. Does the matrix matter? A forest primate in a complex agricultural landscape. Biological Conservation. 135, 212-222.

Baranga, D. 1983. Changes in Chemical Composition of Food Parts in the Diet of Colobus Monkeys. Ecology. 64, 668-673.

Beentje, H., Adamson, J. & Bhanderi, D. 1994. Kenya trees, shrubs, and lianas. Kenya, National Museums of Kenya.

Chapman, C.A., Chapman, L.J. & Gillespie, T.R. 2002. Scale issues in the Study of Primate Foraging: Red Colobus of Kibale National Park. American Journal of Physical Anthropology. 117, 349-363.

Chapman, C.A., Chapman, L.J., Rode, K.D., Hauck, E.M. & McDowell, L.R. 2003. Variation in the Nutritional Value of Primate Foods: Among Trees, Time Periods, and Areas. International Journal of Primatology. 24, 317-333.

Chapman, C.A., Chapman, L.J., Naughton-Treves, L., Lawes, M.J. & McDowell, L.R. 2004. Predicting Folivorous Primate Abundance: Validation of a Nutritional Model. American Journal of Primatology. 62, 55-69.

Chapman, C.A., Webb, T., Fronstin, R., Wasserman, M.D. & Santamaria, A.M. 2005. Assessing dietary protein of colobus monkeys through faecal sample analysis: a tool to evaluate habitat quality. African Journal of Ecology. 43, 276-278.

Chivers, D.J. & Hladik, C.M. 1980. Morphology of the Gastrointestinal Tract in Primates: Comparisons With Other Mammals in Relation to Diet. Journal of Morphology. 166, 337-386.

Clarke, G.P. 2000. Defining the Eastern African Coastal Forests. In: Coastal forests of Eastern Africa (Eds. N.D. Burgess & G.P. Clarke). United Kingdom, IUCN.

Decker, B.S. 1994. Effects of Habitat Disturbance on the Behavioural Ecology and Demographics of the Tana River Red Colobus (*Colobus badius rufomitratus*). International Journal of Primatology. 15, 703-737.

Endress, P.K. 1996. Diversity and evolutionary biology of tropical flowers. United Kingdom, Cambridge University Press.

Fashing, P.J., Dierenfeld, E.S. & Mowry, C.B. 2007a. Influence of Plant and Soil Chemistry on Food Selection, Ranging Patterns, and Biomass of *Colobus guereza* in Kakamega Forest, Kenya. International Journal of Primatology. 28, 673-703.

Fashing, P.J., Mulindahabi, F., Gakima, J., Masozera, M., Mununura, I., Plumptre, A.J. & Nguyen, N. 2007b. Activity and Ranging Patterns of *Colobus angolensis ruwenzorii* in Nyungwe Forest, Rwanda: Possible Costs of Large Group Size. International Journal of Primatology. 28, 529-550.

Fleming, T.H. & Sosa, V.J. 1994. Effects of nectarivorous and frugivorous mammals on reproductive success of plants. Journal of Mammalogy. 75, 845-851.

Gebauer, J., El-Siddig, K. & Ebert, G. 2002. Baobab (*Adansonia digitata* L.): a Review on a Multipurpose Tree with Promising Future in the Sudan. Gartenbauwissenschaft. 67, 155-160.

Groves, C.P. 2007. The taxonomic diversity of the Colobinae of Africa. Journal of Anthropological Sciences. 85, 7-34.

Harris, T.R., Chapman, C.A. & Monfort, S.L. 2010. Small folivorous primate groups exhibit behavioural and physiological effects of food scarcity. Behavioural Ecology. 21, 46-56.

Hughes, F.M.R. 1988. The ecology of African floodplain forests in semi-arid and arid zones: a review. Journal of Biogeography. 15, 127-140.

Kanga, E.M. & Heidi, C.M. 2000. Survey of the Angolan black-and-white colobus monkey *Colobus angolensis palliatus* in the Diani forests, Kenya. African Primates. 4, 50-54.

Kingdon, J., Struhsaker, T., Oates, J., Hart, J.F., Butynski, T.M., De Jong, Y. & Groves, C.P. 2008. *Colobus angolensis ssp. palliatus*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4.

Koyabu, D.B. & Endo, H. 2008. Craniofacial variation and dietary adaptations of African Colobines. Journal of Human Evolution. 56, 525-536.

Lambert, J.E. 1998. Primate Digestion: Interactions Among Anatomy, Physiology, and Feeding Ecology. Evolutionary Anthropology. 7, 8-20.

Lowe, A.J. & Sturrock, G.A. 1998. Behaviour and Diet of *Colobus angolensis palliatus* Peters, 1868, in Relation to Seasonality in a Tanzanian Dry Coastal Forest. Folia Primatologica. 69, 121-128.

Maisels, F., Gautier-Hion, A. & Gautier, J.-P. 1994. Diets of Two Sympatric Colobines in Zaire: More Evidence on Seed-Eating in Forests on Poor Soils. International Journal of Primatology. 15, 681-701.

McDonald, M.M. & Hamilton, H. 2010. Phylogeography of the Angolan Black and White Colobus Monkey, Colobus angolensis palliatus, in Kenya and Tanzania. American Journal of Primatology. 72, 715-724.

Milton, K. 1999. Nutritional Characteristics of Wild Primate Foods: Do the Diets of Our Closest Living Relatives Have Lessons for Us? Nutrition. 15, 488-498.

Rodgers, W.A. 1981. The Distribution and Conservation Status of Colobus Monkeys in Tanzania. Primates. 22, 33-45.

Sobrado, M.A. 1993. Trade-off between water transport efficiency and leaf life-span in a tropical dry forest. Oecologica. 96, 19-23.

The Colobus Trust, 2011. http://www.colobustrust.org/, använd 2011-05-04.

Thompson, B., 2002. http://animaldiversity.ummz.umich.edu/, använd 2011-05-04.

World Agroforestry Centre, 2011. http://www.worldagroforestrycentre.org, använd 2011-05-22.

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