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SAMMANFATTNING

Den svartvita colobus apan (*Colobus angolensis palliatus*) är en trädlevande primat, känd för sin utbredning i fragmenterade skogar längs kusten i Kenya. Den är därmed sårbar för den ökande fragmenteringen av dess skogar. Studien utfördes i mars och april 2011, i Diani Beach i Kenya, där två av de största populationerna av arten finns. Denna studie är en del av en pilotstudie, i vilken metoder prövades inför ett examensarbete på mastersnivå. Syftet med studien var att utforska om det fanns skillnader i habitatanvändning för *C. a. palliatus* i ursprungliga och degraderade skogar i Diani Beach.

Studien utfördes på fyra trupper i två skogar med hjälp av momentan registrering för varje minut. Observationerna utfördes på två trupper i en degraderad skog och på två trupper i en ursprunglig skog. Total samlades 104 timmar in av beteendedata. Beteende, positionshöjd i träd eller position på andra substrat dokumenterades för två fokaldjur åt gången inom varje trupp. Även data om använda trädarter, föda samt GPS positioner samlades in.

Trupperna i de två skogarna föredrog trädpositioner som var fem meter och högre för olika beteenden. Trupperna i den orörda skogen var vanligtvis positionerade i träd, tio meter ovanför marken, medan trupperna i den degraderade skogen använde sig mer av trädpositioner som sträckte sig upp till tio meter. Alla trupper förutom en sågs också ibland äta och vila på marken. De insamlade GPS positionerna användes för att uppskatta arean på truppernas hemområden, som var mellan 0,022 km^2 och 0,061 km^2.

Metoden som användes i denna studie var lämplig för studiens syfte och även om metoden ibland försvårade jämförandet med andra primatstudier så fungerade metoden bra i insamling av beteendedata för *C. a. palliatus.*

ABSTRACT

The Angolan black and white colobus monkey (*Colobus angolensis palliatus*) is an arboreal primate that inhabits coastal forest fragments on the south cost of Kenya and is consequently vulnerable to forest fragmentations. The study was carried out in March and April 2011 in Diani Beach in Kenya where two of the largest populations of the species are distributed. This study is a pilot study to test methods for a Master's thesis. The aim was to investigate any variations in use of two habitats of *C.a. palliatus* and the forests of Diani Beach.

The study focused on four troops of monkeys in two forests using instantaneous sampling method with one minute intervals. Two troops inhabited a pristine forest while the two other a degraded forest. During this period, 104 hours of behavioural data were collected. The monkeys' behaviour, their position trees or positions on other substrate as well the height when on trees, were recorded for two focal animals at a time in each troop. Recordings of used tree species, food items as well as GPS positions were also made.

The monkey preferred top canopies (>10 m) and mid canopies (5-10 m) in the two forests. In the pristine forest the troops were mostly observed in top canopies, while in the degraded forest the troops utilized mid canopies more frequently. All of the troops except from one were seen occasionally feeding and resting on ground. The retrieved GPS points were used to estimate the troops' home range areas, with sizes ranging between 0.022 km^2 and 0.061 km^2.

The methods used in this study was applicable for this research aim, even though the methods in some aspects made comparison with other field studies of primates difficult.

1. INTRODUCTION

1.1. Angolan black and white colobus

The Angolan black and white colobus (*Colobus angolensis palliatus*) is to be found in Africa in the forests of southern Kenya and Tanzania (Kingdon et al., 2008a). The species is known as Peters' Angola colobus (Anderson et al., 2007a) or *C. a. palliatus*, Peters 1868 and is an Old world monkey belonging to the family *Cercopithecidae* and the sub-family *Colobinae* (Fimbel et al., 2001). *C. angolensis palliatus* is one of eight recognized sub-species of the Angolan black and white colobus (*Colobus angolensis*) that are distributed in Angola, the Democratic Republic of Congo, Rwanda, Tanzania and Kenya (Kingdon et al., 2008a). The sub-species of *Colobus angolensis* inhabit lowlands and mountain forests and are mostly arboreal (Kingdon et al., 2008b).

1.1.1. Physical characteristics

C. a. palliatus has a long thick black coat and white symmetrical shoulder mane also known as epaulettes (Groves, 2007). The long tail which stretches from 700 to 850 mm (Thompson, 2002) is black and ends with a thick white tip (Groves, 2007). The female and male are similar in appearance with an average weight of 8.75 kg (Onderdonk & Chapman, 2000). An adult male is slightly larger than a female and can be distinguished from females by its broad band of white pubic hair; the female has only a minor patch. The infant's coat is completely white; at three months of age the pelage slowly turns into black. The body of an adult is slender and adapted for a life in trees although it lacks thumbs and only rudimentary phalanges is present. For compensation, the second toe of the foot is moderately shorter which provide in some degree the species with opposable big toes (Groves, 2007).

1.1.2. Group structure

The Kenyan population of *C.a. palliatus* consists of approximately 3,100 and 5,000 individuals (McDonald & Hamilton, 2010). The population is separated in 560 to 900 smaller groups (Anderson et al., 2007b). The diurnal primate usually lives in family constellations with one or several males. It has been observed that groups of *C. angolensis* can range from six individuals in the Diani Forest in Kenya to troops in Rwanda with over 300 conspecifics (Anderson et al., 2007b). The group size is generally between 2 and 20 individuals (Fashing et al., 2007) with an average of 9 individuals (Onderdonk & Chapman, 2000).

1.1.3. Foraging behaviour and digestion

The folivorous primate is dependent on feed such as leaves but also seeds and unripe fruits (Groves, 1973). The species is well-adapted to digest food that is low in protein and high in fiber, such as mature leaves, through a multi-chambered foregut containing cellulose-digesting microorganisms. This adaption is known as foregut fermentation (Fimbel et al., 2001) and enables the digestion of fibrous food particles such as cellulose and hemicellulose (Groves, 2007). Though the species possesses the ability to digest fibrous foliage, it prefers young leaves and seeds and only forages mature leaves occasionally (Fimbel et al., 2001). An estimation about the feeding habits shows that intake of young

leaves stands for 31% of their diet and mature leaves for 18%, while seeds for 35% . Fruit, flower and flower buds, stems and other forage are each lower than 10 % (Groves, 1973).

Reports of *C. a. palliatus* feeding activities indicate foraging in native and exotic tree species and 116 species are known to be food trees (Anderson et al., 2007c). The most utilized indigenous tree species for both dry and wet season is *Adansonia digitata L.* also known as baobab tree (Lowe & Sturrock, 1998). Other native and major food trees are *Combretum schumanii, Grewia spp., Millettia usaramensis* and *Lecaniodiscus fraxinifolius* (Anderson et al., 2007b). In Anderson et al., (2007c) the most common exotic tree species for foraging leaves and flowers were *Delonix regis* (flamboyant tree), *Bougainvillea spectabilis* and *Azadirachta indica* (neem tree).

1.1.4. Habitat use and threats

The population of *C.a. palliatus* can be found in a diverse range of habitat, for example areas of woodland and shrublands, mangroves and agriculture plantations (Anderson et al., 2007c). For species to survive in an area, the habitat needs to be of good quality (Hacker et al., 1998). For arboreal primates the habitat must consist of both sleeping trees and food trees and provide the monkeys with feed that meets their nutritional requirements. In order to do so there needs to be a balance between sympatric species in the habitat, which depends on same sort of feed and also a balance in troop size. When competition for feed increases between species and conspecifics some may have to wider their home range to obtain their nutritional needs (Dunbar, 1987). According to Hacker et al., (1998) there is a correlation between habitat with high diversity, high quality and sustainable populations of threatened primate species. The diversity and quality may provide the primate species with adequate feed and shelter to maintain a viable population. There is however indications that areas with threatened primate species have high human density (Harcourt & Parks, 2003) and these sorts of areas is disturbed by human activities that may in particular have negative impact on threatened species (Hacker et al., 1998).

C. a. palliatus is listed as least concern in the IUCN red list of threatened species, even though it suffers greatly from deforestation (Kingdon et al., 2008b). In the area around Diani Beach in Kenya where two of the largest populations of the specie is to be found, degradation of forests is a major issue (Anderson et al., 2007a). Along with declining habitats the population in Diani Beach also suffers from other activities induced by humans. The most common cause of death among *C.a. palliatus* is predation of dogs, electrocution of electric cables when trying to cross roads and also road-kills. To prevent both electrocutions and road-kills the conservation organization the Colobus Trust in Diani insulates electric cables and they also put up crossings, colobridges over the roads. The colobridges are used by the primates when crossing roads to reach other habitats (A. Donaldson, The Colobus Trust, personal communication, February 2011).

1.2. Aim of the study

The principal purpose for this study is to determine if the methods used are applicable for *C.a. palliatus*. My study is a part of a Master thesis and is therefore used as a pilot study. Additionally, the aim is to investigate if there are variations in use of two different habitats between the troops of *C.a. palliatus* in the forests of Diani Beach.

2. MATERIAL AND METHOD

2.1. Study site

The study was conducted in Diani which is part of the Kwale district and stretches from Mombasa in the north to Tanzania in the south. Diani (4º 19´ S, 39 º 34´ E) is a coastal city and adjacent to the Indian Ocean (Anderson et al., 2007a). The average temperature for the area is 26ºC and during the dry season from November to April the mean maximum temperature is 33ºC (Anderson et al., 2007b). The rain season occurs twice a year, in March to July and October to December with an annual rainfall of 900 to 1,500 mm (Anderson et al., 2007b).

The area consists of mixed vegetation of crop fields, human settlements and fragments of the pristine coastal forest on a foundation of coral rug. According to Kanga & Heidi (1999) there has been a 75 % loss of the forest area in Diani Beach during a 20-year period. This is due to exploitation of numerous hotels in the area and the main road built in 1971 which dissected the forest. Along with the degradation of the forest, several animal species such as leopards, elephants and lions which earlier inhabited the area are now missing. Some of the remaining animal species in the area are baboons, vervet and sykes' monkeys, bush pigs, sunis and different species of squirrels (Kanga & Heidi, 1999).

2.2. Study subjects

In the present study, two forests in Diani Beach were selected, which both contain indigenous tree species as well as exotic ones. The forest closest to the relief organization the Colobus Trust is a degraded forest were roads, hotels and human settlement intercept the forest. The forest is named CT in this study and two troops of *C.a. palliatus* within the forest were chosen. The first troop CT1 is the most habituated troop of the four troops chosen, due to several behavioural studies that have been conducted on them. The troop consists of nine individuals; two males, four females, two juveniles and one sub-adult. In the other troop CT2 there are also nine individuals, three males, four females, one juvenile and one sub-adult. The second forest in the study is called Baobab and will be referred to as BB. The forest is distinguished as a pristine forest though one part of it is situated in an area with a hotel complex and a major road dissects it into two. The forest accommodates one troop on each side of the road. The troop BB1 is located in the part of the forest with hotels and consists of five individuals with one male, two females, one juvenile and one sub-adult. On the other side of the road the forest is distributed more continuously even though it houses several apartment buildings. Here is BB2 to be found, the least habituated troop of them all. BB2 is a troop of eight individuals with one male, five females, one juvenile and one sub-adult. There are several cable bridges over the road which connects the divided forest and therefore it is possible that the two troops' home ranges in the BB forest may be overlapping.

2.3. Data collection

The study of the four troops was conducted between the 25th of March and the 2nd of April 2011. The eight observation days were divided into morning and afternoon observation sessions, from 06:20 to 09:00 in the morning and in the afternoon between 16:00 and 18:00. Two troops were observed a day and the behaviour of each troop were recorded for four days. The observations were made by two teams, each consisting of one observer, one person recording the behaviour in a data sheet and one native tree guide. The observers and

the recorders shifted work tasks during each observation session. The teams' constellations were not constant and the recorder and the observers followed a rotating schedule which made it possible to observe each troop twice (Table 1). The recorders and the observers were three Swedish bachelor students and one Irish master student.

The behaviour of two focal animals was recorded for fifteen minutes using instantaneous sampling method with one minute intervals with the assistance of a stop watch. After fifteen minutes there was a five minute break and the focal animals were replaced with two other individuals. The selection of an individual was made randomly among males, females, juveniles and sub-adults. For most of the time the most visible ones were picked which may have resulted in selection of the same individual in the next fifteen minute bout.

When observing the behaviour of the focal animals an ethogram (Table 2) containing fourteen behaviours was used. The position of the observed monkeys was recorded in categories as tree species, ground and manmade structure. Along with a behaviour performed in a tree the position in height was also recorded as well as food items when feeding or foraging. If the chosen individual disappeared the behaviour was recorded as out of sight. An additionally recording was made of the weather in each observation period. For monitoring the movement of the troops in their habitat a GPS (Garmin Oregon 550t) was used on minute one and on minute fifteen in each fifteen minute bout.

The total observation time was 104 hours. At two mornings two troops were not located.

Table 1. Observation schedule

Date	**Observer and troop**			
	Camilla	Julia	Robert	Maria
25 March	CT1	CT1	BB1	BB1
26 March	BB2	CT2	BB2	CT2
27 March	BB1	BB1	CT1	CT1
28 March	CT2	BB2	CT2	BB2
29 March	BB1	CT1	CT1	BB1
31 March	CT2	CT2	BB2	BB2
01 April	CT1	BB1	BB1	CT1
02 April	BB2	BB2	CT2	CT2

Table 2. Definition of the behaviours and positions observed in C.a. palliatus

Behaviour		**Definitions**
Basal behaviours	Feeding	Placing of leaves, flowers, fruits etc., into the mouth, also chewing. The search for food using visual scanning in combination with grasping or searching with arms.
	Resting	Lying or sitting when not doing other activities. This includes vigilance.
	Moving	Individual using its limbs to move from one point to another.
	Auto grooming	Individual picking through the fur itself, including scratching.
	Allo grooming	Picking through the fur of another individual.
Social behaviours	Clinging	Infant or juvenile clinging to another individual.
	Interspecific interactions	Interaction with another primate species.
	Positive social interaction	Physical interaction with one or more individuals of the same species with no distress or moving away. Includes copulation.
	Negative social interaction	Physical interaction with one or more individuals of the same species. One or more individuals show alarmed or distressed behaviour by the contact.
	Calling	When one or more individuals vocalize.
	Playing	One individual is chasing or being chased by another individual or two or more individuals are wrestling without distressed behaviour.
Miscellaneous	Time out	Individual is out of sight, lost or the behaviour is not clear.
	Drinking	Individual ingests water.
	Other	Behaviours not defined in the ethogram.
	Data deficient	Troop is not located.

Position of the individual	**Definitions**
Top canopy	Position in tree 10m and above.
Mid canopy	Position in tree between 5 and 10m.
Low canopy	Position in tree 5m and below but above ground level.
Man-made structure	Position on a wall, roof, bridge etc.
Ground	Position on ground.

Tabel 3. Definitions of food items for C. a. palliatus.

Food item	**Definitions**
Flower	Flowers, also including flower buds.
Fruit	Fruits.
Mature leaves	Mature leaves.
Young leaves	Young leaves, including leaf bud.
Unidentified leaves	Leaves but age not identified.
Other	Includes seeds, fossil coral stones, bark, soil, lichen, insects etc. and unidentified food item.

2.4. Data analysis

A collection of data from 30 observation periods was made, where one observation period is either a morning or an evening. For two scheduled mornings two troops were not located. This resulted in data from 14 mornings and 16 evenings. The collected data were pooled by observation periods in Microsoft Office Excel 2007 and the percentages of different variables by each observation period were calculated. The mean $\pm$ standard error of mean (SEM) was calculated in Minitab 15. The data were tested for normal distribution with Anderson-Darling test. The data were analyzed with ANOVA GLM (General Linear Model), otherwise with non-parametric Kruskal-Wallis test. The level of significance was $P < 0.05$.

The collected GPS points were exported into ArcMap (ArcGIS 9.3.1.) with maps of Diani Beach downloaded from Google Earth (http://www.google.com/earth). The area of the home ranges were measured in ArcMap with the formula πr^2.

3. RESULTS

3.1.The use of positions in the two forests

The differences in use of positions for all of the recorded behaviours between the two forests are shown in Figure 1.

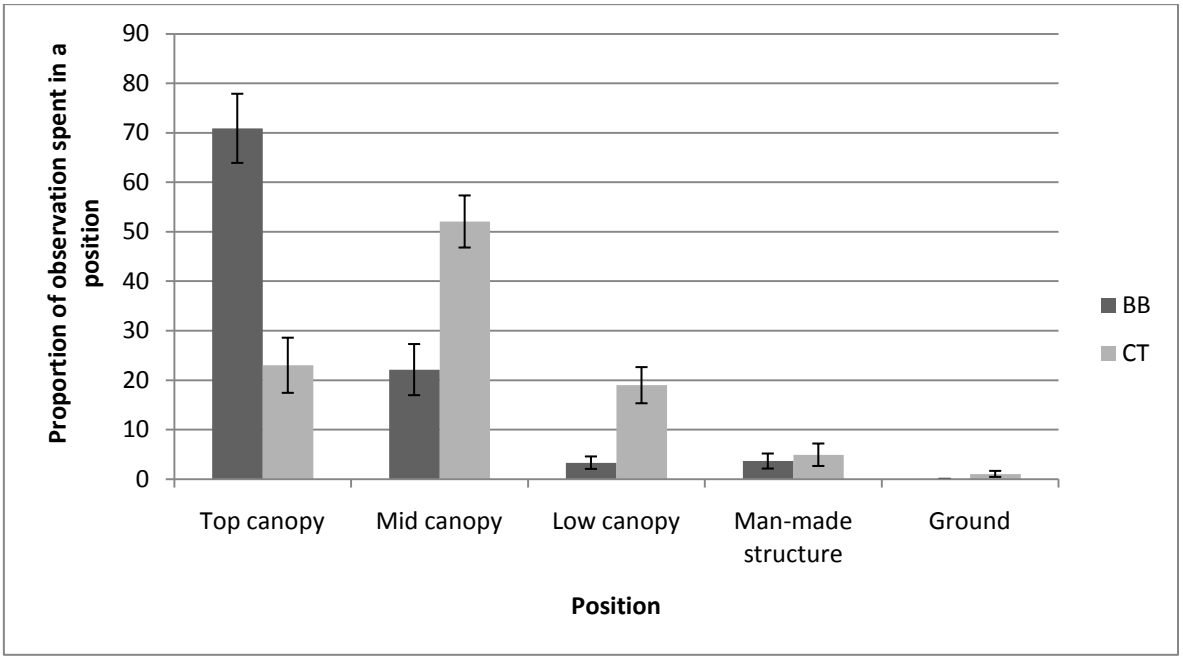

Figure 1.Proportion of observation spent on behaviours in different positions for the monkeys in the CT and BB forest. Top canopy, 10 m and above; mid canopy, 5-10 m; low canopy, 0-5 m; man-made structure, wall, roof, bridge etc.; ground, 0 m.

The position top canopy was the most common position in the BB forest and more preferred compared to the CT forest ($P < 0.001$, $F = 29.34$, $DF = 1$). In the CT forest the most utilized position for the monkeys was mid canopy which was the second most common position in the BB forest ($P < 0.001$, $F = 16.26$, $DF = 1$). Position in low canopy was more common in the CT forest in contrast to the BB forest ($P = 0.001$, $F = 14.69$, $DF = 1$). There are no significant differences in the use of man-made structure and ground between the two forests.

3.2.Feeding and resting in different positions

The behaviour feeding and resting were the most common behaviours shown by the monkeys. The total proportion of observations spent on the positions for feeding and resting for the monkeys are shown in Figure 2.

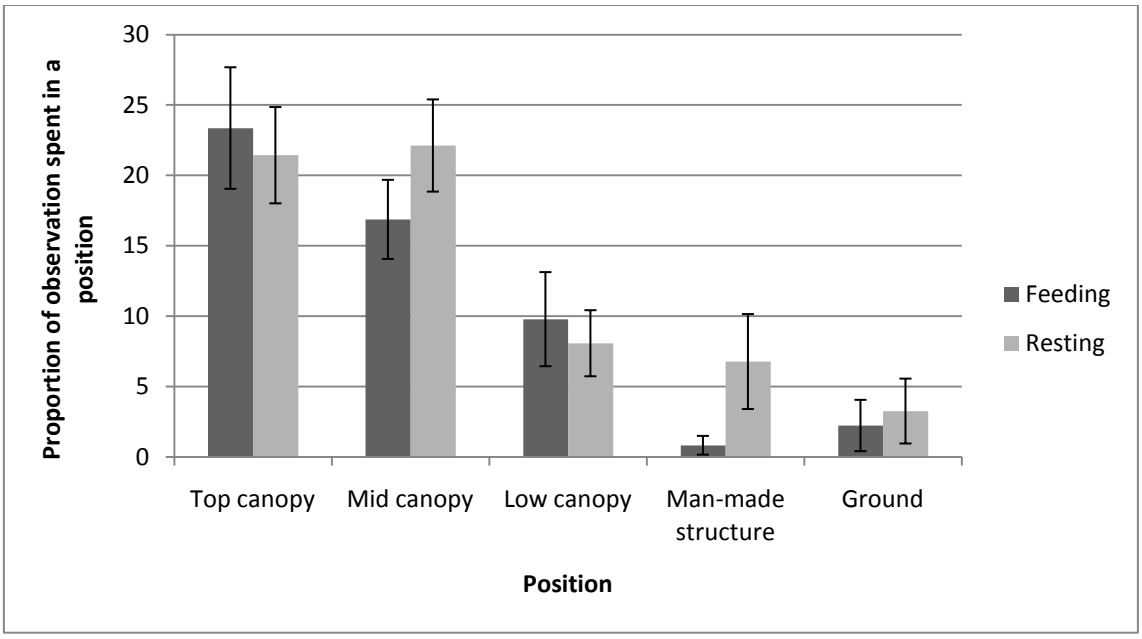

Figure 2. Proportion of observation spent on the behaviour feeding and resting in different positions for the monkeys in the two forests. Top canopy, 10 m and above; mid canopy, 5-10 m; low canopy, 0-5 m; man-made structure, wall, roof, bridge etc.; ground, 0 m.

The positions in top canopy and in mid canopy were the ones that were most preferred. There were no differences in the use for feeding and resting. The monkeys spend more of the observations feeding ($P < 0.001$, $H = 12.12$, $DF = 1$) and resting ($P < 0.001$, $H = 13.23$, $DF = 1$) on low canopy than on ground. Feeding on low canopy was more preferred than feeding ($P < 0.001$, $H = 12.12$, $DF = 1$) on man-made structure while there was no significant difference for resting on man-made structure compared to the behaviour on low canopy. There was no significant difference in resting and feeding between man-made structure and ground.

3.3.Home ranges of the four troops

The GPS points from all of the observation periods were merged together to analyze the utilization of the four troops habitats in the two forests in Diani Beach (Figure 3).

Figure 3. The utilization of the four troops' habitat in the two forests of Diani Beach. The marks on the map are the GPS points retrieved from all of the observation periods. The light and the dark circles are CT1 and CT2 in the CT forest. The quadrangles and triangles are BB1 and BB2 in the BB forest.

There were some variations in the measured home ranges between the two forests BB and CT. The largest home ranges were in the CT forest where CT1 utilized an area of 0.061 km^2 and CT2 an area of 0.053 km^2. In the BB forest the troops utilized a slightly smaller area; the home range of BB2 was 0.049 km^2 while BB1 occupied the smallest home range of all the troops with an area of 0.022 km^2.

4. DISCUSSION

4.1.The use of positions in the two forests

The most common position in the two forests were top canopies (> 10 m) and mid canopies (5-10 m). The troops in the BB forest were most generally observed in top canopies, while the troops in the CT forest preferred mid canopies. The results from my study may be comparable to the study conducted on a population of *Colobus angolensis palliatus*, also in the Kibale district. The population was commonly observed in forests of mixed vegetation with numerous tree species at various heights (Anderson et al., 2007c). The areas inhabited tree species reaching approximately ten meters and above except from the perennial plantations were the average tree height was three meters. *C. a. palliatus* was generally observed in tall vegetations reaching six meters and above (Anderson et al., 2007c). This is also a preference for several sub-species of *C. angolensis* (Thomas, 1991).

It is important to mention that the forests heights in the two forest types in my study were different from each other. The BB forest contained solely trees reaching over five meters and consisted of more trees taller than ten meters compared to the CT forest. This may explain the results from the BB forest were most of the behaviours observed were performed in top canopies.

However, the preference for top canopies is common in other studies of *C. angolensis* and its close relatives. Abyssinian black and white colobus (*Colobus guereza*), western red colobus (*Colobus badius*) and *C. angolensis*, all prefer the top canopies for different behaviours (Thomas, 1991; Gebo & Chapman, 1995a). The mid and low canopies are more utilized by *C. badius* then by *C. guereza*, the latter is rarely seen in low canopies (Gebo & Chapman, 1995b).

The position on ground was seldom recorded in this study though it occurred in several observation periods. The troops in the CT forest utilized the ground more frequently than the troops in the BB forest. The behaviour shown on ground was mostly moving (André, personal observation). One troop in the BB forest, BB2 was never observed on ground, this may be due to the absence of canopies close to the ground in their home range. Despite the general selection for top and mid canopies, both *C. badius* and *C. guereza* are known to be seen on ground occasionally (Gebo & Chapman, 1995b).

The BB2 troop was the least habituated troop and may therefore have resulted in their wide use of top and to some extent mid canopies. The position in tall vegetations could in this case be a predation-avoidance behaviour, making it more difficult for the predators to detect and approach the troop (Reichard, 1998). For moustached monkeys (*Cercopithecus cephus)* in Gabon the use of what the observers called a "safe place" which was located in a tree between 10 and 35 meters from the ground, was utilized for resting and if alarm calls were given in the troop (Tutin et al., 1999). Observations made on white-handed gibbons *(Hylobates lar)* shows some evidence that females, infants and juveniles often uses the tallest trees in their home range to avoid predators (Reichard, 1998). This might explain the behaviour in the BB forest, however no such observations have been made of the troops in this study.

4.2.Feeding and resting in different positions

The result from this study indicates a preference for top and mid canopies when resting or feeding. It seems like the behaviour performed in tall vegetation is similar to other relatives of the sub-family *Colobinae.* For *Colobus guereza* both resting and feeding is more

common in heights over 15 meters, while *C. badius* prefer to perform the behaviours in canopies reaching six meters and above (Gebo & Chapman, 1995b).

Resting or sleeping in tall trees is also common for other primate species. White-handed gibbon *(Hylobates lar)* is associated with resting in large and tall trees as well as wedge-capped capuchin (*Cebus olivaceus).* The latter species' troop size and selection of level of vegetations is known to be correlated; smaller troops were observed to be found higher up in trees when resting compared to larger troops (Reichard, 1998). The assumption is that a smaller troop may have less chance to detect a predator compared to a larger troop. When positioned in tall vegetations the troop is less likely to be approached by a predator from the ground (Reichard, 1998). As mentioned previously the troop size in this study was somewhat different from each other. This could have implicated that smaller troops preferred resting in taller vegetations whereas larger troops may have utilized lower vegetations for the same purpose.

The temperature may also have a significant role when choosing the height in a tree. *H. lar* often selects trees with dense canopies when resting in the tree tops (Reichard, 1998). The same behaviour has been shown for western black and white colobus (*Colobus polykomos*) which frequently has been observed resting in tree tops just below the canopies during the hottest parts of the day (McGraw, 1998). The behaviour of seeking shadow is speculated to be a temperature-regulating mechanism which is also known for other species of *Colobinae.* In contrast, a population of *Colobus angolensis* in Zaire has repeatedly been observed in top canopies without any shadow, feeding or sun-bathing (McGraw, 1994). It is infeasible to make assumption as mentioned previously, as no data of the temperature were collected in this study. Though it is still interesting that the observation made on the troops were recorded during the end of the dry season, which had a temperature above the average (A. Donaldson, The Colobus Trust, personal communication, March 2011) and may therefore have influenced the troops' utilization of top canopies.

Feeding in low canopies was the third most common position for the behaviour of the troops in this study. The result is comparable with *C. guereza* and *C. badius* which both preferred low canopies after top and mid canopies for feeding (Gebo & Chapman, 1995b). This study also indicates that feeding in low canopies was more frequently observed than feeding on man-made structure and on ground. In a study of several species of *Colobinae* the dominant behaviour on ground was feeding, which occurred rarely, while resting took place exclusively in trees (McGraw, 1998). It is of interest that the troops in this study utilized the position on ground for both feeding and resting indifferently. Feeding often occurred on ground when vines were present (André, personal observation). The behaviour is similar for the ground-dwelling pata monkey *(Erythrocebus patas)* (Enstam & Isbell, 2004) and the arboreal sooty mangabey (*Cercocebus atys)* where the latter spend almost 50 % of their feeding behaviour on ground (McGraw, 1998). There are some fascinating dissimilarities between the troops of *C. a. palliatus* in this study. Only the troop BB2 has never been observed on ground, this presumably due to the widely distribution of tall trees in their forest. Neither has this troop been observed on man-made structure, very likely for the same reason, while the other troops has been observed several times for both the positions. Especially man-made structures such as roofs and fencing posts has been particularly utilized for CT1 and BB1 where both feeding and resting behaviour occurred (André, personal observation).

4.3.Home ranges of the four troops

Folivorous primates are known to inhabit smaller home ranges than primates depending on fruits and insects. This is due to a more generous distribution of their primary feed such as leaves compared to other food items. Frugivores and insectivores spend more of their time feeding and moving, in contrast to folivores that spend more time resting and travels shorter distances during the day (Fashing et al., 2007).

The highly folivorous *Colobus guereza,* is a well documented relative to the smaller *C. angolensis palliatus*. In Ethiopia there is a correlation between home ranges and types of habitat in the population of *C. guereza*. The home range for troops in small and fragmented forests varies between 0.001 and 0.005 km^2, while troops in larger and more continuously distributed forests occupies an area of approximately 0.15 km^2 (Dunbar, 1987). The differences may be due to high population density and competitions in food from other species occurring in the same habitat. The conflict may force troops to expand their home range in search for adequate feed (Dunbar, 1987; Thomas, 1991).

The results of the troops' home ranges from this study may not be comparable with the results of *C. guereza*. In Dunbar (1987) the observations were made during both dry and wet season, and the change in season, weather and temperature may have affected the distribution of the population's home ranges. It is difficult to determine if a comparison between the two studies is realistic when only a part of the dry season has been documented in this study. There is also the fact that no statistical analysis has been made and that the troops' GPS positions has been recorded for only four days each. When measuring the home ranges, the animals' movements from several months and seasons are taken into account and the mean value and variance is presented (Börger et al., 2006). However it is still interesting to make some descriptive assumptions of the troops' home ranges and types of habitat. There are some visual differences between the study of *C. guereza* and the troops of *C. a. palliatus*. The troops in the small and fragmented forest CT had the largest home ranges, while the troops in the more pristine BB forest had smaller ones. This is the opposite to the home range sizes and habitat types of *C. guereza.*

The differences between *C. guereza* and *C. a. palliatus* may be due to the fact that *C. a. palliatus* has been noticed in 55 of 124 unprotected coastal forest fragments in the Kwale district (Anderson et al., 2007b; Anderson et al., 2007c). The habitats in this area are known as mixed habitats due to a mosaic of vegetation types and it has been documented that *C. a. palliatus* utilize the matrix as pathways to other areas in their home range. Reports of troops in the forests of Diani Beach shows they can be found up to 4.2 km from the nearest forest (Anderson et al., 2007b). These pathways may contribute to the troops of the CT forest to enlarge their home range areas mainly because a fragmented forest may not be able to meet the troops' nutritional requirements.

Another important aspect is the size of the troops. The troops of the CT forest had a total number of 18 individuals while there were 13 individuals in the BB forest. According to Onderdonk & Chapman (2000), troop size may affect the home range area. An increase in group size may eventually result in reduction of food resources. The troops may then have to travel further distances and thereby expanding their home range area.

4.4.Reflections

4.4.1. Implications of the method used

The method used to obtain data in this study was instantaneous sampling. According to Altmann (1974) this is the most utilized sampling method for behavioural studies conducted in free ranging animals in group constellations. It is often combined with scan sampling or focal animal sampling. In this study focal animal sampling was made on two individuals simultaneously. In the pre-pilot study which was carried out for one day, the scan sampling method was tested with unsatisfying results. The troops CT1 consisted of nine individuals, which made it difficult for an untrained eye to recognize and locate all individuals. In the pilot study the focal animal sampling was then examined and to receive more behavioural recordings two focal animals instead of one were used. There was a noticeable issue when using two focal animals, such as risk of losing one individual while focusing on the other.

Another negative aspect of using two focal animals is that an individual may be observed more often than others. The focal animals were selected randomly among the individuals of the troop and it was usually the most visible ones that were chosen. This is feasible according to Altmann (1974) but there is also a greater likeliness that the previous chosen individual will be selected in the next adjacent observation session if the rest of the troop is out of sight. Even though careful selections of focal individuals were made in this study some individuals may have been observed more than others. The unequal numbers of individuals in the troops may also have contributed to more frequent observations of individuals in smaller troops than in larger troops. This may have resulted in misleading results and data if some of the most frequently observed individuals, for example performed some non species-specific behaviour.

In most of the studies conducted on *Colobus angolensis palliatus* and its relatives, scan sampling has been used. There are therefore some difficulties when comparing the results from this study with other field studies. It would have been preferred to use scan sampling to obtain sufficient behavioural data. In this study, however, it was unrealistic due to the small number of observation days. When using scan sampling it is important to be able to identify each individual in a troop when recording behaviours (Altmann, 1974). This was not manageable for the troops in this study because each troop was only observed for four days. The recorder or observer was restricted to spend two days with each troop, which was a short time to enable to recognize characteristic features of each individual.

Even though a number of difficulties have been noticed during the use of this method, the instantaneous sampling method was regarded as applicable for obtaining adequate data for my study's aim.

4.4.2. Other sources of errors within this study

In other behavioural studies of primates there is a tendency to observe troops for several weeks, months and even years. This study only contains 16 days of observations and may therefore not be able to give an accurate insight of the troops' behaviour. Observations of the troops for at least two months and especially in overlapping seasons may have given a more reliable result regarding the troops' utilization of their habitat and also taking seasonal changes in account.

In this bachelor thesis an elongating in collection of data was not manageable, though the design of the study could have been made differently. An example to collect more

behavioural data could have been to observe more hours per day to ease the comparison of time-activity budgets and home ranges with other studies.

A measurement of the temperature could also have been made during the observation days to retrieve more information of the variation in the weather. Having the temperature as a guideline would have indicated if defined behaviours were more frequently observed during certain weathers.

Observational biases may have affected the collection of data. The definitions of the behaviours and tree heights were well known among the observers and recorders but there could sometimes be difficult to estimate the position or specify the behaviour of an individual. The assumption of the behaviour or position could therefore vary between the individuals among the teams.

4.4.3. The future of *Colobus angolensis palliatus*

C. a. palliatus is listed as least concern in the IUCN red list of threatened species (Kingdon et al., 2008b). A large part of the population inhabits an environment that is changing and is therefore consequently vulnerable to deforestation, since the species diet generally consists of leaves and seeds (Kingdon et al., 2008b).

The protected Shimba Hills Nature Reserve housed in 2007 around 1,600 to 3,300 individuals while the unprotected forest of Diani Beach and Shimoni consisted of 550 individuals altogether. In the latter the forests are fragmented due to human activity (McDonald & Hamilton, 2010). Distribution of infrastructure, construction of hotels and enlargement of agriculture land may scatter an existing forest. With forest fragmentations a diversification of the landscape comes along within the population's primary habitat. The habitat loss is of great concern for the species survival. In a study of tree species mainly used for wood carvings, fuel wood and charcoal, 216 species were identified. Ten of them were native species which stand for more than 45% of the utilization. Nine of the species were found to be food trees for *C. angolensis* and four of them are known to be major food trees (Anderson et al., 2007b). Loggings of forests affect the biodiversity and may also impair other species of primates.

The forests in Diani Beach and Shimoni are severely affected by deforestation (Anderson et al., 2007a). The area accommodate two of the largest populations of *C.a. palliatus* and are therefore of great importance for the conservation of the specie (Anderson et al., 2007a). More scientific research particular in this area needs to be done in order to maintain a sustainable population and to obtain more knowledge of the specie. Future research may also contribute to other species in the area, both plant and animal species which the deforestation also affects. *C. a. palliatus* could therefore act as an umbrella species in the conservation work.

5. CONCLUSIONS

I consider instantaneous sampling on focal animals as used in this study as applicable for my research aim.

The result of this study displayed that *Colobus angolensis palliatus* had a preference for top and mid canopies for different behaviours. On occasion some of the troops were also observed using ground as a position. The home ranges of the troops had some variation in area size, presumably due to presences in different types of habitats.

It is important that research of *C. a. palliatus* is being continued. A large area of the population's habitat consists of fragmented forests. If the degradation of the forests continues the threatened *C. a. palliatus* may suffer from extinction. The species is not as well documented as some of its relatives. This study which is a pilot study for a master's thesis may therefore contribute to a substantial knowledge in the behaviour and ecology of *C. a. palliatus*.

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