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Activity budget of Preuss's red colobus (*Procolobus preussi*) in Korup National Park, South-West region, Cameroon

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ABSTRACT

Preuss's red colobus is critically endangered and endemic to Cameroon and Nigeria. It is one of the least studied red colobus species and therefore further knowledge about the species is crucial for conservation work. Activity budget of Preuss's red colobus was carried in the southern part of Korup National Park, South West region of Cameroon for 18 months and was aimed at contributing to the understanding of the species general behavioural pattern for conservation. Time interval scan sampling method was used for this study. Two thousand three hundred and three individual observations were recorded from 273 group scans for 462 hours. Results revealed general activity time budget for the species, activity related to seasonality, period of the day and age class. In general, this species spent 1: 1: 1: 4: 2 resting, feeding, moving, others and socializing respectively. In wet season they spent more time in all the activities 1: 1: 1: 1: 4 resting, moving, feeding, other and socializing respectively more than in the dry season. Their activity budget within a day revealed the following results: feeding 9: 7: 6 afternoon, morning, mid-day respectively, moving 1: 1: 4 mid-day, morning, afternoon respectively, resting 1:1:2 mornings, mid-day and afternoon respectively, socializing 4: 1:0:2 mornings, mid-day, afternoon respectively and other 1: 1: 3 morning, mid-day, afternoon respectively. Results on the activity budget of age class indicate that adults spent more time feeding (16.31%), resting (25.72%), moving (13.09) than juveniles and infants but infants spent more time socializing (5.55%) than adults (1.58%) and juveniles (00%). This study therefore gives a basic clue of activity budget of Preuss's red colobus, specific for Korup National Park, experiencing human threat. This information can play an important part for the proper management and conservation of this species.

INTRODUCTION

Preuss's red colobus (PRC) are classified as Old World monkey with large body size and are endemic to Africa. They are social primates like other species of red colobus and live in multiple- male/ multiple-female social groups of up to 70 individuals (Groves, 2005). Other red colobus species occupy montane forest, dry Coastal forest and gallery forest living in the upper and middle forest canopy (Werre, 2000; Siex, 2003; Nowk, 2008; IUCN, 2010) but PRC is known to occupy mainly low land rainforest and live in the upper canopy in Korup National Park (KNP). PRC are reported to be strictly arboreal and feed mostly on immature leaves of *Lecomtedoxa Klaineana*, *Xylopiaa ethiopica* (Usongo, 2001) unlike other species of red colobus that sometimes come to the ground to feed on aquatic plants, soil or charcoal or to cross forest gap (Galat-Luong and Galat, 2005). PRC is listed as Critically Endangered on the IUCN Red List of Threatened Species because of hunting pressure and destruction of its habitat; this has led to a decline of more than 80% over the last three generations (Oates 2011). Large proportions of remaining group are included within protected areas (KNP, Cross River national park, and Ebo proposed national park) (Oates et al., 2008). Until recently, PRC has been the focus of few studies (Oates, 2011) and is one of the least studied and this lack of basic knowledge makes conservation effort work difficult. The only study of the species was on their feeding behaviour in Korup National Park (KNP), Cameroon by Usongo and Amubode (2001). Other published information of this species has been limited to sightings and Conservation recommendations (Dunn and Okon, 2003; Linder, 2008). As with other red colobus, PRC is the subject of taxonomic dispute (Groves 2001). For consistency, we follow the taxonomy put forward by Groves (2001) and Struhsaker (2010) as *Procolobus preussi* because of their unique complex vocal repertoire.

Behavioural studies have been published on most species of red colobus (Struhsaker, 2010) yet no study has been published on the activity budgets or behavioural patterns of PRC in general. This study is the first to describe the activity budget of PRC. A change in activity pattern is the most readily measured response to environmental changes (Addisu, 2008). This study was aimed at contributing to the understanding of PRC's general behaviour pattern by evaluating the time spent on the various categories of activities throughout the day and also to examine the effect of seasonality on the various activities.

MATERIALS AND METHODS
Study area

Korup National Park is situated in the South West Region of Cameroon ($4^o53'$-$5^o28'$N and $8^o42'$- $9^o16'$E) and covers 126000 ha of lowland evergreen forest (Figure 1). The region has a single dry season that span from December to February with the hottest month being February. Wet season spans from March to October and August being the coldest month with an average monthly rainfall of 500 mm (MINEF, 2003).

The flora in KNP is dominated by *Protomegaba riamacrophylla*, *Anthonotha fragrans*, *Erythrophleum ivorensi* and *Xylopiaa ethiopica)* (Usongo and Amubode, 2001). The study area is dominated with tall trees. KNP is made up of 14 species of primates including Preuss's red colobus (*Procolobus preussi*), putty-nosed guenon (*Cercopithecus nictitans*), red-eared monkey (*Cercopithecus erythrotis*), crowned money (*Cercopithecus pogonias*), mona monkey (*Cercopithecus mona*), drill (*Mandrillus*

leucophaeus) red-capped mangabey (*Cercocebus torquatus*) and Chimpanzee (*Pan troglodytes*). Drill and Chimpanzee are classified as Endangered; Preuss's red colobus is rated as Critically Endangered in the IUCN Red List and are of particular conservation importance (IUCN, 2010). Red- eared guenon is confirmed to be vulnerable (Oates, 2011).

Methods

Time interval scan sampling procedure was appropriate to use due to the fact that Preuss's red colobus are social primates and are notoriously hard to identify individually (Addisu, 2008; Zeno et al., 2012). Groups were followed randomly at least 5 days per month for 18 months along a permanent transect and human and animal trails (Figure 1). Time interval scan sample was recorded during a 5-minutes period every 20 minutes from dawn to dusk on every day following. Data collection time was partition into three period of the day (morning 6 am to 10 am, mid-day 10 am to 2 pm and afternoon 2 pm to 6 pm). The activity of the first animal seen was recorded at the beginning of each 20 minutes period, but 5 minutes was allowed to find and observe the selected individuals and 15 minutes was used to prepare for the next scan and to record opportunistic data. During each scan, eight individual that could be seen were earmarked for observation. Scanning was done each time from left to right on the first scan and from right to left on the next scan so as to avoid possible biases on eye catching activities such as grooming, mating and fighting (Fashing, 2001). For each scan notes were taken for the following activities: resting (to be inactive, in standing, sitting or lying position (either alone or in group), movement (on motion either by climbing, jumping, running or walking) without picking up or consuming food items or engaged in another behaviour), feeding (to search for, handle, process or consume any food item), social (Grooming, aggression, playing and sexual activity) and other activities (vocalization, watching observer, urinating and defecation).

Data was also collected on age/sex class, females with clinging infants or those with conspicuous perineal swelling were identified. Adult males and females were merged as adults since there were few scores of adult males and females. Adults were those that had reached full size and that appear to have reached reproductive maturity. Juveniles were those that have not reached adult size and were not carried by their mothers. Infants were small still cling to their mothers.

Data analysis

To evaluate time budgets, all activity budgets were first assigned to one of the activity category such as resting, moving and feeding to determine the proportion of time budget allocation of Preuss's red colobus for different activities. First, the proportion of the number of behavioural records for each activity category represented was divided by the total number of activity records (Vasey, 2005). The behavioural records were used to calculate the time budgets for each day and then summed within each month to provide the overall wet and dry season (Di Fiore and Rodman, 2001; Di Fiore, 2003). The data was analysed with Chi-square tests on the time distribution of all behaviours.
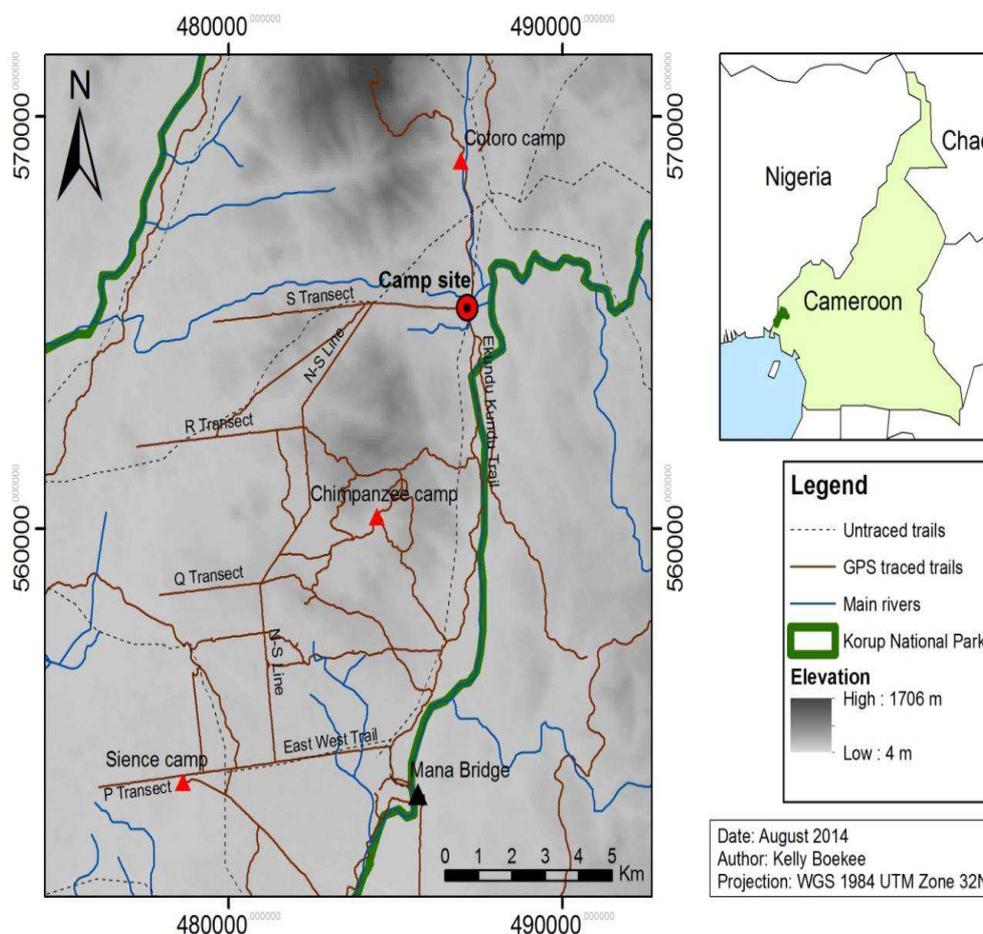
Figure 1: Map of KNP showing trails and transects of study site used for survey (Kelly, 2014).

RESULTS

General activity time budget of Preuss's red colobus

For a total of 462 hours, 76 groups of PRC with 273 group scans comprising 2303 individual were observed with no clear limitations towards repeated counts. The different activities observed were feeding, movement, resting, socials (grooming, fighting and playing) and others (urination, scan, and defecation). Amongst these activities, the main activities were feeding, movement and resting. Social and others were a combination of activities that do not occur frequently. Figure 2 below reveals the different proportion of activities observed during data collection.

The relative frequency distribution of all the recorded activities is as follows; resting 29.74% feeding 23.66%, moving 23.14%, others 16.50%, and socials 6.95%.

Activity time budget related to seasonality

Seasonality is a factor that can affect the activities of PRC. Seasonal variation (dry and raining seasons) on the various activities (Feeding, moving, others, resting, and socials) are presented in Figure 3.

Figure 3 shows that PRC spent more time resting (21, 62%), moving (18, 02%),

feeding (17, 69%), other (13, 29%) and socializing (5, 21%) in the wet season than in the dry season. Resting is the activity that is frequently performed amongst other activities by PRC in both seasons.

Activity time budget in relation to period of the day

A total of 1784 observations of general behaviour were made during the period of data collection. Out of these observations, 722 observations were recorded during morning periods, 709 during midday, and 353 in the afternoon (Table 1).

From Table 1, the most frequent activity that took place in mid-day and morning period was resting followed by movement and in the afternoon feeding dominated followed by resting. Social activity was more in the morning and mid-day than was in the afternoon. The Chi- square test behaviour was significantly dependent on the three periods of the day (P<0.05). The relative frequency of the different behaviours was not evenly distributed throughout the three period of the day.

Activity budget in relation to age class

Activity budget has an effect on the age class of Preuss's red colobus. The activity budget of adult Preuss's red colobus is different from that of juveniles and infants. As seen on Table 1, there is a difference in the activity budget in relation to age class.

Adult Preuss's red colobus spend more of their time resting (25.72%), follow by feeding (16.31%), then movement, in addition they spent least time in social activity (1.5%). For juveniles, they spend more time resting (6.78%), followed by moving (4.21), which is different from Adults and Infants followed by feeding (3.62) and the least is 'others' (0.82%), they did not perform any social activity. Infants show a high percentage (5.79) of movement, followed by social activity (5.55%), then feeding (2.98%). Across the age class, adults spend more time feeding (16.31%) than juvenile (3.62%) and infants (2.98%). But for social activity (5.55%), infants spent more time than adults and juvenile.
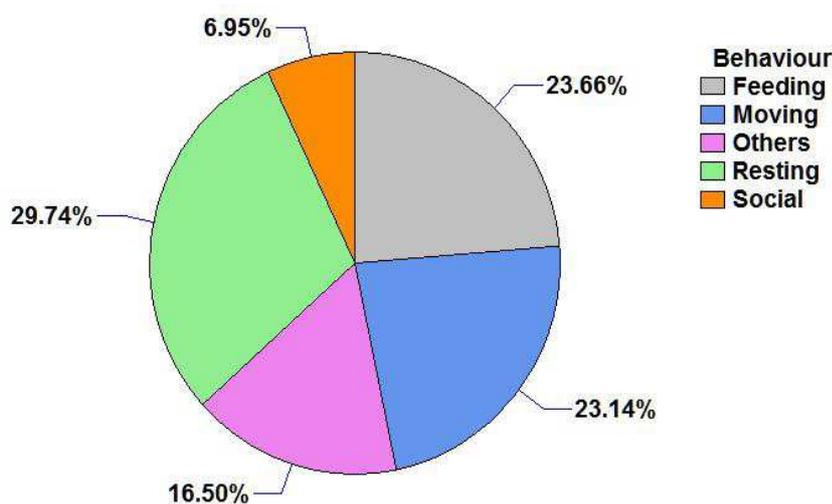
Figure 2: Distribution of relative frequencies of all recorded activity.
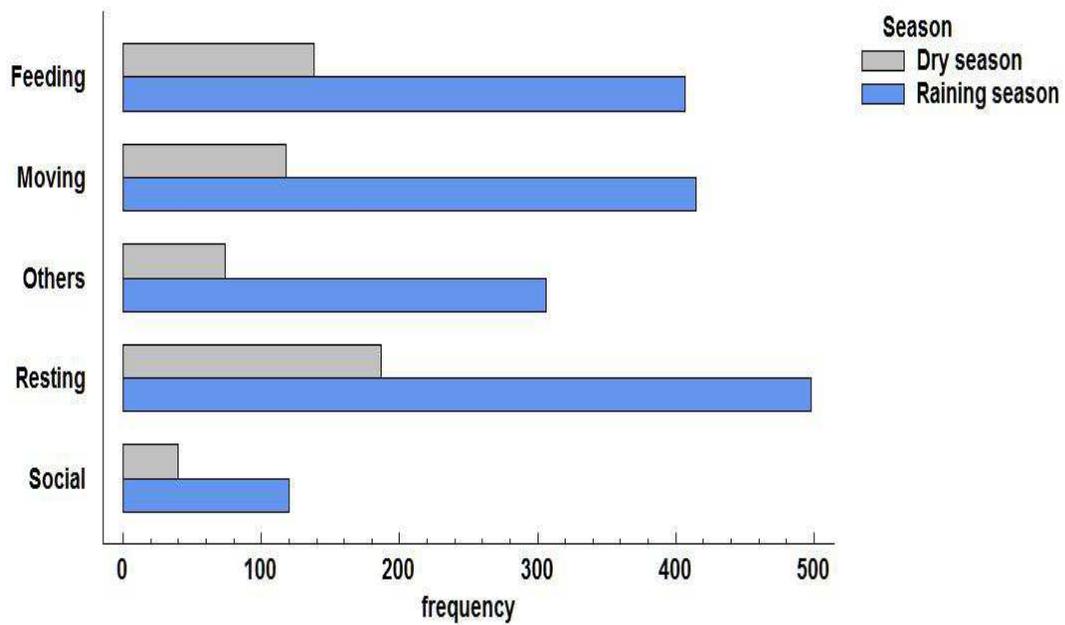
Figure 3 Seasonal activity time budgets for Preuss's red colobus in KNP.

Table 1: Comparison between daily relative frequencies of the behaviour (Feeding, moving, resting, socials and others).

Time period	Feeding	Moving	Others	Resting	Social
Afternoon	8.52	3.14	1.91	6	0.17
Midday	6.33	12	4.99	13.57	2.8
Morning	7.29	9.3	5.55	14.29	4.15

Table 2: Activity budget for Preuss's red colobus for different age class.

~age class in month	Age group	Feeding (%)	Resting (%)	Moving (%)	Social (%)	Others (%)
>52.5	Adults	16.3	25.72	13.09	1.58	11.22
6.5-35.5	Juveniles	3.62	6.78	4.21	00	0.82
2-5	Infants	2.98	2.34	5.79	5.55	00

~ = approximate

Table 3: Summary of activity time budgets of red colobus species by research site.

Species	Study site	Country	Rest %	Feed %	Move %	Social %	Other %	Reference
P. preussi	Korup,	Cameroon	29.7	23.7	23.1	7	16.5	Authors
P. pennantii	Gbanraun,	Nigeria	33	37	25	6	0	Were (2000)
P. tephrosceles	Kanyawara	Kibale	34.6	44.8	9.1	4.5	0	Strushaker (2010)
P. tephrosceles	Ngogo,	Kibale	35.6	32	8.7	7.3	0	Struhsaker (2010)
P. tephrosceles	Gombe,	Tanzania	54	25	8	5.5	5	Clutton-Brock(1974)
P.rufomitratus	Mcheleto,	Tana River	47.8	30	7.2	2.1	0	Mash (1981)
P.rufomitratus	Abuko,	Gambia	52.4	21	12.5	5.6	0	Starin (1991)
P. kirkii	Jozani forest,	Zanzibar	47.3	28.7	12.1	5.3	5	Siex (2003)

DISCUSSION

To date there is no published information on behavioural pattern of Preuss's red colobus. Therefore, comparison on behavioural pattern was made with members of different species of red colobus study in different countries (Table 3). Comparison of Preuss's red colobus with other species should be considered with caution due to differences in species, methodology and forest composition in different studies. However, this can give some information on how Preuss's red colobus are similar or different with other species.

Several studies of different species of red colobus from varying study sites and countries (Were, 2000; Siex, 2003; Struhsaker, 2010) record activity budget that are similar to that of this study even though the percentage of this study is generally lower than most of other study sites except for 'other' behaviours with high percentage (Table 3). However these differences could be partially due to differences in operational definitions of behaviours and categories used by other researchers and conservation status

Preuss's red colobus, in this study, spent less time resting (29.7%) just like the red colobus (34.6% and 35.6%) in Kibale and red colobus (33%) in Gbanraun (Struhsaker, 2010; Were, 2000) as oppose to those of the other groups in Gombe Tanzania, Abuko Gambia and Mcheleto Tana River that spent more of their time resting (54%, 52.4%, and

47.8% respectively) (Clutton-Brock, 1974; Marsh, 1981; Starin, 1991) (Table 3). This difference might be due to their climatic conditions and habitat. Tropical rainforest (Korup National Park, Kibale and Gbanraun) have higher elevation and cooler climate than the other study sites. Tropical rainforest is less seasonal than the other study sites in terms of intermonth variation of rainfall and temperature (Struhsaker, 2010). This can partially explain why red colobus spent less time resting in the Tropical rainforest study sites. Marsh (1981) supported this fact by showing that when temperature is high, *Procolobus rufomitratus* spent more time resting and less time feeding.

Concerning seasonality, there were significant differences between seasons in the activity time spent in feeding, resting, moving, social and other. This difference may be attributed to environment, dietary variables and the length of the season (Shah, 2003). PRC spent more time feeding in the raining season than in the dry season. This may be attributed to the fact that in raining season PRC spend greater amount of time to feed on the abundance of young leaves to satisfy their energy requirements compare to the dry season. They also spend more time resting during the rainy season than the dry season. This period is the time where much food is consumed and so need more rest to digest the food. In addition, they adopt a curled posture on the canopy during heavy rainstorms and

when temperature is low (personal observation). On the other hand, Dasilva (1992, 1993) argued that this phenomenon only takes place in colobus species (*Colobus polykomos*) because of their large body size and do not occur in Procolobus due to their small body size, which requires them to maintain higher-quality diet (Oates, 2011). Information on the activity budget of diurnal variability of red colobus is lacking. Therefore, comparison cannot be made with other red colobus species.

Arboreal primates are involved in daily rhythms of behavioural activity (Clutton-Brock, 1993; Lawes and Piper, 1992) and feeding is their peak activity in the morning and afternoon period. There is a slight difference with those of Preuss's red colobus that spend more time feeding only in the afternoon and more time resting in the morning and mid-day, even though the trend of feeding is high in the morning and afternoon (Table 1). This could be an adaptation to temperature changes during the day and it could also be a way of maximizing food intake, assuming that feeding time is limited by digestion time (Harrison, 1984).

Adults spend more time feeding than juveniles and infants, the reason are not really clear. Feeding would have been expected to show high scores in infants follow by juvenile since they are growing. This can be probably because some of them are still suckling and more so they spend more time moving and playing. Infants spend more time in moving and social (>90% is playing). These higher scores are attained by lower resting scores. Infants could hardly be seen isolated; they were always closer to one another or to their mothers. This is probably related to their high playing scores and that they still depend on their mothers.

Conclusion

In the light of the foregoing, Preuss's red colobus exhibit five different categories of behaviour (resting, feeding, moving, social and other) just like other red colobus species

in different African countries with resting as the most frequent activity. The age class structure of Preuss's red colobus indicates that adults spend more time feeding than juveniles and infants. This result was somehow bias for the fact that infants are supposed to feed more because they are young and need to grow. Nevertheless, comparison with other species of red colobus was not possible due to lack of information on activity budget of age class structure of different species of red colobus. Moreover, further research will be appropriate to confirm this result or prove it otherwise. Furthermore, the fact that this study could not distinguish male Preuss's red colobus from female could also have altered the result.

The activity budget for time period of Preuss's red colobus differ from those of other arboreal primates where feeding is the peak activity in the morning and afternoon which is different from that of Preuss's red colobus where feeding is the peak activity in the afternoon only. In this study of Preuss's red colobus behaviour, the findings suggest that the observed population differs in some of its behaviours from what has been described for other species of red colobus. In order to look into the reasons behind these differences, a longer study, in which more environmental factors are included in the analysis, together with comparative analysis with other populations, would be ideal. In such a study, individual identification would provide more options in the choice of method, which then could be extended to focal animal sampling in addition to scan sampling.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

SNF and VBE were the field investigators and drafted the manuscript. MM and TEA designed the study and supervised the work. All authors read and approved the final manuscript.

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