

# Roloway Guenon (*Cercopithecus diana roloway*) and White-Naped Mangabey (*Cercocebus atys lunulatus*) Prefer Mangrove Habitats in Tano é Forest, South-Eastern Ivory Coast

Sery Gonedelé Bi<sup>1,2\*</sup>, J-C Koffi Bené<sup>2,4</sup>, E. A. Bitty<sup>2,3</sup>, B. K. Kassé<sup>3</sup>, A. N'Guessan<sup>2,3</sup>, A. D. Koffi<sup>2,3</sup>, Bertin Akpatou<sup>2,3</sup> and Inza Koné<sup>2,3</sup>

<sup>1</sup>Department of Genetics, University Felix Houphouët Boigny, Abidjan, Ivory Coast, 22 BP 582 Abidjan 22

<sup>2</sup>Swiss Center for Scientific Research in Ivory Coast, 01 BP 1303 Abidjan 01

<sup>3</sup>Laboratory of Zoology and Animal Biology, Felix Houphouët Boigny, Abidjan, Ivory Coast University, 22 BP 582 Abidjan 22

<sup>4</sup>Cytology Laboratory and Animal Biology, University Jean Lorougnon Guédé Daloa, BP 150 Daloa

## Abstract

There are three primate taxa which have the same range in West Africa (eastern Ivory Coast and western Ghana): Miss Waldron's red colobus *Piliocolobus badius waldronae*, the Roloway guenon *Cercopithecus diana roloway* and the white-naped mangabey *Cercocebus atys lunulatus*. They were previously listed as critically endangered; however, *Cercocebus atys lunulatus* was recently downgraded to endanger. A series of surveys have been conducted since the early 1990s in the tropical forests of Ghana and Ivory Coast to survey these taxa. In 2006, these studies led to the conclusion that the Tanoé forest, south eastern Ivory Coast should be considered a top priority site for primate conservation in West Africa. From February 2008 to March 2008; and in March 2009, we carried out field surveys in the Tanoé Forest over 22 days to gather updated distribution information to assess the conservation status of all diurnal primate taxa occurring in that forest, with special focus on the red colobus, Roloway guenons and white-naped mangabeys. During walk surveys of 429.3 km by three teams, we failed to observe any red colobus monkey. *Diana roloway* guenons were encountered at 0.10 groups/Km in the flooded forest vs 0.65 groups/km in mangroves and white-naped mangabeys were encountered at 0.07 groups/km in the flooded forest vs 0.50 groups/Km in mangroves. Both these taxa were significantly more frequently encountered in mangroves compared to flooded forests. The high observation rate of Roloway monkey and white-naped mangabey in mangroves seems to indicate an adaptive strategy developed by these taxa to avoid hunting pressure. In addition, with its abundant foliage and the permanent presence of water throughout the year, mangrove offers food for monkeys.

**Keywords:** Conservation; Ivory coast; Endangered primates; Flooded forest; Habitat preference; Mangroves; Tanoé forest; West Africa

## Introduction

There are three forest monkeys of conservation concern which share the same range in West Africa (eastern Ivory Coast and western Ghana): Miss Waldron's red colobus *Piliocolobus badius waldronae*, the Roloway guenon *Cercopithecus diana roloway* and the white-naped mangabey *Cercocebus atys lunulatus*. These taxa are considered the most threatened primate taxa amongst primates occurring in West Africa. All three taxa were previously listed as critically endangered, and Miss Waldron's red colobus is considered probably extinct [1], although recent evidence suggested that the taxa is still persisting in the Tanoé forest [2] also called Ehy forest in the literature. The three taxa have been listed at least once among the 25 most endangered monkeys in the world (<http://www.iucnredlist.org>). Except for *Cercocebus atys lunulatus* which has been downgraded endangered since 2006, *Piliocolobus badius waldronae* and *Cercopithecus diana roloway*, continue to be listed on the top list of the 25 most endangered monkeys in the world.

Since the early 1990s, while primatologists search the forests of Ghana and Ivory Coast for evidence of surviving Miss Waldron's red colobus monkey, they also documented the continuing decline of Roloway guenons and white-naped mangabeys.

The three taxa are found in primary and secondary lowland moist forest, and riverine and gallery forest in the Guinean Forest Zone [3]. In contrary to Roloway monkey and Miss Waldron's red colobus monkey which largely occupy forest canopy, white-naped mangabey is largely terrestrial but also use the forest canopy [3].

Researchers generally consider habitat type, food type, and activity schedule as the major axes along which niches diverge in animal

communities [4,5], and have demonstrated divergence along these axes among primates and between primates and other mammals [6-8]. Here we examine how habitat types are partitioned among Roloway guenons (*Cercopithecus diana roloway*), white-naped mangabey (*Cercocebus atys lunulatus*) and Miss Waldron's red colobus (*Piliocolobus badius waldronae*).

Understanding the habitat preferences of endangered species is critical to developing effective strategies for their management and conservation [9]. This is especially true for species that occur in only a small fraction of their overall geographic range, such as the Roloway monkey, white-naped mangabey and Miss Waldron's red colobus.

Indeed, within their historical range, Roloway guenons and white-naped mangabeys have been extirpated from many unprotected and protected areas and the monkeys are nearing extinction [10-15]. Very recent surveys failed to confirm the presence of Roloway guenons in reserves in western Ghana, including one where the monkeys have been seen only several years earlier [16]. In Ivory Coast, the status of Roloway

**\*Corresponding author:** Sery Gonedelé Bi, Department of Genetics, University Felix Houphouët Boigny, Abidjan, Ivory Coast, 22 BP 582 Abidjan 22, Tel: +225 23 47 27 90, E-mail: [gonedelebi@yahoo.fr](mailto:gonedelebi@yahoo.fr)

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guenon is equally dire. Surveys made ten years ago documented Roloway guenons in two forests: the Yaya Forest Reserve and forest adjacent to the Ehy Lagoon [2,17]. Field surveys made from 2004 through 2006 in Ivory Coast failed to document Roloway guenons and white-naped mangabeys in several forests [13,14], with the exception of the Tanoé Forest and the Dassioko forest reserve for white-naped mangabeys [13,18,19]. Due of the presence of several endangered primate species in the Tanoé forest, it has been suggested that this forest represents a top priority site for the conservation of primates in West Africa [13].

In this study, we present updated data on the abundance of Roloway guenon and white-naped mangabeys in the Tanoé Forest and highlight their habitat preferences.

## Methods

### Study site

The Tanoé Forest (approximately 12,000ha) is an unprotected forest in south-eastern Ivory Coast, at the boarder of Ghana, between the latitudes 5°05' and 5°15' and the longitudes 2°45' and 2°53' (figure 1). The land is owned by all the villages surrounding the forest and each of these communities hold native rights to exploit the forest. There were no protection schemes for native use of forest resources either from the communities or from the government until 2006, when a pilot community-based management system for the Tanoé Forest was initiated with nine neighbouring villages.

Precipitation in the region varies from 1400 to 1600 mm/year, with highest rainfall in the wet season from March to December [20]. The Tanoé Forest is a littoral forest and is inundated during most times of the year.

The preliminary plant inventory carried out in 20 plots of 400 m<sup>2</sup> revealed that 33 plants species over 279 found in the Ehy forest are of conservation concern [20]. These 33 plant species comprise 19 plant

species endemic to either Ivory Coast (5 species) or West Africa, 15 plant species endemic to Upper Guinea, and 13 species including endemic species that are on the red lists of IUCN (*Tricalysia reflexa*, *Salacia columna*, *Tieghemella heckelii*, *Xylopia villosa* etc.).

Based on tree composition and the depth of ground water, two habitat types characterize that forest: the flooded forest and the mangroves. While the flooded forest consists of evergreen forest inundated during most times of the year, the mangrove forests are permanently flooded and more difficult to access. Tree species that essentially compose mangroves are *Pandanus candelabrum* and *Cyrtosperma senegalense*, around 11 meters in height. Nevertheless the trees crowns very often exceed 25 meters in height in the flooded forest. The depth of the ground water in the mangroves of the Tanoé forest averaged 0.4 m in the dry period and 1m in the wet season. In the dry period, part of the flooded forest consists of terra firma and another part is covered by water, where the depth of the ground water averaged 0.2 m.

### Survey method

Before conducting the survey, we obtained authorization from local administrative and traditional authorities. From February 2008 to March 2008; and in March 2009, we carried out field surveys in the Tanoé Forest over 22 days. The presence of the red colobus, Roloway guenons and white-naped mangabeys was ascertained through direct sighting or by vocalisations. Direct observations and censuses were carried out along paths created for patrolling purposes and when necessary new paths were opened. During the survey, our team was divided into three subgroups to carry out surveys which totalled 1188 hours- teams' effort. To survey a forest, we generally formed three teams each composed of a researcher and a local guide recruited among hunters or former hunters. The three teams examined different zones simultaneously so that a relatively large area was covered every day. This is the only method that may be used at the moment in the Tanoé Forest since no transect has been established and walking along straight lines bearing a compass is hardly doable because of the impracticability of many patches of the swampy Tanoé forest. All the researchers' involved in the survey are primatologists who have ample experience in conducting surveys in remote areas and are familiar with the target species found in the Tanoé Forest. We walked slowly (an average distance speed of 0.5 km/hour in mangroves and 0.8km/hour in the flooded forest) and quietly along these paths, looking and listening for primates. While walking, we stopped every 10 minutes to listen to primates more carefully. The three teams examined different zones simultaneously so that a relatively large area was covered each day. Our survey walks lasted for nine hours per survey day and were made between 06:30 and 17:30, with a break between 12:00 and 14:00 when primates are less active. A total of 429.3 km was covered by the teams during the survey in the Tanoé Forest, corresponding to an average distance of 6.51 km covered per day by each team.

During the surveys, primates were identified either by the sight or their vocalizations. Their locations were recorded using GPS devices and mapped. Snap shots of primates were made whenever possible.

Data recorded for each primate observation included: date, time, species and location and group size. Since we did not used transect line methods, we did not estimate the density of the populations. However, we estimated the relative abundance based on animal encounter rate, or "sightings" per km [21].

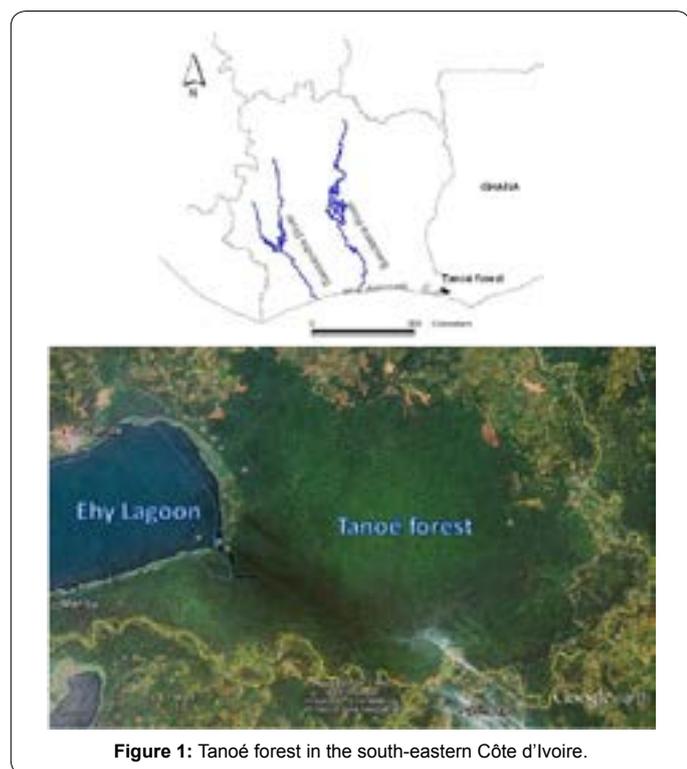


Figure 1: Tanoé forest in the south-eastern Côte d'Ivoire.

## Results

Roloway guenons were encountered at 0.38 groups/km. White-naped mangabeys were encountered at 0.280 groups/km surveyed. When comparing the encountered rate per habitat, the two taxa were mostly encountered in the mangroves where the encounter rates were higher for both taxa (Diana roloway: t-test=10.64, P=0.000, df=33; White-naped mangabey: t-test=12.23, P=0.000, df=33,  $\alpha=0.05$ ) (Table 1).

The mean number of *C. d. roloway* (0.38 groups/km) and *C. a. lunulatus* (0.28 groups/km) can be considered as a relative abundance of the species in the Tanoé Forest.

In March 2008, we once heard a call similar to that of a red colobus but we were not able to confirm the species. Western black-and-white colobus (*Colobus vellerosus*) were only found in the flooded forests (0.04 encounters/km) but not in the mangroves (Table 1) and olive colobus (*Procolobus verus*) were encountered at a relatively low rate in both habitat types (0.05 encounters/km in flooded forests, 0.11 encounters/km in mangroves). The most abundant species in both habitat types were Lowe's mona monkeys *Cercopithecus campbelli lowei* and lesser spot-nosed monkeys *Cercopithecus petaurista petaurista*. We failed to find any evidence of *Pan troglodytes verus* in the Tanoé Forest.

Evidence of poaching was found in the area around Atchimanou, a village closer to the Ghanaian border. A total of 24 gun shots were heard from that direction during the 22 days of survey. No poacher camps were detected during the survey. We were also not able to find empty cartridges in the forest. During the period of the survey (February - March), most human activities in the forest were from fishing in the swamp by the local communities.

### Groups size and polyspecific associations

Based on visual contacts, the composition of the encountered

groups is presented in Table 2. Mean group size for *Cercopithecus diana roloway* was higher than for *Cercocebus atys lunulatus* (Table 2).

Out of 38 Diana roloway sightings, 21 were single-species (55.26 %), 17 (44.74 %) were mixed-species (Table 3). Mixed-species sightings included either two to four species groups (Table 4).

Nine types of polyspecific associations were found between *C. d. roloway* and the other primate taxa occurring in the Tanoé forest: association of *C. d. roloway* with one species (n=4); two species (N=3); three species (N= 2) (Table 4). Among these associations, *C. d. roloway* tends to be more often associated with *Cercopithecus campbelli lowei*.

Contrary to *C. d. roloway* which was equally found at monospecific and polyspecific association (55.26% vs 44.74%), *C. a. lunulatus* was more found in monospecific troupes (78%). The association formed by both taxa constitutes one of the rarest ones (Table 4).

## Discussion

### Abundance

Our results indicate an exceptional abundance of Roloway guenons and white-naped mangabeys in the Tanoé Forest. In the Ankasa Resource Reserve in Ghana, Oates et al. [11] found Roloway guenons with an encounter rate of 0.04 groups/km. This rate is ten times less than that found in the Tanoé Forest. With regards to the white-naped mangabeys, Oates et al. [11] found an encounter rate of 0.02 groups/km, which is fourteen times less than what we found in the Tanoé Forest. Based on the survey data in 2007 and 2008, Bené et al. [18] found a relative abundance of 0.139 and 0.075, respectively for Diana roloway and white-naped mangabey in the Tanoé Forest. Our relative abundance data are greater than the one estimated by Bené et al. [18]. It is likely that the population of the primate taxa in the Tanoé Forest increased in number or our distance estimate methods is different from the one used by Béné et al. [18]. Indeed these authors used an average speed of 0.8-1 Km/hour during the walk. However, when using

Species	number of group sightings		groups / km		
	flooded forest	mangroves	flooded forest	mangroves	overall
<i>Cercopithecus diana roloway</i>	35	50	0.10	0.65	0.38
<i>Cercocebus atys lunulatus</i>	24	38	0.07	0.50	0.28
<i>Ptilocolobus badius waldroneae</i>	0	0	0	0	0
<i>Cercopithecus campbelli lowei</i>	85	70	0.24	0.92	0.58
<i>Cercopithecus petaurista petaurista</i>	50	56	0.14	0.73	0.44
<i>Colobus vellerosus</i>	26	0	0.07	0	0.04
<i>Procolobus verus</i>	16	14	0.05	0.18	0.11
<i>Pan troglodytes verus</i>	0	0	0	0	0

Table 1: Relative abundance of the primate taxa observed in Tanoé Forest (distance in flooded forest 352.8 km, in mangroves 76.5 km).

Species	group size			
	mean	SD	minimum	maximum
<i>Cercopithecus diana roloway</i>	12	4.88	6	22
<i>Cercocebus atys lunulatus</i>	9.31	4.09	6	17
<i>Ptilocolobus badius waldroneae</i>	—	—	—	—

Table 2: Group size Diana roloway and white-napped mangabey.

Species	no. of observation	no. of polyspecific association	% association
<i>Cercopithecus diana roloway</i>	38	17	44.74
<i>Cercocebus atys lunulatus</i>	16	4	25
<i>Ptilocolobus badius waldroneae</i>	—	—	—

Table 3: Polyspecific association of Diana roloway and white-napped mangabey.

Species	n	frequency (%)
<b>Diana roloway</b>		
<i>C. d. rol</i>	21	55.26
<i>C. d. rol</i> + <i>C. a. lun</i>	1	2.63
<i>C. d. rol</i> + <i>C. c. low</i>	5	13.16
<i>C. d. rol</i> + <i>C. p. pet</i>	2	5.26
<i>C. d. rol</i> + <i>P. ver</i>	1	2.63
<i>C. d. rol</i> + <i>C. c. low</i> + <i>C. p. pet</i>	2	5.26
<i>C. d. rol</i> + <i>C. c. low</i> + <i>P. ver</i>	1	2.63
<i>C. d. rol</i> + <i>C. c. low</i> + <i>C. p. pet</i> + <i>P. ver</i>	2	5.26
<i>C. d. rol</i> + <i>C. c. low</i> + <i>P. ver</i> + <i>C. vel.</i>	1	2.63
<i>C. d. rol</i> + <i>C. a. lun</i> + <i>C. p. pet</i>	2	5.26
<b>White-napped mangabey</b>		
<i>C. a. lun</i>	12	78
<i>C. a. lun</i> + <i>C. p. pet</i>	1	6.25
<i>C. a. lun</i> + <i>P. ver</i>	1	6.25
<i>C. a. lun</i> + <i>C. p. pet</i> + <i>C. c. low</i>	1	6.25
<i>C. a. lun</i> + <i>C. d. rol</i> + <i>C. p. pet</i>	1	6.25

*C. d. rol*: *Cercopithecus diana roloway*; *C. a. lun*: *Cercocebus atys lunulatus*; *C. c. low*: *Cercopithecus campbelli lowei*; *C. p. pet*: *Cercopithecus petaurista petaurista*; *P. ver*: *Procolobus verus*; + : mixed with

**Table 4:** Composition and frequency of polyspecific associations of *Cercopithecus diana roloway* and *Cercocebus atys lunulatus* sighted.

the average speed of these authors, our abundance data remain greater (0.24 vs 0.14 groups/Km for Roloway monkey and 0.19 vs 0.08 groups/Km for white-naped mangabey).

The numbers of Roloway guenons and white-naped mangabeys have severely been reduced in recent years elsewhere in Ivory Coast. The two taxa have been locally extirpated from several forests [13,14,22] where they were previously reported [11,12]. In Ghana, Oates et al. [11] estimated that the number of Roloway monkeys has been reduced to less than 1,000 individuals and possibly as low as 500. Current data and recent field surveys [1,23] in Ghana indicates that these taxa have experienced dramatic population declines over the last two decades, and are facing extirpation within their range in this country.

Based on the rates of encounters, this study confirmed that *Cercopithecus campbelli lowei* and *Cercopithecus petaurista petaurista* along side with their sister taxa *C. c. campbelli* and *C. p. buttikoferi* were the most common primates of Ivory Coast [22]. Lowe's and lesser spot-nosed, were also found to be the most common primates in Ghana [1]. The particular adaptive capability of these monkeys in primary and secondary forests may play important role in their singular richness throughout West Africa. They did not appear to be specialized to any particular habitat type, since they are found in swamp forests, semideciduous forests, fragmented semi-deciduous forests, and grasslands near forest fragments [3,24].

The probable extinction of Miss Waldron red colobus was reported by Oates et al. [1] after a minimum of one decade of unsuccessful surveys in its historical home range. However, it was reported the evidence that a hunter killed at least one individual of that species recently in the Tanoé Forest (Ehy Forest) [2]. The fact that we could not confirm the presence of *Piliocolobus badius waldronae* during our survey in the Tanoé Forest suggested that they are probably extinct in that forest and in the wild.

The extirpation of *P. b. waldronae* from the Tanoé Forest in a very short period of time could be explained by hunting pressure as observed in other forests [8,25,26]. Beside red colobus monkeys, the

two other large-bodied monkeys encountered in the Tanoé Forest are *Colobus vellerosus* and *Cercocebus atys lunulatus*; each of them as an adult female body mass of >6 kg [27]. The relative abundance of these two taxa at the Tanoé Forest ascertains the vulnerability of red colobus monkey to hunting pressure compare to the other large body sized monkeys.

### Reasons for abundance

Subsistence and commercial hunting have devastating impacts on primate populations in many regions in Africa, even in protected areas [28] and forests of difficult access such as the Tanoé Forest [2], where hunting pressure has probably been more important in part of the forest that is more accessible. The high primate abundance we found in the Tanoé Forest may reflect its singular relative undisturbed structure and relatively low hunting pressure by humans due to its inaccessibility [13], particularly the forest zone occupied by mangroves. The particular difficult access of the Tanoé Forest has probably impact on the preservation of its fauna. Indeed, in the absence of ground consistency, it is difficult for any non arboreal predators (particularly humans) to get close to the monkeys without being detected. It is also likely that the time dedicated to our survey was not enough to detect such effect or that the primates of the Tanoé Forest have been able to adapt to these disturbance. The high observation rate of Roloway guenons and white-naped mangabey in mangroves seems to indicate an adaptive strategy developed by these monkeys to avoid hunting pressure, since mangroves are more difficult to access compared to the flooded forest. In addition, by its abundant foliage and the permanent presence of water within the year, mangrove offers food for monkeys [29]. We are aware that primates may exhibit seasonal change in home-range use according to food resources [30] and that our study lasted on a period of time that did not cover different seasons occurring in the study area. Hence, season effects on the distribution of Roloway guenons and white-naped mangabey in the Tanoé Forest needs to be elucidated.

Despite the difficulty to access the forest, we encountered considerable human-induced disturbance in the form of medicinal plants harvests, fishing and agricultural clearings. These activities appear to have been facilitated by the establishment of roads inside the forest by a logging company for timbers exploitation. These roads facilitate easier access to the forest, particularly during the dry period. The greatest threat ever posed to the forest despite its high conservation value was its planned replacement by a palm oil plantation in 2008. Thanks to vigorous protest campaign by conservationists and the local communities, that project was abandoned.

Of note is that in late 2006, a pilot community-based management program for the Tanoé Forest was launched. This program involved several villages surrounding the forest. For each of these villages, three former hunters were involved in the project as forest assistants and they also participated to the awareness raising campaigns in these villages. This has probably contributed in the reported decrease of hunting pressure in the following years as witnessed by the unusual presence of monkeys in some areas at the periphery of the forest [31].

### Polyspecific association

A number of studies have suggested that Diana monkeys are very popular association partners for other monkey species, because of their high rates of vigilance [32] and predator alarm calling behaviour [33].

In the Taï National Park (Taï NP) in western Ivory Coast, the monthly association rate of Diana monkey ranged from 31 % to 72 %

(average 54 %) [34]. The rate observed in the Tanoé Forest (44.74%) extend matches the one reported in the Taï NP. However, this rate is low compared to the average rate in the Taï NP. The relatively low rate of association observed in the Tanoé Forest could be attributed to the low number of predation in the Tanoé Forest during the study. The main predators within the Tanoé Forest monkeys are humans, while for Taï NP, besides humans, three other major predators of monkeys are found: crowned hawk eagles (*Stephanoaetus coronatus*), leopards (*Panthera pardus*) and chimpanzees (*Pan troglodytes verus*) [35,36].

Contrary to Diana monkeys, the sooty mangabeys present a monospecific profile. This is probably due to their terrestrial activity and their much larger home ranges, which make them less suitable as partners in permanent or semi-permanent associations [17].

## Conclusion

The Tanoé Forest represents one of the rare areas where several endangered primate taxa in West Africa have persisted. It serves as refuge for remnant populations of threatened species such as *Cercopithecus diana roloway*, *Cercocebus atys lunulatus*, *Colobus vellerosus* and perhaps *Ptilocolobus badius waldroneae*.

In many cases, the probabilities of a long term survival of the primates in the Tanoé Forest is low; because of a combination of factors due to their isolation, hunting pressure and habitat clearing. The survival of this natural landscape requires socio-economic measures often sensitive and complex. For this reason, the socio-economic realities of the entire region should be studied so as to obtain the basic understanding of the context and potential for promoting initiatives which will favour biodiversity conservation. There is also an urgent need for an assessment of the density of *Cercopithecus diana roloway*, *Cercocebus atys lunulatus* and other primates of the Tanoé Forest, a clear understanding of specific habitat composition (eg. food quality, food availability) and the effect of seasons on species distribution that is crucial in determining population distribution and abundance in order to develop effective conservation measures.

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