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Activity rhythm of Grauer's Gorilla: *Gorilla beringei* graueri (Primate, Hominidae) in Kahuzi-Biega National Park, (South - Kivu, Democratic Republic of Congo)

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Abstract

A study was conducted from 2012 to 2014 in the high altitudes of the Kahuzi-Biega National Park in the Democratic Republic of Congo with the aim of knowing the rhythm of activities of the gorillas of the Chimanuka family during visits. To carry out this study, scanning and focal animal methods were used. Six social behavior activities were considered, namely ground feeding, height feeding, foraging, habitat change, family resting, and agonistic interactions. It appears from this study that these activities overlap and take place differently according to the season during the time of the visits from 8 am to 12 pm. This rhythm of activities can help to organize attractive visits then to increase the tourist affluence in the park and to realize a lot of income.

Keywords: Grauer's Gorilla; Kahuzi - Biega National Park; Social Behaviour; Family Chimanuka; South Kivu

1. Introduction

There are in ten African countries from Nigeria to Uganda, two species of gorillas and four subspecies (Genton, 2012): the eastern gorillas *Gorilla beringei* includes the eastern lowland gorillas or gorillas of Grauer (*Gorilla beringei* graueri) and mountain gorillas (*Gorilla beringei beringei*). Western gorillas Gorilla gorilla includes Cross River gorillas (Gorilla gorilla diehli) and Western lowland gorillas (Gorilla gorilla gorilla) (Yumoto et al. 1994 and Wilson and Reeder, 2005).

Our study focuses on one of the eastern gorilla subspecies, the Grauer's gorilla (*Gorilla beringei* graueri), also known as the eastern lowland gorilla. It has been known as a distinct subspecies of the mountain gorilla since 1914 (Matschie, 1914). It is found only in the Democratic Republic of Congo where it inhabits lowland and mountain forests up to 2,500 m, with numbers that would be less than 3,000 individuals (Nixon et al., 2005). It is one of the country's endemic species (Yamagiwa et al., 1996b). This characteristic militated during the creation of the National park of Kahuzi - Biega, in initials, PNKB in the East of the country by the Ordinance n° 70 / 316 of November 30, 1970 for the safeguard of this subspecies of gorilla by the setting aside of 60,000 ha of high altitude forests located on the Kahuzi and Biega mountains (Casimir, 1975a and 1975b).

The population of Grauer's gorillas living at high altitude in PNKB includes several families, of which eleven families have been identified and regularly monitored. They are made up of 144 individuals (ICCN, 2013). One of these families, called the “Chimanuka family” living at the high altitude of the park, is used to the human presence. It is the subject of regular educational and tourist visits from the Tshivanga station where the park management is located (ICCN, 2009).

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According to the local organization of the park, visitors leave from the Tshivanga station in the morning to meet the animals. Sightings only begin when visitors are in front of the gorillas as long as the animals allow. The time allowed for observations covers the period from 8 a.m. to 12 p.m. local time (Barhakaziga, 2010).

Visitors' satisfaction is not limited to the sight of the gorillas alone. It also includes the spectacle that the animals offer them and which they have witnessed. This spectacle encompasses a variety of activities and gestures that gorillas exhibit in front of observers (ICCN, 2012).

What activities do the animals undertake in the presence of tourists and during the authorized period for observations? It is to answer this question that we undertook the study of the rhythm of activities of the gorillas of the Chimanuka family.

The show fuels conversations among humans, ensures and nurtures the success of vision tourism at PNKB, the maintenance of gorilla habitat and the survival of the Chimanuka family.

1.1. Study environment

The PNKB covers an area of 600,000 ha (Butynski, 2001). It has two areas of different altitude: (i) the low altitude (5,400 km2) is located in the Congolese basin near Itebero – Utu. It includes the part of medium and low altitude forests added to the west of the park in 1978 and (ii) the high altitude (600 km2) at the western border of the Congolese basin, north-east of Bukavu (ICCN, 2009). This park has been the subject of many works (Mangambu et al., 2010).

It extends between $1^0$36' and $2^0$37' south latitude and between $27^0$33' and $28^0$46' east longitude (ICCN, 2012). The altitude varies between 600 and 3,308 m (ICCN, 2009). The highest elevations from which the park takes its name are Mount Kahuzi (3,308 m) and Mount Biega (2,790) (Casimir, 1975a and 1975b). Both mountains are at high altitude in the park where this study was carried out. It hosts the different families of monitored, semi-habituated and habituated gorillas.

The seasonal succession is determined by the proximity to the Equator of the PNKB region and its hinterland. There are two rainy seasons (March - May and September - December) followed by two short, relatively dry seasons (January - February and June - August). The rainfall regime in the region around Lake Kivu oscillates between 1,200 and 300 m in altitude (Wils et al., 1976).

2. Material and methods

Park managers successfully habituated the Chimanuka family to human presence in 2000 (ICCN, 2009). It accepts the human presence between 7 m and 10 m. The individuals of the gorillas quietly carry out their usual behavior. They can be monitored during visits or observations. Since that time, it has been the subject of vision tourism.

Our study was carried out from 2012 to 2014, i.e. 294 days in the field, including 168 days in the rainy season and 126 days in the dry season.

In 2012, the Chimanuka family numbered 33 individuals, including a dominant male called Sylver Back and bearing the family name (26 years old); 9 adult females (aged) from 15 to 23 years old; 5 Blackback males from 10 to 11 years old; 3 sub-adults from 7 to 9 years old; 6 juveniles from 3 to 6 years old and 9 babies from one to two years old (ICCN, 2012). In 2013, changes were observed within this family; it comprised 34 members. The structure of these members is as follows: 1 dominant male (27 years old), 10 adult females, 6 subadults from 6 to 8 years old, 7 juveniles from 3 to 6 years old and 10 babies (ICCN, 2013).

In 2014, the Chimanuka family numbered 31 individuals including 1 Sylverback (28 years old), 9 adult females, 3 Blackbacks, 4 subadults, 5 juveniles and 9 babies (ICCN, 2014).

The Tshivanga station has a team of 5 people responsible for locating the Chimanuka family every day using a MAP 60 CSX model GPS. We joined this team when collecting data on the activities of the members of this family. When in contact with the animals, we stopped at the regulatory distances of 7 m authorized for visits, taking into account the position of the dominant male (Macfie and Williamson, 2010). It happens that the dominant male does not tolerate the human presence very close to the members of his family. Its tolerance therefore conditioned the realization of the observations. Individual gorillas can approach at distances of less than 7 m.

Various information indicates that gorillas wake up as early as 5:30 a.m. during the dry season and around 7 a.m. during the rainy season (Barhakaziga, 2010). But according to the regulations of the Park, the visit of these primates for tourist purposes can only be done between 8 a.m. and 12 p.m. It was during this time of day that we also worked. Scanning was done at time intervals.

In relation to the object of our study, we have retained six main activities that gorillas perform in front of tourists. These are Ground Feeding (G.F.), Height Feeding (H.F.), Search Feeding (S.F), Habitat Change (H.C), group resting which we call "Family Resting". (F.R)" and Agonistic Interactions (A.I.) or confrontation between two families including the dominant male.

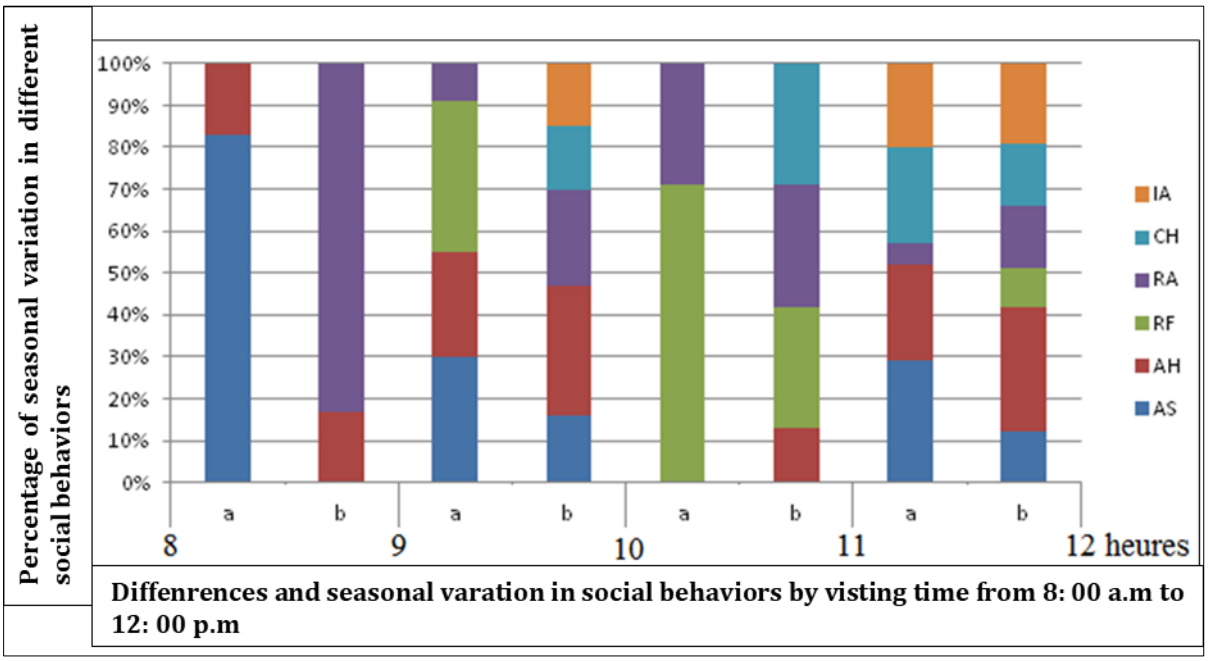
The quantification of these behaviors was made by the "scan" method (White and Edwards, 2001). To do this, we counted by a time interval regime of one hour the duration of each activity every 15 minutes with a Quemex chrono for 4 hours a day.

These data were taken for 21 days per month. They were counted for 168 days during the rainy season and 126 days during the dry season. The averages for each activity were calculated to have the data per hour of visit. These data were processed with Excel software to generate histograms relating to the activity rate of Grauer's gorillas at PN.

3. Results

Figure 1 shows how members of the Chimanuka family behave during the tourist period. Their activities are characterized mainly by fluctuations throughout the day and also between seasons.

At the first hour of contact with the animals, that is to say between 8 and 9 a.m., in the rainy season, all the members of the family devote themselves to feeding. If this behavior occupies the whole community, we see that the majority of individuals feed at ground level and very few go up high. This activity stabilizes the family which, moreover, makes few trips. At the same period in the dry season, there is a total change in behavior. Animals travel long distances in search of food. A few individuals still explore the tops of the trees in search of food. Thus, the first hour of the day is characterized by the immobility of the gorillas in the rainy season and by a lively activity of the animals in the dry season.



Legend: IA = Agonistic Interactions; CH = Habitat Change; RA = Food Research; RF = Family Rest; AH = Feeding at Height; AS = Ground Power; a = rainy season and b = dry season

Figure 1 Rhythm of activity of gorillas of the Chimanuka family

From 9 a.m. to 10 a.m., in the rainy season, feeding still occupies nearly half of the family members, some of whom stay on the ground and others high up. At the same time, a fairly large slice of individuals rests, and very few change their habitat. During the dry season, although the feeding behavior presents the same facies as in the rainy season, the

majority of individuals feed in height. The other animals remain active either they make short trips or they go elsewhere in search of food. It is during this period that agonistic interactions also occur within the Chimanuka family. Overall during this time interval, the group of animals remains stable in the rainy season and increases their movements in the dry season.

Between 10 and 11 a.m., the highlight of this period is family rest during the rainy season. This behavior affects most members of this family and very few change sites. In the dry season, animal behavior differs. More than half of them remain active as in the previous time slot. Rest only engages a small proportion of individuals. Overall during this period the gorillas display a stable behavior in the rainy season. This behavior involves few individuals during the dry season.

From 11 a.m. to 12 p.m., feeding behavior, both on the ground and at height, resumes in the rainy season for more than half of the members of the Chimanuka family. For the rest of the members, some move small distances from the group and others change sites to go elsewhere. Agonistic interactions are observed during this period. In the dry season, the types of activities are similar to those in the rainy season. The small difference that we have noticed lies in the fact that it is at this time that some individuals in the group are indulging in rest. Otherwise, as a whole and during this time slot, the gorillas become active again regardless of the season.

4. Discussion

During the rainy season when feeding on the ground, the gorillas do not move much and sightseeing is optimal especially between 8 am and 9 am. Gorilla visits are allowed each time for one hour at the Tshivanga station. (Yamagiwa et al., 2003) confirm that tourists should not spend more than an hour near habituated great apes.

In the dry season, ground feeding takes place between 9 and 10 a.m. and 11 and 12 p.m. Visits are possible but they are disrupted by the improvised movement of the gorillas of the Chimanuka family if food becomes scarce in places.

In the rainy season, we observe the feeding in height between 9 and 10 am and from 11 and 12 am but does not last. Low-rise branching of trees and shrubs at high elevations creates a dense canopy of evergreen foliage (Mühlenberg et al., 1994). The Head of Tour Guide delays the visits and waits for the animals to return to feed.

If the great apes are not readily visible on first approach, staff should escort and direct tourists 200 m away to wait until the great apes rest or move to an area with vegetation. is more open to then start an authorized period of observation for one hour (IRSNB, 2008 and Macfie and Williamson, 2010).

In the dry season, feeding at height is very characteristic. It takes place from 8:30 a.m. to 10 a.m. and from 11 a.m. to 12 p.m. This is the fruiting period. During this period the gorillas climb more to take the yellow fruits of Myrianthus holstii.

Weghe (2004) and Yamagiwa et al., 2005) show that gorillas climb trees mainly to pick fruit. Given their weight, adult males are seen there less often than females and young at height. Visits are very attractive with the observation of gorillas that gather to eat the fruits of Myrianthus holstii. The dominant male is observed mainly on the ground (Weber, 2005).

The Chimanuka family's search for food takes longer because of Myrianthus holstii's isolated feet at high altitudes. (Yamagiwa et al., 2003) mention that Grauer's gorillas consume more fruit than Bwindi's but not as much as western lowland gorillas.

In the rainy season, family rest can begin around 9.30 a.m. if food is plentiful, but takes place between 10 a.m. and 11 a.m. During this period, the visits are optimal and enliven the visitors who also take photos. This is the main time of the day during which the members of the group remain close to each other (RBINS, 2005). (Wilson and Reeder, 2005) mention that among mountain gorillas, visits are planned to coincide, if possible, with the gorillas' rest periods, allowing for excellent viewing conditions. It is the same for the gorillas of the Chimanuka family.

In the dry season, family rest occurs less and often late because the gorillas travel long distances before finding food. The rest time can vary from 10.30 a.m. to 11 a.m. and from 11.30 a.m. to 12 p.m. and often the rest is of short duration. During our observations, we noticed that few individuals associate during rest in the dry season. This activity would often involve the dominant male, an adult female, a juvenile, and a few babies. It was rare for all the family members to meet there as in the rainy season. The visits are not a success as during the rainy season and the animals are less attractive. They appear in small numbers of individuals and during a short rest period.

Another type of rest develops there: solitary rest away from the eyes of visitors and this behavior was not the subject of our study.

The search for food is observed during the rainy season from 10.30 a.m. to 11 a.m. if the family rest started early (9.30 a.m. to 10.30 a.m.). Foraging for food dominates during the dry season. It is done more than 8 am to 10 am. Gorillas travel long distances to search for the scattered feet of Myrianthus holstii. It is the main food during this period. Visits are inappropriate because it is difficult on the one hand to find the gorillas and on the other hand to follow them during this period. The feet of Myrianthus holstii are the sites sought by the gorillas and the meeting places of several groups. More than one visit has been canceled for not having found the Chimanuka family. Then the gorillas lose weight and they become aggressive.

The change of habitats does not manifest much during the rainy season. It can intervene after the family rest from 11 to 12 hours. This behavior is more noticeable in the dry season. It runs from 9 a.m. to 12 p.m. The gorillas run in single file and pass the dense secondary forests with isolated feet of Myrianthus holstii in the marshy areas with Cyperus latifolia finally the bamboo forests, these are forests with Arundinaria alpina. They also use tracks created in the park. During this activity, visits are reduced or suspended.

Agonistic interactions are less frequent during the rainy season than in the dry season. This activity takes place between 11 a.m. to 12 p.m. after resting or more frequently when foraging for typical food such as Afrocania volkensis fruits during the month of May. (Mühlenberg et al., 1994) report that the food of eastern lowland gorillas is fairly evenly distributed over their territory.

In the dry season, agonistic interactions are very frequent. They can take place from 9 a.m. to 10 a.m. and from 11 a.m. to 12 p.m. They are characterized in the dominant male in particular by the surveillance of the individuals of the family, the launching of violent cries and the beating of the chest. This behavior leads to the loss of some individuals of the gorillas. The Chimanuka family who lost 5 Blackbacks, 2 Adult Females and 2 Juveniles during a clash on July 2, 2014. We can also observe the death of some individuals following other fights. This is the case of the dominant male of the Langa family and the adult female Makali of the family studied. This loss of individuals weakens the cohesion at the family level of the Chimanuka gorillas and affects the success of the visitation activity. During the visits, the tourists observed fighting between two families twice in the rainy season and five times in the dry season.

5. Conclusion

The present study was conducted at high altitude in the Kahuzi-Biega National Park in order to know the rhythm of activities of Grauer's gorillas of social behavior during authorized visits of 8 to 12 hours. The Kahuzi-Biega National Park has experienced a decline in benefits due to tourist activities by the loss of two families who were accustomed to it and who were victims of periods of unrest. Knowledge of the activity rhythm of Grauer's gorillas and social behavior will allow park managers to apply a planned organization of visits according to favorable times and by season. This also has an impact on the awareness of visitors and local communities to guarantee the tranquility of the gorillas and their survival.

(Macfie and Williamson, 2010) report that visitation success expectations for a given site will depend on the type of tourist, the habitat, the species or subspecies involved, and the activity being offered. The pace of activities also contributes.

Compliance with ethical standards

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Disclosure of conflict of interest

I am Innocent MASIALA MABIALA author of the manuscript. Professors Séraphyn Ifuta Ndey and Julien Punga Kumanenge are thesis supervisors. I declare that there is no conflict of interest.

Statement of ethical approval

This study is carried out on the endemic subspecies of the Democratic Republic of Congo at Kahuzi – Biega National Park. I declare that *Gorilla beringei* graueri belongs to the Kingdom amimalia, phylum Chordata, Class of mammalia, Order of Primates, suborder Haplorrhini, Infra-order Simiformes, micro-order Catarrhini, Super family Hominoidae, family Hominidae, Species *Gorilla beringei* and subspecies *Goirlla beringei* graueri.

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