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Diet and Travel Distances of Golden Monkey (*Cercopithecus mitis kandti*) in a Pine Plantation Outside Gishwati-Mukura National Park, Rwanda

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Abstract: Primates living in fragmented and degraded forest environments face multiple challenges such as the reduced availability of food resources. We used the group scan method to study the diet and travel distance of endangered golden monkeys (*Cercopithecus mitis kandti*) inhabiting exotic pine plantations (*Pinus patula*) outside their native forests in the highly fragmented Gishwati-Mukura landscape, Rwanda, from July to August 2018. We found that golden monkeys consumed parts of at least 17 plant species. Notably, their diet consisted largely of pinecones and needles and differed from the frugi-/folivorous diet of other golden monkeys inhabiting patches of native vegetation. We also found that the mean hourly travel distance of the population inhabiting the pine plantation is longer than that of their counterparts who live in native forests. The dietary flexibility in studied groups indicates their adaptability to non-native forests. The high intake of pine might be representative of availability, rather than preference, given its ubiquitous presence in these plantations and the lack of alternative, native plant food resources. The differences in travel patterns are potentially due to the more scattered availability of native food resources, and higher disturbance in pine forests compared to native forests. Future studies are needed to determine the long-term sustainability or probability of persistence of golden monkeys in exotic pine plantations to inform conservation management outside protected areas.

Key words: Diet, golden monkey, native forest, habitat fragmentation, exotic pine plantation, travel distance

INTRODUCTION

Human-driven conversion and alteration of native vegetation, specifically the rapid destruction of tropical forests (Arroyo-Rodríguez *et al.* 2013), induces the loss, fragmentation, and degradation of primate habitat (Carvalho *et al.* 2019). These alterations ultimately restrict the range and abundance of primates (Sean 2011; Sharma *et al.* 2012; Estrada *et al.* 2017), leaving many species on the verge of extinction (Estrada *et al.* 2012). As fragmentation and loss of suitable habitat and food resources also force primates to visit human-dominated landscapes, they are increasingly involved in human-wildlife conflicts (Hill 2018), experience changes in population connectivity and gene flow (Chapman *et al.* 2013; Su *et al.* 2022), and are exposed to infectious diseases and new forms of

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Figure 1. Adult male golden monkey (*Cercopithecus mitis kandti*) feeding on needles of a pine tree (*Pinus patula*). Photograph by Marcel Ngabikwiye.

predation (Chapman *et al.* 2013). Although some primates occasionally use non-native food or habitat resources (see e.g., Tesfaye *et al.* 2013; Chaves & Bicca-Marques 2016; Spehar & Rayadin 2017;), others are forced to rely heavily on non-native vegetation following habitat loss and fragmentation (Torres-Romero *et al.* 2023). While the long-term impacts of such forced shifts on the diet is currently unknown, we can learn from case studies on differences in the diet and travel distance between primates living in natural habitats compared to those living in anthropogenically altered habitats. For example, little is known of the ecology of golden monkeys (*Cercopithecus mitis kandti*) that occupy patches of pine-dominated (*Pinus patula*) plantation forests outside the protected Gishwati-Mukura National Park (GMNP) in Rwanda (Tuyisingize *et al.* 2022).

The golden monkey, or golden guenon, is an endangered subspecies of blue monkey that is affected by habitat loss, fragmentation, and degradation (Butynski & de Jong 2020). The range of this primate is restricted to two isolated fragments: the Virunga massif (Rwanda, Uganda, and Democratic Republic of the Congo) and GMNP (Butynski & de Jong 2020; Siegel *et al.* 2020). These two fragments of native vegetation were disconnected in the late 1950s by the conversion of habitat into a largely agricultural landscape (Spinage 1972). Both fragments have since experienced additional reduction and degradation of habitat (Nyandwi & Mukashema 2011), with the Gishwati section of GMNP being reduced to approximately two percent of its original cover since the 1980s (from ~280 to <10 km^2; Plumptre *et al.* 2001; Nyandwi & Mukashema 2011). Following this conversion of native forest to other land cover types (predominantly agricultural land), some golden monkeys shifted their range to occupy pine plantations (Tuyisingize *et al.* 2022; Figure 1).

Existing research on golden monkeys concentrated primarily on populations residing in protected areas (see e.g., Twinomugisha *et al.* 2006; Tuyisingize *et al.* 2022). Consequently, there is a scarcity of information regarding the ecology of golden monkeys that utilize pine plantations. Here, we present a first step to filling this data gap by focusing on golden monkey diet and travel patterns. We predicted these behaviors differ from those found in populations inhabiting native forest fragments. Specifically, we hypothesized that golden monkeys within our research area exhibit dietary habits distinct from those inhabiting the nearby native forests of GMNP. We expected them to consume parts of *P. patula*, a plant not

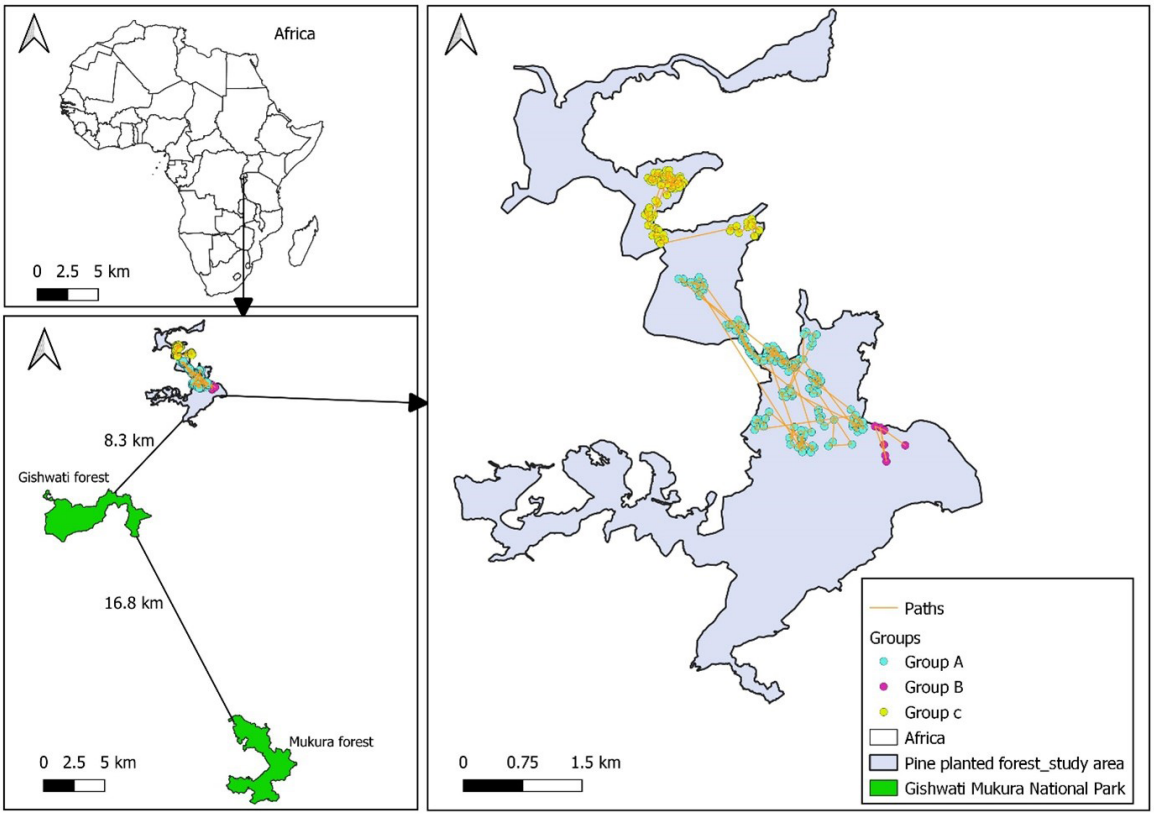

Figure 2. Study area near Gishwati-Mukura National Park, Rwanda.

typically eaten by golden monkeys living in the nearby forest of GMNP (Tuyisingize *et al.* 2022), alongside native key food species for energy and protein supplementation (Beeson 1989; Lawes 1991; Twinomuguisha *et al.* 2007; Tuyisingize *et al.* 2022). We also expected golden monkeys to travel relatively long distances as native food resources are scarcer and more scattered.

METHODS

In July and August 2018, we studied three semi-habituated golden monkey groups that inhabit patches of pine forest approximately halfway between Volcanoes National Park and GMNP (~12 km from both; 1°43'20.64" S, 29° 28'0.17" E (Figure 2). This forest, found at 2,100 – 2,500 m elevation, is dominated by exotic *Pinus patula*, *Acacia* sp., and *Eucalyptus* sp. trees (Nyandwi & Mukashema 2011).

We conducted daily follows of three golden monkey groups (Tables 1 and 2), but the number of sampling days varied due to logistical difficulties and group visibility. Because the monkeys are semi-habituated, we were able to make observations from fairly close range. From 08:00 to 14:00, once we found a group of monkeys, we positioned ourselves on the periphery of the group. We conducted 5 minutes of scan sampling with a 20-minute interval between

Table 1. Group composition of golden monkey study groups A, B, and C in the pine plantation outside Gishwati-Mukura National Park, Rwanda.

Age-sex class	Group A	Group B	Group C
Adult Males	1	1	1
Adult Females	6	4	9
Juveniles	5	2	17
Infants	2	2	6
Group size	14	9	33

Table 2. Observation duration in days and hours spent in the pine plantation by golden monkey study groups and number of scans obtained for each group.

Group	#days	#hours	#scans
Group A	11	38	113
Group B	3	11	33
Group C	7	35	105

each scan (Altmann 1974). While traversing the outer edges of the group during scans, we recorded whether each individual was feeding (harvesting, processing, chewing, or ingesting food) or engaging in other activities. If the activity was feeding, we recorded the food type (e.g., plant species, insect) and parts (cones, fruits, needles, leaves, flowers, shoots, stems, tendrils, and bark). First, we assessed the individual contributions of food items (species parts) to each group's diet. Then, we aggregated the dietary data from all three groups and computed the proportion of food items within the combined diet.

At the end of each scan, using the last monkey following the direction of the group, we recorded its location with a handheld Garmin GPSmap 64X. Then, using QGIS 3.28.12, we calculated the daily travel distance by connecting the consecutive GPS location records of each day. To assess the travel distances of golden monkeys in a non-native habitat compared to their counterparts in the native habitat, we complemented our dataset by including data collected during the same period (July-August 2018) from a habituated group (33 individuals followed over 31 days) residing within the GMNP. The Dian Fossey Gorilla Fund provided these data, which were collected using research methods identical to those outlined above with the exception that GPS points were taken at the approximate center of the group's location.

RESULTS

We found that golden monkeys in our study area consumed a minimum of 21 food plant items from 17 food plant species. Group A consumed 16 food plant species, while Group B and Group C consumed

Table 3. Contribution of food plant species to the diet of golden monkey groups (A-C) in pine plantation.

Food plant species	Status	Group A	Group B	Group C
Pinus patula	Exotic	72.5	66.7	89.9
Oldaenia alpina (bamboo)	Native	5.9		1.2
Acacia mearnsii	Exotic	4.8	13.3	2.4
Basella alba	Native	3		0.6
Coccinia mildbraedii	Native	3	6.7	
Peucedanum linderii	Native	2.2	6.7	
Loberia gibberoa	Native	1.9		
Discopodium penninervium	Native	1.5		2.4
Galium simense	Native	1.5		0.6
Ipomoea involucrate	Native	0.7	6.7	0.6
Isachne mauritiana	Native	0.7		0.6
Rubus steudneri	Native	0.7		0.6
Alnus acuminata	Exotic	0.4		
Maesa lanceolata	Native	0.4		
Rumex bequaertii	Native	0.4		
Solanum nigrum	Native	0.4		
Eucalyptus sp.	Exotic			1.2

Table 4. The mean percentage of consumed food plant species and their parts in the combined diet of the three golden monkey study groups in pine forests of the Gishwati-Mukura landscape ranked by the importance of food plant species.

Rank	Food species	Family	Origin	Leaves	Needles	Cones	Fruits	Bark	Flowers	Pith	Stem	Tendrils	Mean % (±SD)
1	*Pinus patula*	Pinacea	Non-native		33.5	42.9		4.2					80.5 (2.51)
2	*Oldaenia alpina*	Poacea	Native	4.5									4.5 (0.27)
3	*Acacia mearnsii*	Fabacea	Non-native				1.6		2.1				3.7 (0.34)
4	*Coccinia mildbraedii*	Cucurbitaceae	Native				1.9						1.9 (0.17)
5	*Peucedanum linderi*	Apiaceae	Native							1.4			1.4 (0.14)
6	*Galium* sp.	Rubiacea	Native								1.1		1.1 (0.09)
7	*Discopodium penninervium*	Solanaceae	Native				0.2			1.1			1.3 (0.54)
8	*Basella alba*	Basellaceae	Non-native									1.5	1.5 (0.11)
9	*Eucalyptus* sp.	Myrtaceae	Non-native							0.4			0.4 (0.09)
10	*Ipomoea involucrata*	Convolvulaceae	Non-native									0.7	0.7 (0.08)
11	*Loberia gibberoa*	Lobeliaceae	Native							0.7			0.7 (0.08)
12	*Isachne mauritiana*	Poaceae	Native								0.7		0.7 (0.08)
13	*Rubus* sp.	Rosaceae	Native			0.7							0.7 (0.08)
14	*Rumex bequaerti*	Polygonacea	Non-native							0.4			0.4 (0.06)
15	*Alnus acuminata*	Betulaceae	Non-native							0.2			0.2 (0.05)
16	*Maesa lanceolata*	Primulaceae	Non-native				0.2						0.2 (0.05)
17	*Solanum nigrum*	Solanaceae	Non-native	0.2									02 (0.05)
Number of feeding observations				19	134	155	18	18	7	17	2	12	

Table 5. Range and mean of hourly travel distance (in meters) of golden monkey groups in pine plantation forest outside (A-C) and within (GMNP) Gishwati-Mukura National Park, Rwanda.

Golden monkey Group	Group Size	Number of days	Daily travel distance (meters)	
			Mean	Range
A	14	11	760	(176 -1454)
B	9	3	304	(67 - 521)
C	33	7	540	(53 - 843)
GMNP group	33	31	144	(30-635)

5 and 10 food plant species, respectively (Table 3). All groups devoted a significant proportion of observed feeding on *P. patula*, ranging from 67% to 90%. By combining the diet of all groups, we found that the vast majority of feeding events included *P. patula* (80.5 ± 2.5% of events) followed by *Oldeania alpina* (4.5 ± 0.3%), *Acacia mearnsii* (3.7 ± 0.3%), *Coccinia mildbreadii* (1.9 ± 0.2%), *Basella alba* (1.5 ± 0.1%), and *Peucedanum linderi* (1.4 ± 0.14%) (Table 4). Cones and needles obtained from *P. patula* accounted for approximately 42.9% (± 1.3) and 33.5% (± 0.1), respectively, among the most-consumed food parts. In contrast, leaves and fruits from other food types contributed approximately 4.7% (± 0.4) and 4.5% (± 0.7), respectively (Table 4).

The mean daily travel distance of golden monkey groups in pine-planted forests was 534 ± 23 m (56-1454) (N = 21) and was longer than the mean travel distance of the GMNP group (Table 5). In addition, the mean distance travelled by the largest study group in the pine plantation (C) was nearly four times longer than the mean for the same-sized GMNP group.

DISCUSSION

Golden monkeys that inhabit the pine plantation forest near GMNP consume parts of at least 17 different plant species, 13 of which are native to the region, and show substantial differences in the recorded diet composition of the three study groups. As hypothesized, dietary habits of golden monkeys in pine-dominated forests strongly differ from those living in the nearby native forests of GMNP. Most of their diet is comprised of the cones and needles of *P. patula*. As these food items are not commonly consumed by predominantly folivore (Virunga massif) or frugivore (core GMNP) golden monkeys, our findings confirm earlier suggestions that golden monkeys exhibit considerable dietary flexibility (Twinomugisha *et al.* 2006; Tuyisingize *et al.* 2022). This study also revealed that golden monkeys residing in pine plantations tend to travel longer distances than their counterparts that live in native forest vegetation, which is in line with our prediction.

The high intake of *P. patula* might be representative of availability, rather than preference, given its ubiquitous presence in these plantations and the lack of alternative, native plant food resources. Alternatively, golden monkeys could have a selective preference for specific nutritional elements found in the *Pinus* genus (Maganga & Wright 1991; McMara 2005), a topic for further study. Similarly, future studies may reveal why the three studied groups vary in diet, though we acknowledge that these differences could be linked to biases in sampling effort.

The relatively long travel distances of golden monkeys in pine plantations could stem from the scarcity and more scattered or patchy distribution of native food resources (e.g., bamboo), a pattern also observed in ranging patterns of lion-tailed macaques, *Macaca silenus*, in the Western Ghats of India (Erinjery *et al.* 2014). Alternatively, long travel distances in pine forests could be caused by a high number of disturbances (e.g., human disturbances) as animals aim to avoid pressure from human presence (Li *et al.* 2005). Finally, travel distances can be influenced by group size, with larger groups travelling longer distances (Gillespie & Chapman 2001), though we found that the GMNP group traveled shorter distances than the groups in the pine plantation even when comparing only groups of the same size.

Although most golden monkeys inhabit fragments of native forests, we found that pine plantations offer additional habitat and food resources, at least in the short term. However, primates that inhabit isolated patches of non-native vegetation may fail to persist in the long term as they are "trapped" in habitat of inferior quality while

being disproportionally vulnerable to threats such as predation and human-wildlife conflicts (Estrada *et al* 2012; Chapman *et al.* 2013). Future studies should assess temporal trends in the density and distribution of these golden monkeys, determining their rate of reproduction, and study the prevalence and nature of threats to their long-term persistence. Such deeper information on the golden monkey's use and adaptation to pine plantations will be crucial for the design of effective conservation and management strategies (see e.g., Tuyisingize *et al.* 2023).

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Confirmed Presence of a Small, Isolated Population of *Cercopithecus mitis* on Idjwi Island, Democratic Republic of Congo

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Abstract: The blue monkey (*Cercopithecus mitis*) was presumed extirpated from Idjwi Island, Lake Kivu, eastern Democratic Republic of Congo (DRC) due to widespread deforestation and habitat fragmentation in recent decades. This study confirms the presence of a small, isolated, population of at least 50 *C. mitis* individuals using camera traps and direct observation. Scan sampling was used to assess *C. mitis* feeding and vigilance behaviors in the remnant Bulolero Forest and adjacent agricultural fields. We also conducted Knowledge-Attitude-Practice (KAP) surveys with smallholder farmers affected by *C. mitis* crop raiding. *C. mitis* exhibited higher vigilance during crop sowing and harvesting periods due to the presence of farmers. KAP surveys suggested that community attitudes towards *C. mitis* are generally negative, with the primates perceived as crop predators and opportunistically hunted for bushmeat. This study sets the stage for developing community-based conservation strategies to enhance the conservation of *C. mitis* and its habitat on Idjwi Island.

Key words: Vigilance, Feeding, Human-wildlife Conflict, Guenon

INTRODUCTION

The blue monkey (*Cercopithecus mitis*) is a highly polytypic species, with a complex and extensively debated taxonomy (Dandelot 1974; Napier 1981; Groves 2001; Grubb *et al.* 2003; Kingdon 2013, 2015; Lawes *et al.* 2013; Butynski & De Jong 2019). There are currently 16-18 subspecies are recognized, some of which lack accuracy on their geographic distribution (Stuart & Stuart 2017). Because few molecular studies including *C. mitis* have been conducted (e.g., Zinner *et al.* 2022), classification of *C. mitis* subspecies are largely based on phenotypic traits such as coloration and fur patterns and on geographic distributions (Butynski & De Jong 2022).

C. mitis on Idjwi Island in Lake Kivu, eastern Democratic Republic of Congo may represent one of three subspecies, *C. mitis schoutedeni, C. m. stuhlmanni,* or *C. m. doggetti*, which differ in coloration and geographic distribution. *C. m. stuhlmanni* has a short, very dark dense coat, grizzled back, black cap with sharply defined blue-grey grizzled diadem while *C. m. doggetti* is grizzled grey or golden back, black cap with sharply defined, grizzled diadem (Kingdon 2015). Phenotypically, *C. m. schoutedeni* has been distinguished from the two nearest subspecies of *C. mitis* (*C. m. stuhlmanni* and *C. m. doggetti*) based on color variation (Stuart

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& Stuart 2017; Butynski & De Jong 2022). *C. m. schoutedeni* exhibits broad color variation spanning from gray to silver gray, with a notably dark dorsal region and a predominantly dark coat variably speckled with lighter patches (Schouteden 1948; Kingdon 2015). The silver-gray coloration of *C. m. schoutedeni* is the taxon's defining characteristic among the *Cercopithecus mitis* group. According to the geographic distribution of the 3 subspecies, *C. m. stuhlmanni* has an expansive range in eastern DRC, Ethiopia, and East Africa to the great Rift Valley (Kingdon 2015). There is uncertainty in the distribution of *C. m. doggetti* and the degree of overlap with neighbouring subspecies (Kingdon *et al.* 2008). *C. mitis schoutedeni* is still a poorly understood taxon. Thus, the subspecies of the *C. mitis* whose presence has been confirmed at Idjwi Island remains to be clarified.

Although *C. m. schoutedeni* had been classified as a subspecies *of C. mitis* (Kingdon 2013; Lawes *et al.* 2013; Butynski & De Jong 2019), the IUCN SSC African Primate Specialist Group currently treats the taxon as a synonym of *Cercopithecus mitis stuhlmanni* (e.g., Butynski & De Jong 2019). This taxonomic arrangement for *C. mitis* was adopted at the IUCN SSC African Primate Red List Assessment Workshop in Rome in April 2016 (Butynski & De Jong 2019). However, more molecular studies are needed to further understand the evolutionary history and taxonomy of *C. mitis* (Butynski & De Jong 2022; Zinner *et al.* 2022). Recognizing that further investigation is warranted on the validity of *C. m. schoutedeni* as a separate subspecies, we will use *C. mitis* hereafter to describe the population of guenons recently reconfirmed to be present on Idjwi Island in Lake Kivu, eastern DRC.

Since the 1980s, Idjwi Island has experienced unprecedented deforestation due to rapid human population growth and saw an influx of refugees from neighboring countries around 1994 (Kabonyi 2004; Buchekabirhi 2010; Habakaramo *et al.* 2015). The growing population was estimated at 320,000 inhabitants as of 2016 (Akilimali *et al.* 2022) and relies heavily on subsistence farming and forest resources for timber and charcoal production. These pressures have disrupted the island ecosystem and its wildlife (Thomson *et al.* 2012; Habakaramo *et al.* 2015). In particular, the Nyamusisi Forest has nearly disappeared, once having covered about 17 percent of the island's surface area (RDC-MECNT 2012; Akilimali 2017; Amani 2018). Surveys in the remnant forest indicated that several species had vanished from the ecosystem, including primates (e.g., Kabonyi 2004; Safari 2016). In fact, *C. mitis* was widely presumed extirpated from the island (Basabose 2015).

This study provides evidence that a small, isolated population of *C. mitis* persists on Idjwi Island in the Bulolero Forest, a remnant of the Nyamusisi Forest (Figure 1). We examined feeding activity, and vigilance of *C. mitis* in the forest and adjacent agricultural fields. We also surveyed landowners to understand community knowledge, attitudes, and practices (KAP) regarding *C. mitis* and forests. Finally, we propose community-based conservation action to secure the population of *C. mitis* and its habitat on Idjwi Island.

METHODS

Study area

The study was conducted in the Bulolero Forest, which straddles the Ntambuka and Rubenga Chiefdoms, on Idjwi Island in Lake Kivu, eastern Democratic Republic of Congo (Figure 1). The Bulolero Forest is a degraded relic of the Nyamusisi Forest, formerly the largest forest on Idjwi Island (RDC-MECNT 2012; Akilimali 2017; Amani 2018). Following massive deforestation on Idjwi Island, the remaining animal species have taken refuge in forest fragments and rocky sites, such as that of Bulolero Forest (~25 ha). The people of Idjwi Island are mostly smallholder farmers. Due to population growth and the tradition of inheritance, small farms are regularly broken up into smaller plots that are insufficient for family needs.

Idjwi Island is the second largest inland island (680 sq. km of which 310 sq. km is terrestrial and 370 sq. km is territorial waters) of the African continent (Safari 2016; Amani 2018). Geographic data place Idjwi Island between 1°59' and 2°28' S and between 29°05' and 28°26' E. Idjwi remains dominated by mountainous terrain including the Muganzo mountains in the center of the north (1,829 m above sea level) and especially Nyamusisi in the center of the island, the highest peak at 2300 m altitude (Kalala *et al.* 2019) (Figure 2).

Data collection

To confirm the presence of *C. mitis* on Idjwi Island, we installed 14 infrared camera traps (Bushnell Trophycam HD agressor, Bushnell Trophycam HD trail camera) across the study area where higher presence probability of *C. mitis* was confirmed by fresh trails, food remains, and droppings (Tobler *et al.* 2008; Xiao 2014; You *et al.*

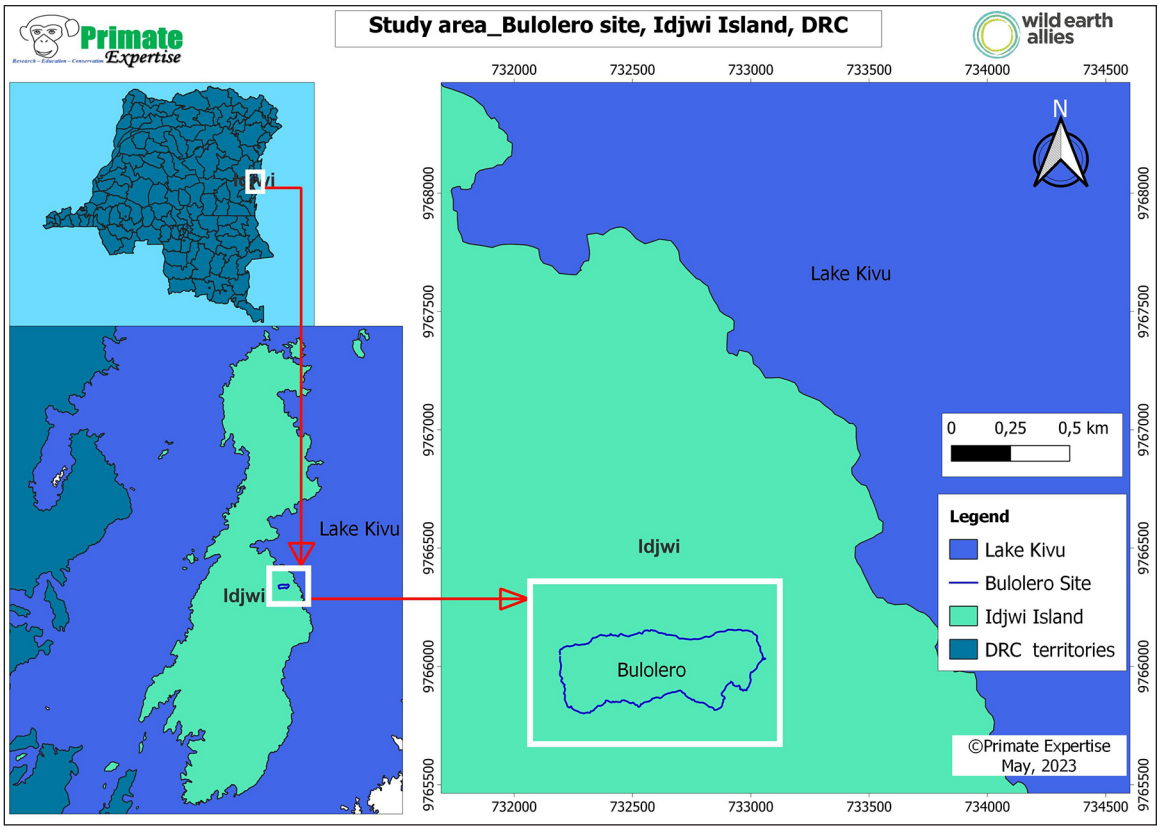

Figure 1. Location of a small, isolated population of *C. mitis* in Bulolero Forest on Idjwi Island, eastern Democratic Republic of the Congo.

Figure 2. Representative image of the rugged terrain and patchy forests of in Bulolero Forest, Idjwi Island, eastern Democratic of Congo. Photograph by Augustin Basabose.

2022). At each installation station, cameras were oriented at 0° or 180° (North-South direction) to avoid solar rays affecting the camera lens, often with a deviation (± 20°) to compensate for visual obstacles (e.g., windfalls, dense vegetation, and streams) (N'goran *et al.* 2020; Monket *et al.* 2021). The cameras were attached to trees at heights of 40-60 centimeters above the ground (Figure 3). All camera traps functioned properly and remained operational for 15 days in April 2019. The cameras were set to hybrid mode (video and photo) taking three photos followed by a 60-second video. Our overall sampling effort represented 210 camera trap days.

We assessed the vigilance and feeding behavior of *C. mitis* in their core range to understand how the primate responds to human presence during periods of farming activity. The monkeys in this study were afraid of the human presence and it was very difficult to observe the behavior of the troop members. The only activity in which the monkeys engaged that could be easily observed from a distance, and during which their vigilance behavior was observed, was feeding. Feeding included ingesting, processing, harvesting or searching for food.

Vigilance was defined as a visual scan beyond the range of the troop members, with the entire face turned towards the observers. The vigilance event was noted when a feeding individual abruptly stops eating and fixes its gaze on the observers for a moment before continuing to eat or fleeing. Vigilance and feeding behaviors of *C. mitis* were recorded using the scan sampling method (Altmann 1974) during a three-month period in 2019 (April-June), resulting in 339 5-minute observation sequences. The number of times a monkey subject exhibited vigilance in each 5-minute scan was recorded.

Finally, we conducted Knowledge-Attitude-Practice (KAP) surveys with 24 smallholder farmers whose lands were located within the core of the *C. mitis* range in Bulolero Forest. Semi-structured interviews covered community perceptions of – and interactions with – *C. mitis* and forests.

Data analysis

A one-way ANOVA was performed to compare the effect of month on *C. mitis* feeding and vigilance behaviors. Linear regression was used to assess the relationship between behavioral activity (i.e., vigilance and feeding) and human presence. R software and Jamovi software were used for analysis of behavioral data. KAP survey data were analyzed using Microsoft Excel.

Figure 3. Team researcher installs a camera trap in Bulolero Forest, Idjwi Island, eastern Democratic Republic of Congo. Photograph by Augustin Basabose.

RESULTS

Cercopithecus mitis presence confirmed on Idjwi Island

The camera traps produced a total of 1,872 images and videos with wildlife, domestic animals, and people. *C. mitis* was the most documented wildlife species, representing 2.1 percent of total captures (n = 39), including footage of infants and juveniles. Other wildlife captures included species of birds (n = 27) and rats (n = 13). The remaining footage captured people (n = 1,778) and domestic goats (n = 15), together representing about 96 percent of total captures. Overall, these results confirm the presence of *C. mitis* on Idjwi Island (Figure 4) and indicate high levels of human activity in *C. mitis* habitat.

Vigilance and feeding behaviors

During April-June 2019, *C. mitis* exhibited different levels of vigilance ($F = 4.77$, $p < 0.001$) and feeding activity ($F = 2.94$, $p = 0.003$) across months (Figure 5). Across all months, *C. mitis* spent more time exhibiting vigilance than feeding behaviors. Highest vigilance and lowest feeding activity occurred in May (Figure 5), which may be explained by increased human presence in agricultural fields during harvesting season.

We found a weak correlation between *C. mitis* vigilance and distance to people (Figure 6). Though

Figure 4. *C. mitis* recorded by camera traps in Bulolero Forest, Idjwi Island, eastern Democratic Republic of Congo.

C. mitis exhibited higher vigilance as people approached, the trend was not statistically significant ($r = -0.33$; $p > 0.05$). Group size had little effect on vigilance.

The time of day influenced *C. mitis* vigilance and feeding behaviors, with most activity occurring in the morning (08:00–12:00). Highest frequencies of vigilance and feeding were observed during 10:00–12:00, followed by the period 08:00–10:00 (Figure 7). Increased vigilance during late morning was likely explained by increased human activity; morning is the preferred time for cultivation by smallholder farmers in the area. In addition, there was an increase in the number of *C. mitis* during this time as they searched for food.

Community knowledge, attitude, and practices (KAP)

KAP survey respondents demonstrated good knowledge about *C. mitis* and its natural habitat. All 24 respondents confirmed that *C. mitis* is a wild animal. Seventeen respondents (70.8%) said they regularly observe *C. mitis* in Bulolero Forest, while six respondents (25%) were surprised to learn that monkeys still exist on Idjwi Island. Seven people (29.2%) knew that monkeys are primates and closely related to humans.

Overall, respondent attitudes towards *C. mitis* were negative. Of the 24 respondents, twenty people (83.3%) reported that *C. mitis* and humans

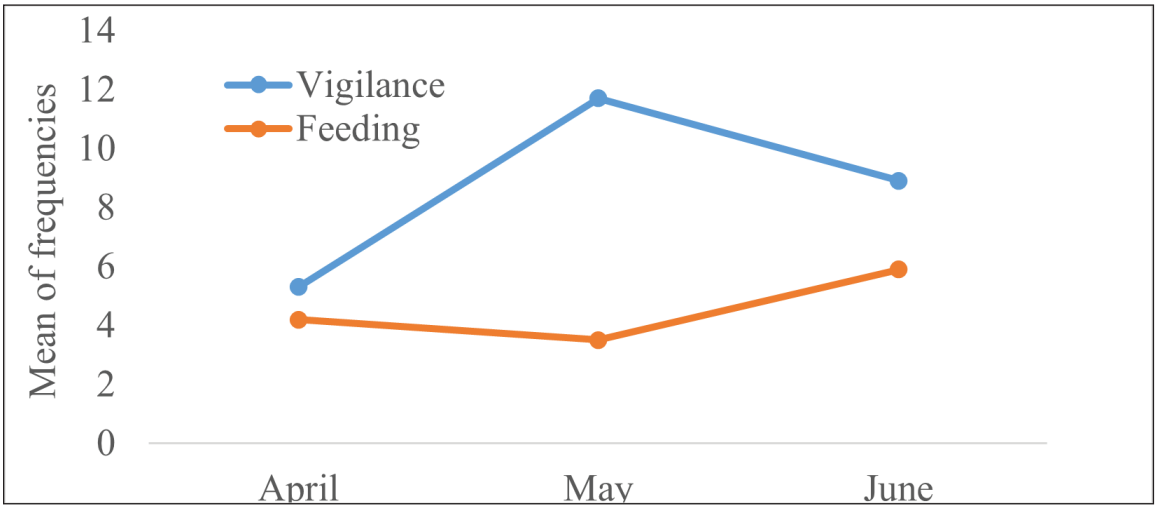

Figure 5. Frequency of *C. mitis* vigilance and feeding during April-June 2019 in Bulolero Forest, Idjwi Island, eastern Democratic Republic of Congo.

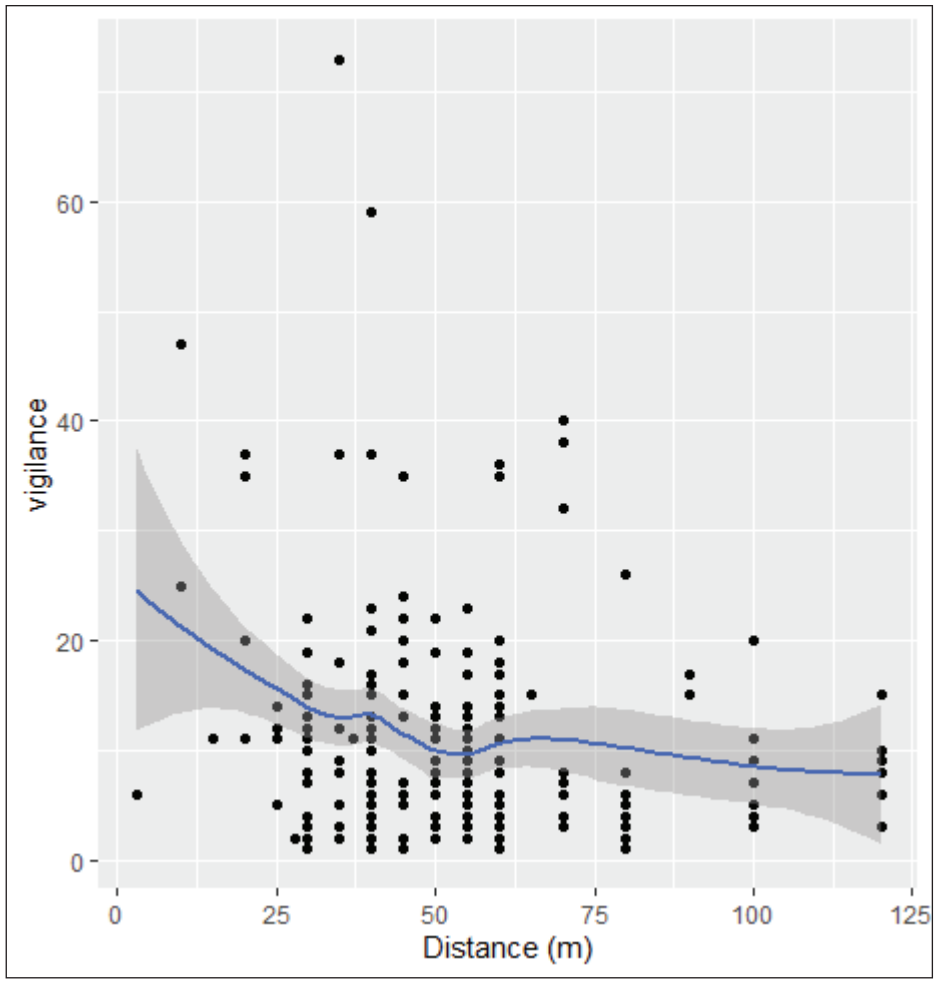

Figure 6. *C. mitis* vigilance decreased as distance to humans increased in Bulolero Forest, Idjwi Island, eastern Democratic Republic of Congo.

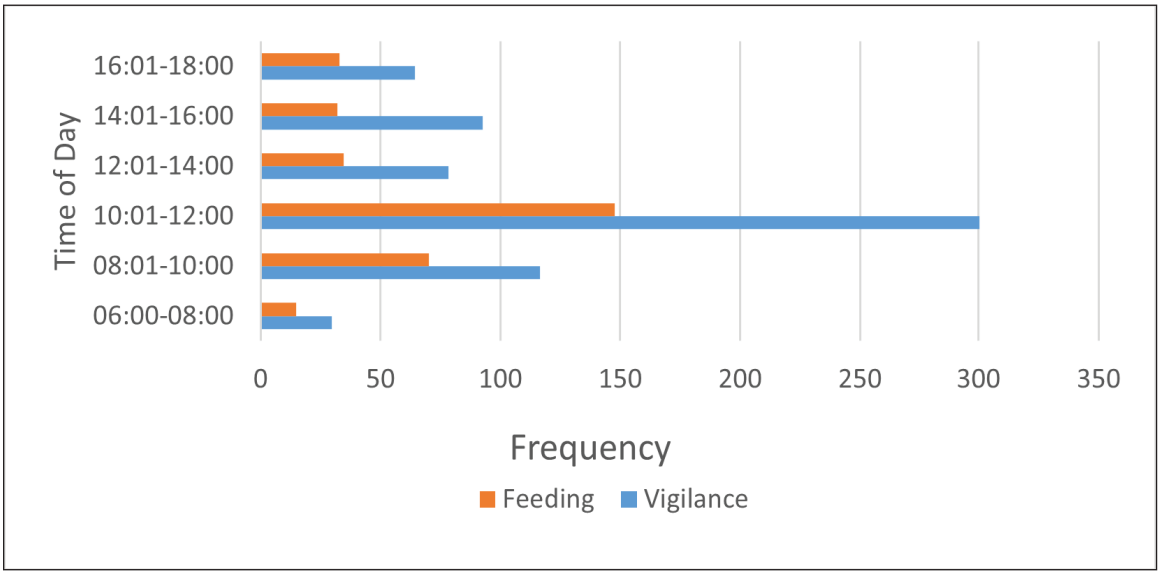

Figure 7. Frequency of *C. mitis* vigilance and feeding throughout the day (06:00-18:00) during April-June 2019 in Bulolero Forest, Idjwi Island, eastern Democratic Republic of Congo

negatively impact one another, while only four (16.7%) agreed that *C. mitis* may live near humans without issue. Ten respondents (41.6%) said that *C. mitis* raid agricultural fields.

Eleven people (45.8%) said monkeys are edible, while five (20.8%) said monkeys are considered edible only in certain Indigenous communities, such as Batwa. Eight people (33.33%) said monkeys are not edible. Most respondents (75%) reported that people hunt *C. mitis* for meat or in retaliation for crop raiding, while 10 of 24 respondents (41.6%) reported to have consumed *C. mitis*.

Landowners also demonstrated relatively good knowledge about forests and related ecosystem services. Most respondents (83.3%) considered the natural forest to be unsustainable though 75% recognized forests as a source of goods and services, such as firewood and non-timber forest products (e.g., mushrooms).

DISCUSSION

This study reconfirms the presence of *C. mitis* on Idjwi Island in eastern Democratic Republic of the Congo (DRC), following the species' presumed extirpation after decades of forest loss and fragmentation. Camera traps installed in the small, fragmented Bulolero Forest captured 39 independent photographs of individual guenons identified as *C. mitis*. Rough preliminary estimates based on camera trap footage and direct observation indicate at least 50 individuals in the population, including infants and juveniles.

This new evidence confirming the presence of *C. mitis* on Idjwi Island now warrants further study to identify the population to subspecies. While previous reports and studies (Kingdon *et al.* 2008; Kingdon 2013; Lawes *et al.* 2013) have suggested that *C. mitis* on Idjwi Island belong to the subspecies *C. mitis schoutedeni*, more recent reports treat the taxon as a synonym of Stuhlmann's blue monkey (*Cercopithecus mitis stuhlmanni*) (e.g., Butynski & De Jong 2019). Thus, genetic studies are necessary to clarify the taxonomy of *C. mitis* on Idjwi Island and its conservation status.

Regardless of taxonomic designation, the *C. mitis* population of Idjwi Island is highly vulnerable to local extirpation. Idjwi Island has undergone massive deforestation in recent decades, leaving the remaining forest habitat highly degraded and fragmented (Thomson *et al.* 2012; Habakaramo *et al.* 2015). The *C. mitis* population has taken refuge in a rocky escarpment within the Bulolero Forest, a relic of the larger Nyamusisi Forest which once covered about 17% of the island (RDC-MECNT 2012; Akilimali 2017; Amani 2018). Our camera traps revealed high levels of human activity in the Bulolero Forest where *C. mitis* range.

This finding is unsurprising given that most of Bulolero Forest has been converted for agriculture, despite the steep, rocky slopes which characterize the landscape.

Our study also documented vigilance and feeding behaviors of *C. mitis* on Idjwi Island to understand how human activity might be affecting the population. In primates, vigilance plays an important role in survival strategies (i.e., protection from predators) and in reproductive strategies (i.e., detection of mates and competitors) (Elgar 1989; Kutsukake 2007; Busia *et al.* 2016). As predator avoidance is prioritized, vigilance behaviors may include detecting predators, monitoring group members, and sometimes assessing escape routes (Bednekoff & Lima 1998; Treves 2000).

In this study, *C. mitis* spent more time on vigilance than feeding, regardless of time of day or month. This trend was especially apparent in May when more smallholder farmers were present nearby cultivating and harvesting crops. Feeding activity decreased as vigilance increased, indicating that feeding and vigilance does occur simultaneously in this population. *C. mitis* group size had little effect on vigilance. These results indicate that *C. mitis* exhibit predator avoidance in the form of vigilance when people approach. Heightened vigilance in this population may also suggest elevated stress levels, which have negative impacts on reproduction, neurophysiological activities, and many other biological processes (Balzamo 1980; Cords 1995; Cowlishaw 1998; Busia *et al.* 2016). Therefore, the prioritization of vigilance over feeding in this population may have important implications for the long-term survival of *C. mitis* on Idjwi Island.

Knowledge, attitude, and practices (KAP) surveys conducted with smallholder farmers active in the core *C. mitis* habitat offered insights regarding the interactions between *C. mitis* and people. Though landowners generally had good knowledge of *C. mitis*, negative attitudes and practices towards the primate prevailed. Notably, many respondents regarded *C. mitis* as crop predators (41.6%), and most respondents (75%) reported that people hunt monkeys for meat or in retaliation for crop raiding. Nearly half of respondents had reportedly eaten *C. mitis* meat. Negative interactions with *C. mitis* may be attributed to two primary reasons: (1) severe poverty and food insecurity which characterize these communities, and (2) weak involvement of local

communities in primate conservation. Community awareness and engagement in conservation action will be essential to ensuring that *C. mitis* remain on Idjwi Island.

Historically, *C. mitis* inhabited Idjwi Island's natural forests and enjoyed protection from local conservation-centric tradition, including the belief that consuming primate flesh was taboo; however, intergenerational knowledge transmission has waned over time (Rahm 1966). Socioeconomic hardships and recurring social conflicts have catalyzed a paradigm shift in societal norms, prompting a surge in bushmeat hunting and deforestation, which has, in turn, precipitated habitat fragmentation and decimated the *C. mitis* population. While poverty may elucidate prevailing adverse attitudes towards natural resources, including nonhuman primates, the dearth of knowledge among younger cohorts presents a formidable impediment to conservation endeavors.

CONCLUSION AND RECOMMENDATIONS

This study confirms the presence of a small, isolated population of *C. mitis* on Idjwi Island after its presumed extirpation. Our preliminary research also identifies existential threats facing the population and underscores the urgent need for developing community-based conservation strategies to avert the extirpation of *C. mitis* on Idjwi Island. We recommend immediate implementation of the following conservation strategies:

- Promote alternative livelihood projects in and around Bulolero village to improve community well-being and reduce human-induced pressures on *C. mitis* and its habitat.
- Restore degraded forests to provide suitable habitat for *C. mitis*.
- Promote behavior change campaigns through sustained education and outreach projects.
- Launch health projects and other social services to improve community health and well-being.
- Develop a community-based *C. mitis* monitoring system that integrates community participation in conservation activities and delivers benefits to the people of Idjwi island.
- Conduct a baseline census to estimate the population size of *C. mitis* on Idjwi Island.
- Conduct DNA analyses to clarify taxonomy and assess genetic diversity of the *C. mitis* population on Idjwi Island.

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Revisiting the Second Largest Forest of Guinea a Decade Later: Conservation Status, Chimpanzee Presence, and Threats in Diécké, Korohouan Area

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Abstract: The Diécké Forest is the second largest classified forest in Guinea and is an area of high conservation significance for many species including the western chimpanzee, *Pan troglodytes verus*. It has attracted several research expeditions focusing on chimpanzee presence and tool use since 1993. These studies also identified several instances of human activities impacting primates and other wildlife. Aside from Bossou, Diécké is the only other locality in Guinea where chimpanzees are known to crack nuts with tools. We visited the Diécké Forest in November 2018 to review the status of chimpanzee presence, nut-cracking activity, and conservation threats. We report our findings along with an up-to-date overview of relevant historical, socio-political, environmental, and scientific developments in the vicinity. Our survey took place in the vicinity of Korohouan village where research on chimpanzee nut-cracking had previously been conducted. We found scarce evidence of chimpanzee presence in the area (n = 3) with no recent traces of nut-cracking or other activities. Conversely, we found a high incidence of hunting (6.31/km) within the protected area, with small-scale agriculture and commercial activities predominating forest fragments outside the protected area. The intensification of human activities in Diécké pose a serious threat to one of the largest remaining lowland evergreen forests of West Africa and the endangered species that inhabit it, such as the Western chimpanzee. Our study highlights the need for urgent and concerted conservation action and provides an important case study on the disappearing cultural heritage of a chimpanzee population in a human-impacted habitat.

Key words: anthropogenic disturbance; chimpanzee; conservation; habitat fragmentation; human activity; nut-cracking; population decline

Résumé: *La forêt de Diécké est la deuxième plus grande forêt classée de Guinée et constitue une zone de haute importance pour la conservation de nombreuses espèces, y compris le chimpanzé de l'Ouest,* Pan troglodytes verus*. Hormis Bossou, Diécké est le seul autre endroit de Guinée où les chimpanzés sont connus pour concasser des noix avec des outils. Plusieurs expéditions de recherche axées sur la présence des chimpanzés et l'utilisation d'outils ont eu lieu depuis 1993 jusqu'en 2011. Ces études ayant également identifié plusieurs cas d'activités humaines qui ayant un impact sur les primates et d'autres animaux sauvages. Nous avons visité la forêt de Diécké en novembre 2018 pour examiner l'état de la présence des chimpanzés, l'activité de concassage de noix et les menaces pour la conservation. Nous accompagnons nos découvertes d'un aperçu des derniers développements historiques, sociopolitiques, environnementaux et scientifiques dans la région. Notre enquête a eu lieu près du village de Korohouan où des recherches sur le concassage des noix par les chimpanzés avaient déjà été menées. Nous avons trouvé seulement 3 preuves de la présence de chimpanzés, mais aucune trace récente de concassage*

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de noix ou d'autres activités. Bien au contraire, nous avons enregistré une incidence élevée de chasse (6,31/km) dans la zone protégée, et une prédominance de l'agriculture à petite échelle et des activités commerciales dans les fragments forestiers autour de la zone protégée. L'intensification des activités humaines à Diécké constitue une menace sérieuse pour l'une des plus grandes forêts sempervirentes d'Afrique de l'Ouest et pour les espèces menacées qui y habitent, comme le chimpanzé de l'Ouest. Notre étude souligne la nécessité d'une action concertée de conservation urgente et fournit une étude de cas importante sur la disparition du patrimoine culturel d'une population de chimpanzés dans un habitat anthropique.

Mots clés: perturbation anthropique; chimpanzé; conservation; fragmentation de l'habitat; activité humaine; concassage des noix; déclin de la population

INTRODUCTION

The Diécké Forest in Guinea was first recognized as an important area for studies of chimpanzee culture following a nationwide chimpanzee and large mammal census in the late 1990s, which found evidence of chimpanzee nut-cracking activities alongside other indirect traces of chimpanzee presence (Ham 1998). Subsequent research focusing on chimpanzee tool use revealed that the techno-cultural traditions of Diécké chimpanzees differed from that of the nearby long-term field site of Bossou, establishing Diécké as a locality of interest for comparative research on chimpanzee technology and culture (Matsuzawa *et al.* 1999; Humle & Matsuzawa 2001; Carvalho *et al.* 2007, 2008; Carvalho 2011).

Despite these promising beginnings, partly due to a period of political instability and the 2013 Ebola outbreak, research on the chimpanzees of Diécké, their technology, and culture remained stagnant between 2009 and 2018. We returned to Diécké in November 2018 on a reconnaissance expedition to check the status of chimpanzee presence and nut-cracking activity in the forest near Korohouan. In the present study, we provide the first up-to-date overview of the historical, socio-political, environmental, and scientific developments around the Diécké Forest since the 1990s and examine our findings within this context. We assess the potential for future research in this Classified Forest and discuss implications for conservation.

Diécké Forest

The Diécké Forest is located in the Yomou prefecture of the Guinée Forestiére region (Figure 1; Ham 1998). It extends over 700 km^2, spanning approximately 35 km across north to south and east to west (Humle & Matsuzawa 2001; Kormos *et al.* 2003), and borders Liberia to the southeast. The landscape is characterized by a large collection of small hills with elevation ranging 50-800 m above sea level (Carvalho *et al.* 2007; Carvalho 2011). It is part of the Western Guinean Lowland Ecoregion and is composed predominantly of a moist evergreen forest, where large girth timber species form a dense canopy, interspersed by pockets of riparian forest and swamp-forests dominated by *Raphia* palms (Robertson 2001; Brugiere & Kormos 2009; Carvalho 2011; Haba & Couch 2018). This region has an annual rainfall of 1,730-2,250 mm (calculated from 2000-2018 data - see Supplementary Online Material*; Harris *et al.* 2020), and experiences a long wet season between April and December followed by a very short dry season between December and March (Carvalho *et al.* 2007). It has two main rivers running southwest, but there are also many smaller streams that flood, creating swamps that restrict access to some parts of the forest (Robertson 2001; Carvalho *et al.* 2007).

Conservation status and initiatives

There are currently 162 Classified Forests (*forêts classées*) in Guinea and Diécké is one of the 40 in Guinée Forestiére (Ministère de l'Environnement, des Eaux et Forêts 2019b). It is the largest near-pristine lowland evergreen forest in Guinée Forestiére and one of the few remaining near-pristine forest mosaics of the Upper Guinean Forest ecosystem (Couch & Haba 2018; Akobi & Poissonnier 2021; Fauna & Flora International 2021), a part of the Western Guinean Lowland Ecoregion that persisted through the glaciation cycles and global cooling of the Pleistocene (Carvalho *et al.* 2008; Kalan *et al.* 2020). Today, the Western Guinean Lowland Ecoregion is the most threatened ecoregion in Guinea (Brugiere & Kormos 2009). As such, Diécké represents an ancient and important forest refuge that has provided a stable tropical climate and habitat to a range of taxa, including chimpanzees, for thousands of years (Kalan *et al.* 2020; Barratt *et al.* 2021).

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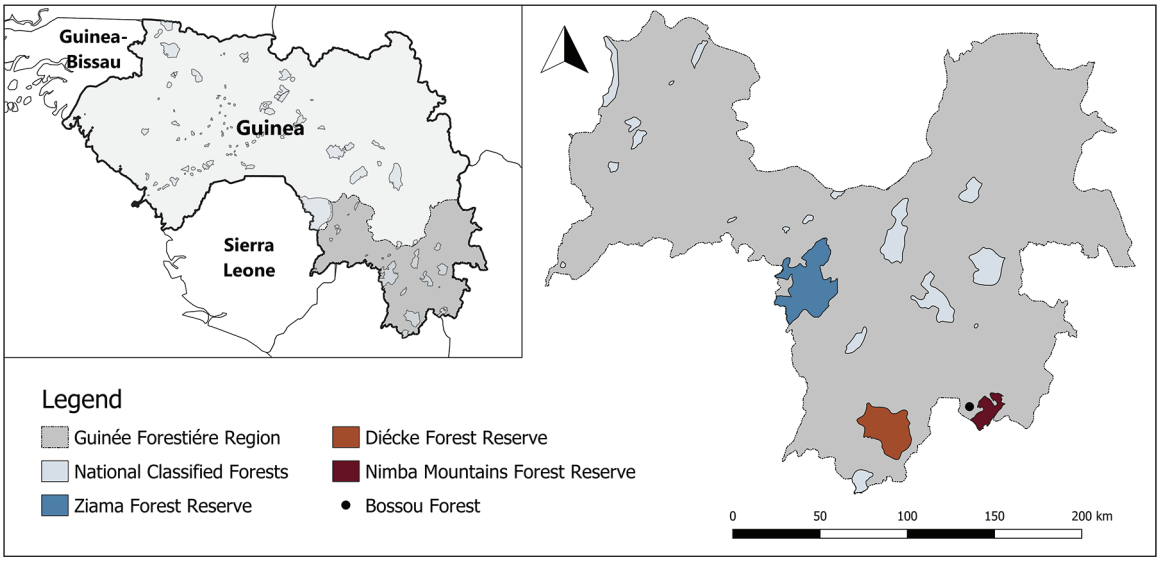

Figure 1. Map of the national Classified Forests of Guinea and the locations of the Ziama, Diécké, Nimba, and Bossou forests.

The Diécké Forest has been ranked as one of the highest Key Biodiversity Areas for West Africa and is among the top five plant biodiversity areas at a national level (Brugiere & Kormos 2009; Haba & Couch 2018; Haba *et al.* 2018; Fauna & Flora International 2021). Additionally, Diécké has been identified as part of one of four transboundary areas of importance for the conservation of the critically endangered western chimpanzee, *Pan troglodytes verus* (Humle *et al.* 2016; Heinicke *et al.* 2019a). The forest is home to a further 61 species of conservation concern, including the African dwarf crocodile (*Osteolaemus tetraspis*: IUCN Red List: vulnerable) and the tenth largest population of pygmy hippopotamus (*Hexaprotodon liberiensis*: IUCN Red List: endangered) (Robertson 2001; Akobi & Poissonnier 2021; Kormos *et al.* 2003). It is also an Important Bird and Biodiversity Area (IBA), with 141 avian species (Akobi & Poissonnier 2021), such as the threatened Yellow-casqued hornbill (*Ceratogymna elata*: IUCN Red List: vulnerable), Yellow-bearded greenbul (*Criniger olivaceus*: IUCN Red List: vulnerable), Green-tailed bristlebill (*Bleda eximia:* IUCN Red List: near threatened), and White-necked rockfowl (*Picathartes gymnocephalus*: IUCN Red List: near threatened) (Robertson 2001).

Protective legislations have been in place since 1932, when the French colonial administration established the Diécké Forest as a natural reserve, and later as a Classified Forest (Akobi & Poissonnier 2021). Following Guinean independence, Classified Forests, such as Diécké, have remained under State governance with restrictions on human activities (Brugiere & Kormos 2009). However, the majority of Classified Forests have no formal management plan and are severely degraded (Brugiere & Kormos 2009). The Diécké Forest is one of the few that has been actively managed by government authorities since 1991 via a series of fixed-term projects (1991-1994: PROGEFOR; 1996-2003: PGRR; 2004-2009: PGRF; 2017-2024 MRU-IWRM) aided by funds from financial institutions such as The World Bank, Kreditanstalt für Wiederaufbau (Germany), and the Canadian International Development Agency (The World Bank 1997; IUCN 2016; Ministère de l'Environnement, des Eaux et Forêts 2019a). Now under the remit of the Centre Forestiére de N'Zerekoré (CFZ) government wildlife authority, these conservation efforts have sought to restore the forest and prevent further degradation through sustainable rural development, community engagement, reforestation and the monitoring of illegal activities via regular patrols (Diallo 1996; The World Bank 1997; IUCN 2016). Despite these efforts, recent government reports indicate that threats to forest degradation prevail (Bureau de Stratégie et de Développement 2020a; 2020b), which has led some conservation practitioners to recommend that the Diécké Forest is attributed national park status – the highest level of formal national protection (Brugiere & Kormos 2009).

Human impact

Guinea is among the 10 countries in the world most affected by deforestation, with nearly a third

(2.9 million ha) of tree cover lost between 1960 and 2020 (Akobi & Poissonnier 2021). Like many parts of Guinea, the forests of Guinée Forestiére have been affected by escalating anthropogenic disturbance, such as agriculture, logging, mining, and hunting, since the beginning of the colonial era in 1905 (Akobi & Poissonnier 2021), although archaeological evidence indicates that small scale land use practices, including food production, have occurred in the area since 200 BCE (Kay *et al.* 2019). While Classified Forest are protected under State legislation, some conservation initiatives have been the subject of negative public perception, with residents complaining of a lack of consideration for local communities and traditional land use rights (Leach 2008).

Accelerated population growth and development of commercial ventures in response to international resource demand in the last 30 years are exacerbating the threats to the Diécké Forest and other natural reserves (Akobi & Poissonnier 2021). In a survey by the Wild Chimpanzee Foundation in 2011, which covered 11 chimpanzee localities in Guinea, Diécké was found to be the third most negatively affected by human pressure, only surpassed by the Nimba Mountains and Ziama, which are also located in Guinée Forestiére (Wild Chimpanzee Foundation 2012). The rise of extractive industries and large-scale agriculture has also raised public health and socio-economic concerns among local communities in Guinée Forestiére and elsewhere (Baldé 2018a; Human Rights Watch 2018; Balde *et al.* 2019; Guilavogui 2020). The quality of life in the region remains very poor, with the majority of Guinée Forestiére inhabitants living on less than $850 per year and suffering from malnutrition (Akobi & Poissonnier 2021). This highlights the interconnectedness of conservation concerns and socio-economic issues and the need for conservation approaches that acknowledge these realities (Mitani *et al.* 2024).

Across Africa, hunting, agricultural expansion, logging and mining are currently the main human threats affecting African ape populations (Junker *et al.* 2024). The following sections provide an overview of the latest developments of these four activities around the Diécké Forest to contextualize our survey findings and draw attention to the conservation and socio-economic challenges ahead.

Poaching

Illegal hunting within the Diécké Forest has remained high throughout the last three decades (Ham 1998; Kormos *et al.* 2003; Carvalho 2011; Bureau de Stratégie et de Développement 2020a), with Diécké representing one of the chimpanzee localities in Guinea most negatively affected by hunting pressure (Wild Chimpanzee Foundation 2012). Poachers are known to set up camps within the Classified Forest, where they will spend several days trapping and hunting wild animals for bushmeat and other products to sell in larger cities such as N'Zérékoré (Kormos *et al.* 2003; Akobi & Poissonnier 2021). In the past, chimpanzees inhabiting the forest have also fallen victim to this exploitation, with three killings reported by CFZ in 2001 (Kormos *et al.* 2003).

CFZ has implemented several preventative measures in the Diécké Forest, such as monthly patrols by forest rangers (ecoguards) to track down poachers, monitor illegal hunting activities, and raise awareness in local communities (Sangbalamou 2020). However, the ecoguards have said that these missions are constrained by the lack of crucial resources, such as means of transportation, GPS devices, camping equipment, and weapons (Sangbalamou 2020).

Other regions of Guinée Forestiére, such as Ziama and Mount Nimba, have benefitted from financial support from the EU/UNOPS, which provided equipment and training to the then Ministère de l'Environnement, des Eaux et Forêts for the launch of a pilot paramilitary conservation scheme – Projet d'Appui à l'Opérationnalisation d'un Corps Paramilitaire des Conservateurs de la Nature (PAOCPCN) (IUCN 2016). However, these projects are often short-term, and lack funding continuity. An assessment presented at the CITES CoP18 reports that Guinea has no government budget allocated for protected areas, with efforts supported exclusively by foreign governments and international NGOs (Convention on International Trade in Endangered Species of Wild Fauna and Flora 2019). Thus, while the establishment of a more permanent presence would help reduce hunting pressure (Kormos *et al.* 2003), strong political commitment and strategy is needed to ensure long-term allocation of funding and resources (Brugiere & Kormos 2009).

Rubber and palm oil industry

It is estimated that between 2000 and 2018 approximately 25% of the Guinée Forestiére region suffered tree cover loss, with agriculture identified as the primary driver (Fitzgerald *et al.* 2021). The Diécké Forest is surrounded by rubber and oil palm plantations that are controlled by the

Société Guinéenne de Palmiers à Huile et d'Hévéa (SOGUIPAH) – the largest rubber and palm oil producer in the country (Balde *et al.* 2019; Fauna & Flora International 2021). SOGUIPAH is an agro-industrial public company that was founded in 1987 to support the sustainable development of industrial and family-owned plantations and promote local development and food security (The World Bank 2016; Fauna & Flora International 2021). Over the years it has received financial support from multiple donors including the African Development Bank, the Arab Bank for Economic Development in Africa, and the European Investment Bank (López-Cálix 2020). Today, SOGUIPAH's land holdings extend across ~230 km^2, employing over 3,500 workers on its plantations and in its factories for processing rubber, palm oil, and soap (Thompson *et al.* 2021). The company also purchases natural rubber and palm fruits from around 3,000 local smallholders, and supports them by providing training, planting material, and technical assistance (Balde *et al.* 2019; Fauna & Flora International 2021).

Large-scale oil palm plantations have frequently been associated with habitat fragmentation and biodiversity loss, with negative impacts on adjacent intact forests (Wich *et al.* 2014; Linder & Palkovitz 2016; Strona *et al.* 2018). SOGUIPAH's sustainability measures include reforesting areas affected by artisanal slash-and-burn practices, and the establishment of *collines écologiques*, small (~700 ha) protected forests, within their concessions to provide ecosystem services to local communities and wildlife (Keita & Bedinger 2008; GEF 2019). SOGUIPAH reportedly manages these areas and monitors the impact of its activities on the environment (Fauna & Flora International 2021), however, it is presently unclear how successful these measures have been due to absence of published data.

While SOGUIPAH has contributed towards social infrastructure in the region such as health clinics, schools, roads, and access to water (López-Cálix 2020), its operations have been associated with negative socioeconomic impacts (Balde *et al.* 2019). Between 2011 and 2016, SOGUIPAH's oil palm and rubber exports increased by 900% and 50% respectively (López-Cálix 2020), yet employees and small-hold suppliers have claimed that their incomes are increasingly insufficient, accusing the company of enforcing its own pricing system and overriding contractual agreements (Balde *et al.* 2019). In February 2020, workers protested against their employer due to wages in arrears of 2-3 months, an issue that has been recurring since 2013 (Guilavogui 2020).

Logging

Timber is one of the most sought-after natural resources in Guinea. Logging activity in Guineé Forestiére has been controlled by Forêt Forte, a subsidiary of the Taiwanese company Coujy Corporation, since 2002 when it was granted exclusive concessionary rights by the Guinean government to exploit the region's surviving forests, including the protected areas of Diécké and Ziama (Akobi & Poissonnier 2021; Fauna & Flora International 2021). While operations in these two forests have been halted by the Ministère de l'Environnement et du Developpement Durable (formerly Ministère de l'Environnement, des Eaux et Forêts) (Fauna & Flora International 2021), reports and local media coverage indicate that this could change imminently (Camara 2017; Baldé 2018b; Akobi & Poissonnier 2021).

Forêt Forte is already exploiting classified forests in other parts of Guinea (Akobi & Poissonnier 2021; Foret Forte 2021a). While it claims to be committed to sustainable and ethical development (Foret Forte 2021b; Nydegger 2021), the company has been repeatedly accused of abusive logging that could lead to the decimation and irreversible deforestation of the last pristine forests in Guinea (Camara 2017; Baldé 2018b; Guilavogui 2018; Akobi & Poissonnier 2021). The local NGO *Touche pas à ma foret*, the national green party (*Parti Écologique de Guinée* - PEG), and the local youth centre (*Maison des jeunes et de la culture de N'Zérékoré*) are amongst those that have strongly criticised the latest Forêt Forte agenda, claiming that the company has failed to comply with its reforestation and infrastructure development commitments, did not consult with local communities, nor respect their traditions with regard to the sacred areas of the forest (Akobi & Poissonnier 2021). Beyond the forest and into production, news reports from 2018 impart that workers at the Forêt Forte factory in N'Zérékoré were on strike for over 6 months due to poor living and working conditions (Baldé 2018a, 2018b).

Mining

Guinea harbours the largest bauxite reserves and untapped iron ore deposits in the world (Ministry of Mines and Geology 2021a, 2021b). Historically, the exploitation of mineral resources has been constrained by political conflicts and poor transport infrastructure throughout the country. In recent years, however, mining operations in Guinea, have expanded drastically in response to the growing

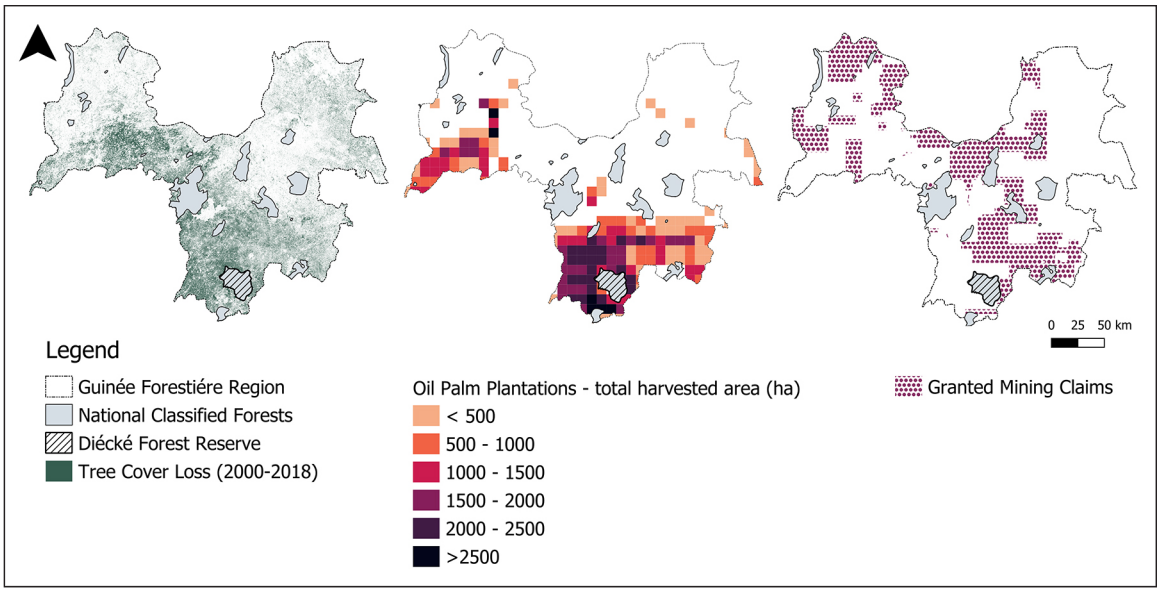

Figure 2. Distribution of main commercial activities and tree cover loss in the Guinée Forestiére Region. Tree cover loss in Guinée Forestière from 2000 to 2018 was mapped using Landsat analysis ready data and a regionally calibrated, annual forest change detection model (as per Fitzgerald *et al.* 2021). The map of oil palm plantations is presented as the total area harvested (in hectares) during 2017, with white areas indicating locations where commercial oil palm activities are absent. The original data is available from the Harvard Dataverse, under a CC-by-4.0 license (Online source: International Food Policy Research Institute, 2020; https://doi.org/10.7910/DVN/FSSKBW). The map for mining claims is an approximate rendering of the areas where mining exploration and/or extraction has been approved. This includes past, current and future activities. The information was sourced from a publicly available dataset where no interrogation of the data is possible (SNL Metals & Mining, an offering of S&P Global Market Intelligence, 2020; Online source: https://panda.maps.arcgis.com/home/item.html?id=6f8e17219c354878af009a6cc9a9f571).

global demand for rare metals and minerals (Fauna & Flora International 2021). The national economy has benefitted greatly from these developments, ranking fifth in the International Council of Mining and Metals (ICMM) Mining Contribution Index of 2020 (ICMM 2020).

Large-scale mining, as well as artisanal and small-scale mining, are now conspicuous across the Guinean landscape, with many mining claims intersecting areas of high biodiversity and carbon value, including regions that harbour endemic forests and threatened species (Fauna & Flora International 2021). Recently, Guinea has been found to have one of the highest overlaps in chimpanzee population abundance and mining areas in West Africa, with over 80% of Guinea chimpanzees estimated to face the impacts of the mining industry in the near future (Junker *et al.* 2024).

The largest active mining concessions in Guinée Forestiére are located in the Nimba Mountains (a UNESCO World Heritage Site) and Simandou. Further mining claims have been granted to the South and East of the Diécké Forest (Figure 2). Initial prospection of the deposits to the south of the Diécké Forest has estimated a resource potential of approximately 1.2 billion tonnes of iron ore (Al Khaldiya Mining 2021). Within Guinée Forestiére, the Diécké mining concession is the closest mineral reserve to a working railway with access to the coast (Al Khaldiya Mining 2021), making it an attractive extraction site for quick and direct export of natural resources through Liberia. In 2020, the Kuwaiti-backed Al Khaldiya Mining group signed a memorandum of understanding with the Liberian government to transport 789 million tons of iron from its Diécké project via the Yekepa-Buchanan rail line (Mehnpaine 2020). As of 2023 the permit for exploration at the Diécké iron ore site remains active and has been put forward for renewal (Project code: 22713, Ministère des Mines et de la Géologie and Trimble Land Administration 2023).

With the mining industry expected to surge in the coming years (Sonter *et al.* 2020; Junker *et al.* 2024), the region will attract a large influx of people which will generate greater demand for food, resulting in agricultural expansion (Lanjouw *et al.* 2013). Likewise, increased industrial activities will boost infrastructure developments, particularly transport networks and electricity, providing greater access to the region (Lanjouw *et al.* 2013). While

this may bring positives to local communities, it could have grave consequences for public health and the natural environment, if not properly regulated. In the Boké region (Guinée Maritime, western Guinea), decades of bauxite mining, involving the multinational mining corporations Rio Tinto, Alcoa, and Dadco, is already having devastating impacts on nearby human settlements and the surrounding environment, such as water contamination, air pollution, and soil infertility (Human Rights Watch 2018; Oakes 2019; Rolando Mazzuca 2019; Sidiki 2019). Loss of land and livelihoods, reduced access to clean water, and other threats to public health are amongst the damaging consequences highlighted in the latest Human Rights Watch report (2018) concerning bauxite mining in Guinea. Coupled with the environmental degradation and biodiversity loss in the Boké region, including the plight of chimpanzees (O'Mahony 2019; Bergen 2020), this is a worrying prospect for the future of other mining localities such as Diécké.

Chimpanzee status and tool use

To date, there have been a total of six published chimpanzee surveys and research expeditions in the Diécké Forest (Figure 3; Table 1). An initial national census in 1988, based on questionnaires, estimated the existence of around 50 chimpanzees in the area (Sugiyama & Soumah 1988). Subsequent transect-based surveys using the number of chimpanzee nests as a proxy for population size, estimated between 209–307 individuals in 1997 (Ham 1998), and 25–253 individuals in 2011 (Wild Chimpanzee Foundation 2012). These are, however, rough estimates. Furthermore, the number of chimpanzee communities in the area remains unknown. Direct observations of chimpanzees have so far only been confirmed by Ham (1998), Humle and Matsuzawa (2001), and Carvalho (2011), who also recorded chimpanzee presence through motion detecting cameras.

It was during the 1997 census in the Yossono area (Figure 3) that evidence of nut-cracking activity was first encountered (Ham 1998) – a collection of stones surrounded by broken nuts in the vicinity of a *Panda oleosa* tree. Subsequent surveys in the Nonah and Yossono areas specifically targeting technological and cultural traces, found additional nut-cracking sites of both *Panda* and *Coula* nuts, confirming cultural divergence relative to the nearby site of Bossou, where chimpanzees only crack oil palm nuts

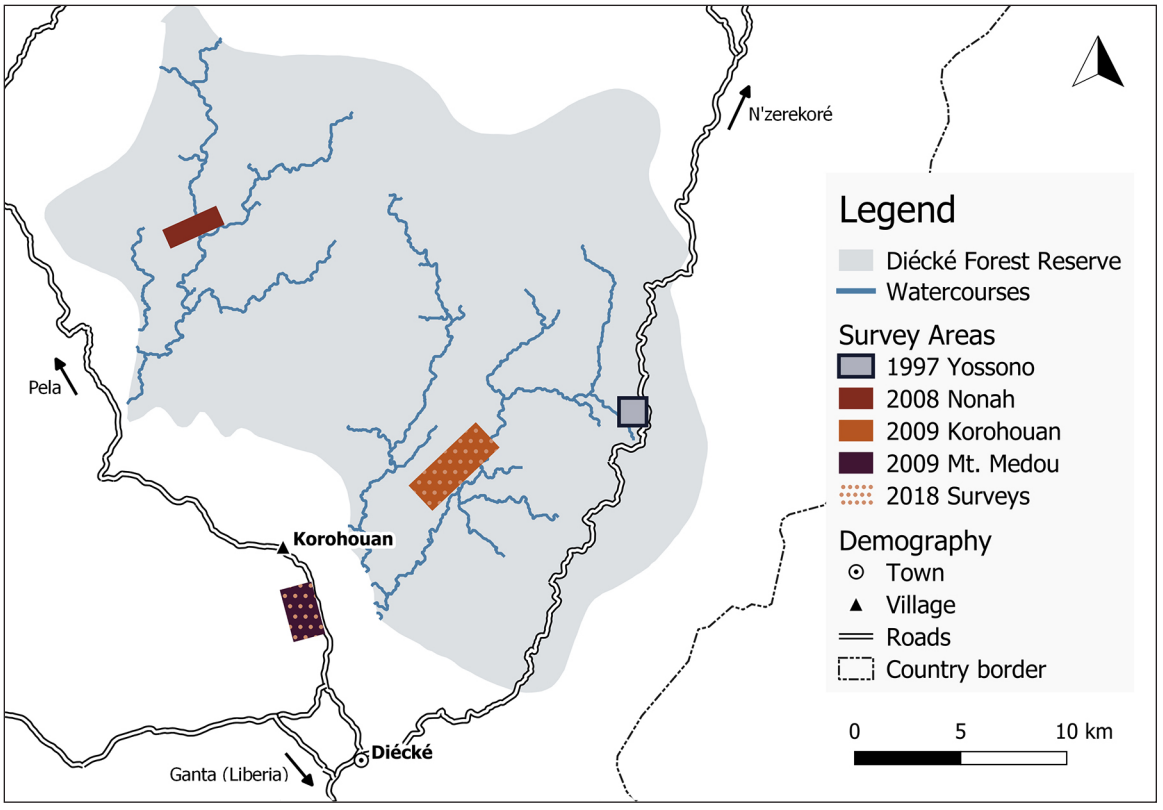

Figure 3. Map of the Diécké Forest highlighting the locations of known survey areas and nearby villages.

Table 1. Summary of the survey activities that have taken place in and around the Diécké Forest region. Empty cells represent unknown or unavailable information.

Year	Survey goals[a]	Method[b]	Forest section[c]	Duration[d]	Distance surveyed[e]	Reference
1988	CP	I				Sugiyama & Soumah 1988
1997	CP, W, H	LT, I	E	1	5.2	Ham 1998
1999	CTU	ES	NE, NW	3		Matsuzawa *et al*. 1999
2000	CTU	ES	NE, NW	10		Humle & Matsuzawa 2001
2006	CNC, CP	ES, TSM	NW, S	19 (NW: 3 + 8 + 4; S: 6)		Carvalho *et al.* 2007
2008	CNC, CP	ES, TSM	NW	12 (8 + 4)		Carvalho 2009
2009	CNC, CP, W, H	ES, LT, MTC, TSM	S	37 (12 + 14 + 11)		Carvalho 2009
2011	CP, W, H	LT	FW		144.8	WCF 2012
2018	CP, CNC, W, H	LT, ES	S	5	21.7	This study

[a] CP = chimpanzee presence; CNC = chimpanzee nut-cracking; CTU = chimpanzee tool use; H = human activity; W = wildlife.
[b] ES = exploratory surveys; I = interviews; LT = line transects; MTC = motion triggered cameras; TSM = tool site monitoring.
[c] General survey area: FW = Forest-wide; NE = North-East; NW = North-West; S = South.
[d] Values indicate total duration (in days) of each survey effort. Values in parentheses represent the duration of individual trips.
[e] Values reported in kilometres.

(Matsuzawa *et al.* 1999; Humle & Matsuzawa 2001).

The most recent and longest research endeavour focusing on the nut-cracking behaviours of the Diécké chimpanzees took place between 2006 and 2009 in the Nonah and Korohouan areas (Carvalho *et al*. 2007; Carvalho 2011). This research aimed to investigate, within a primate archaeology framework, the direct and indirect evidence of nut-cracking and to compare with research being conducted in parallel in Bossou (Carvalho *et al.* 2008, 2011). This was the first archaeological investigation of chimpanzee tool use conducted in the Diécké forest, making it only the third chimpanzee locality to host research of this kind, following Taï and Bossou (Mercader *et al.* 2002; Carvalho *et al.* 2008).

Nine trips occurred during the 2006-2009 period, lasting a total of 68 days (Carvalho 2009, 2011). A total of eight nut-cracking sites were documented, along with traces of chimpanzee feeding, nests, and tracks (Carvalho *et al.* 2007). Comparisons with the Bossou data revealed that the chimpanzees of Diécké used larger tools to crack open nuts and exclusively used fixed outcropping stones as anvils, while Bossou chimpanzees always used smaller, movable tools (Carvalho *et al*. 2008). These differences are likely connected to differences in the number of movable stones available in each respective site, as well as in properties of the target foods (e.g., *Panda* nuts are larger and harder to crack; Boesch & Boesch, 1983).

Korohouan: revisited a decade later

In 2018, nearly a decade after the last primate archaeological research in the area, we returned to the Korohouan locality on a reconnaissance expedition to follow-up on previous work and review the status of chimpanzee presence and technological activity. This included revisiting known nut-cracking sites, searching for new sites, documenting traces of chimpanzee presence, and recording the availability of resources and raw materials targeted by chimpanzees for nut-cracking. An additional goal was to document the presence of other wildlife and traces of human activities (e.g., fishing, hunting) to assess the broader conservation status and threats in the area.

MATERIALS AND METHODS

Study site

Korohouan (7° 26' N; 8° 59' W) is a small village located near the southern border of the Diécké Forest, around 12 km northwest of Diécké town, along the Diécké-Pela Road (Figure 3). The human population is estimated to be approximately 3000 people and predominantly lives off subsistence farming and employment by SOGUIPAH.

The Korohouan survey area includes a section

to the northeast of the village within the classified forest area of the Diécké Forest (Figure 3). To facilitate surveys in this area, we set up a temporary camp at the former site of Camp Lethou (7° 27' N; 8° 54' W), located on the border of the Gbin river, around 18 km from the Korohouan village. Camp Lethou was originally established during the 2008 research activities (Carvalho 2009). The survey area also extends to Mont Medou (hereafter, Mt. Medou; 7° 24' N; 8° 59' W) – a small patch of forest surrounded by cultivation fields to the south of the village (Figure 3), where local people have frequently observed chimpanzees in the past (Carvalho 2006).

Data collection

The 2006-2009 surveys

The Korohouan surveys of 2006–2009, led by SC, took place over four separate field trips, totaling 43 days. These surveys primarily focused on: the mapping and monitoring of chimpanzee nut-cracking sites; transect surveys of raw materials, nut species, and chimpanzee presence (e.g., nests, faeces); and the archaeological excavation of an abandoned chimpanzee nut-cracking site (Carvalho 2011). In 2009 the research team also installed two motion triggered cameras in the Mt. Medou area along two chimpanzee trails, each active for a total of 50 and 25 days, respectively. While data on wildlife abundance and human impact was not collected systematically, the unpublished reports include several accounts of the human activities encountered (Carvalho 2006, 2009). We provide a summary of the unpublished findings pertaining to nut-cracking sites (number of tools, site activity status), chimpanzee traces (nests, feeding, tracks, faeces), and human activities to contextualize the results from the 2018 surveys.

The 2018 surveys

In November of 2018, KAW and MF organised a six-day reconnaissance expedition to the Korohouan area. The research team spent 5 days in the Classified Forest (25 Nov 2018 – 29 Nov 2018) and one day surveying Mt. Medou (01 Dec 2018). Surveys were initially conducted by navigating towards the four known nut-cracking sites and other features of interest documented between 2006–2009 (e.g., chimpanzee nests, traces of other primates, camera trap locations). We also carried out a 1.3-km line transect intersecting the two nut-cracking sites with the most recent traces of activity. In total we surveyed a distance of 21.7 km. For all nut-cracking sites encountered during surveys, we recorded the number of tools and raw materials present, and characterised the associated (source) *Panda* and *Coula* trees (within a 5-m radius) according to each of the following binomial attributes: alive (tree is producing leaves/flowers and has no visible sign of disease or significant damage/injury); bearing fruit (fruits/nuts are visible in the tree and/or on the ground). We compare the data to that collected during the 2006–2009 surveys led by SC.

All evidence of wildlife and human presence found during the survey was logged on a handheld GPS device and described by source (i.e., taxa), type of trace (e.g., footprint, feeding, snare, hunting camp, shotgun shells), as well as approximate age. Because the 2006–2009 surveys did not record these data, we use the data from the 2011 WCF wildlife status report to provide historical context and a baseline for examining general trends. To enable this comparison, we calculated our total travel distance from live tracks recorded during fieldwork, after overlapping segments and stationary logs had been removed during post-processing in QGIS. We also recorded any concurrent traces of the same source and age as one observation, as these were likely to be the product of the same event.

Data sharing statement

All data generated or analysed during this study are included in this article and its Supplementary Online Material. They can also be found in the IUCN Database and A.P.E.S. Wiki. Further enquiries can be directed to the corresponding author.

RESULTS

To provide context and a baseline for inferring general trends we present the results from the 2018 surveys alongside data and other relevant findings from the last known surveys which, to date, have largely remained unpublished or confined to grey literature (except for Carvalho *et al.* 2007; Carvalho 2011). We compare data on chimpanzee presence and nut-cracking activity primarily to the data from the 2006–2009 Korohouan surveys. For traces of other wildlife and human activities we refer to the 2011 WCF survey as a point of comparison.

Chimpanzee presence

During the 2006–2009 surveys, the research team identified several chimpanzee traces in the Korohouan area of the Classified Forest (hereafter classified forest area), including nut-cracking sites,

arboreal nests, faecal remains, feeding traces, and trails (Carvalho 2006, 2009) (Table 2; Figure 4). In the Mt. Medou area, the team found an additional nut-cracking site, as well as several chimpanzee nests (Table 2). In 2009, six chimpanzees were encountered while feeding on a *Landolphia owarensis* tree in the classified forest area. Chimpanzees were also captured once on each of the two motion triggered cameras installed in 2009. To our knowledge, these remain the only direct sightings to be filmed by researchers in the Diécké Forest region.

In 2018, we found two traces of nut-cracking activity and one decayed nest in the classified forest area, both estimated to be around 1 year old. Evidence of chimpanzee presence in Mt. Medou was limited to four potential chimpanzee trails (Table 2). No further chimpanzee traces were found during the 2018 surveys. Compared to the 2006 and 2009 absolute encounter rates, the 2018 surveys yielded the lowest records of chimpanzee presence in both the classified and Mt. Medou areas (Table 2). This decline is even starker when compared to the nest data recoded in 2011 by the WCF (Wild Chimpanzee Foundation 2012). When adjusted by the distance surveyed, the number of nests per km in the classified forest area was 90% lower than encounter rates reported in 2011 (Table 3).

Chimpanzee nut-cracking activity

During the 2006–2009 surveys, the research team identified a total of four nut-cracking sites in the surveyed areas. Two of the sites had month-old traces of nut-cracking (SB4, SB5; Figure 4e), and one other site (SB3) appeared to have been inactive for several years as a number of tools were buried under soil (Carvalho *et al.* 2007). SB3 comprised of a large lithic assemblage (n = 40) and was the target of an archaeological excavation in 2009 (Figure 4f; Carvalho 2006, 2009).

During the 2018 survey, all four previously recorded nut-cracking sites of the 2006–2009 surveys were found, a few of which still bore traces of previous work such as white ink numbers on tools, and remnants of the test pits dug during the excavation at SB3. Two additional nut-cracking sites were encountered in the classified forest area. *Panda* and *Coula* trees at all nut-cracking sites were healthy and yielding fruits at the time of data collection, except for the tree located at the Mt. Medou nut-cracking site (SB6; Table 4). Furthermore, all sites had multiple stones that would be suitable to use as nut-cracking tools (Table 4). Nevertheless, only two out of six sites showed moderately recent traces of nut-cracking, including the excavated site (SB3) and a newly discovered site nearby (~250 m south; Table 4). Based on the state of decay of cracked nuts and weathering of traces on the tools, we estimate that these two sites were last active around one year earlier. The remaining four sites showed very little evidence of recent nut-cracking, with severely weathered moss-covered tools and no visible nut-shell debris, suggesting these sites have been inactive for several years.

Traces of other wildlife

During the 2006–2009 surveys, SC recorded the presence of pygmy hippopotamus, dwarf crocodile, dwarf forest buffalo (*Syncerus caffer nanus*) and bay duiker (*Cephalophus dorsalis*) (Carvalho 2011). Unpublished data from the 2006-2009 field reports

Table 2. Evidence of chimpanzee traces documented in the Korohouan area during the 2006-2009 and the 2018 surveys. Values indicate number of unique individuals/traces encountered during each survey period. Brackets represent observations recorded by motion-triggered cameras. Question marks (?) indicate potential traces.

	Classified forest area				Mt. Medou			
Evidence type	**04/06**	**03/09**	**04/09**	**11/18**	**04/06**	**03/09**	**04/09**	**11/18**
chimpanzee sightings			6				(2)	
nut-cracking traces	3	1		2	1			
nests	6	8	7	1	25	3	6	
feeding traces	2		3					
tracks	1		2			1		4?
faeces			2			1		
TOTAL	**12**	**9**	**16**	**3**	**26**	**5**	**7**	**4?**

Figure 4. Direct and indirect evidence of chimpanzee presence in the Diécké Forest, recorded in 2009. a) juvenile male chimpanzee; b) Adult male chimpanzee; c) chimpanzee nest; d) chimpanzee feeding traces; e) stone anvil and hammer used by chimpanzees to crack nuts; f) excavation of a nut-cracking site, SB3. Photographs by Susana Carvalho.

also noted direct sightings of northern bushbuck (*Tragelaphus scriptus*; Figure 5a), feeding traces of a monkey (species unknown; Figure 5b), and tracks from a leopard (*Panthera pardus*), which is now facing rapid decline throughout West Africa, with only a few small remnant populations reported for Guinea (Stein *et al.* 2020). The photographic record also captured amphibians and reptiles (Figure 5c and 5d; see Supplementary Online Material for a full list of fauna and flora encountered). The 2011 WCF data

Table 3. Summary of mammalian traces documented in 2011 by the WCF (144.8 km), compared with traces encountered during the 2018 survey in the Korohouan classified forest area (21.7 km). Note that the 2018 chimpanzee data refers only to nests encountered to enable comparison with the 2011 chimpanzee data, for which only nests were recorded.

	2011 – Diécké Forest		2018 – Korohouan	
Taxa	**n**	**n/km**	**n**	**n/km**
Carnivores	3	0.02	0	0.00
Chimpanzees	44	0.30	1	0.05
Other primates	41	0.29	1	0.05
Bovids	420	2.90	2	0.09
Suids	23	0.16	4	0.18
Small mammals	21	0.14	14	0.65

categorized traces into carnivores, primates, bovids, suids, and small mammals (e.g., rodents).

In 2018, we found 23 traces of other mammalian wildlife (Table 3). This included footprints of mongoose (*Herpestes sanguineus*), duiker (*Cephalophus* sp.), pangolin (*Phataginus tricuspis*), suids (*Hylochoerus meinertzhageni; Potamochorus porcus*), and dwarf forest buffalo, as well as feeding traces of a warthog and a monkey of unknown species (see Supplementary Online Material for a full list of fauna and flora encountered). Encounter rates (n/km) of wildlife were considerably lower than the 2011 records for all taxonomic groups except for suids and small mammals (Table 3).

Human activities

In 2006, SC noted that the hunting frequency in the forest was extremely high and there was evidence that Camp Lethou was once used by illegal hunters in between research visits. Around the forest periphery, commercial activities were already established, with SOGHIPAH operating in the Korohouan area at the time of the surveys (Carvalho 2011). SC was also informed by local villagers of diamond mining in the vicinity.

During the forest-wide surveys of 2011, hunting was also identified as the main threat to wildlife, averaging an encounter rate of 1.45/km (Table 5; Wild Chimpanzee Foundation 2012). Other notable traces included trails (1.26/km) and agricultural activities (0.3/km). The data from our 2018 surveys also indicated a high incidence of traces associated with hunting activity (e.g., snares, shotgun shells, abandoned hunting camps) in the Korohouan classified area (Figure 6). When adjusted to the distance surveyed, this value was over four times higher than values recorded in the forest-wide survey of 2011. During the time spent at Camp Lethou, we also heard six gunshots over two consecutive nights. These are not included in Table 5 as the location of the shots was indeterminable.

Trails and instances of agricultural activities were not as prevalent within the classified forest

Table 4. Data recorded for nut-cracking sites surveyed in 2006-2009 and 2018.

			2006-2009		2018			
ID	**Year found**	**Species**	**Activity[a]**	**Tools (n)**	**Tree status[b]**	**Stones available (n)**	**Activity[a]**	**Tools (n)**
TS42/SB4	2006	Coula	~ 1 mo	6	A, BF	135	I	4
TS43/SB5	2006	Coula	~ 1 mo	11	A, BF	66	I	7
TS44	2018	Panda			A, BF	84	I	2
TS45/SB3	2006	Panda	I	40	A, BF	74	~ 1 yr	37
TS46	2018	Coula			A, BF	86	~ 1 yr	7
TS47/SB6	2006	Panda	U	10	A			3

[a] mo = month; yr = year; I = inactive; U = unknown

[b] A = alive; BF = bearing fruit

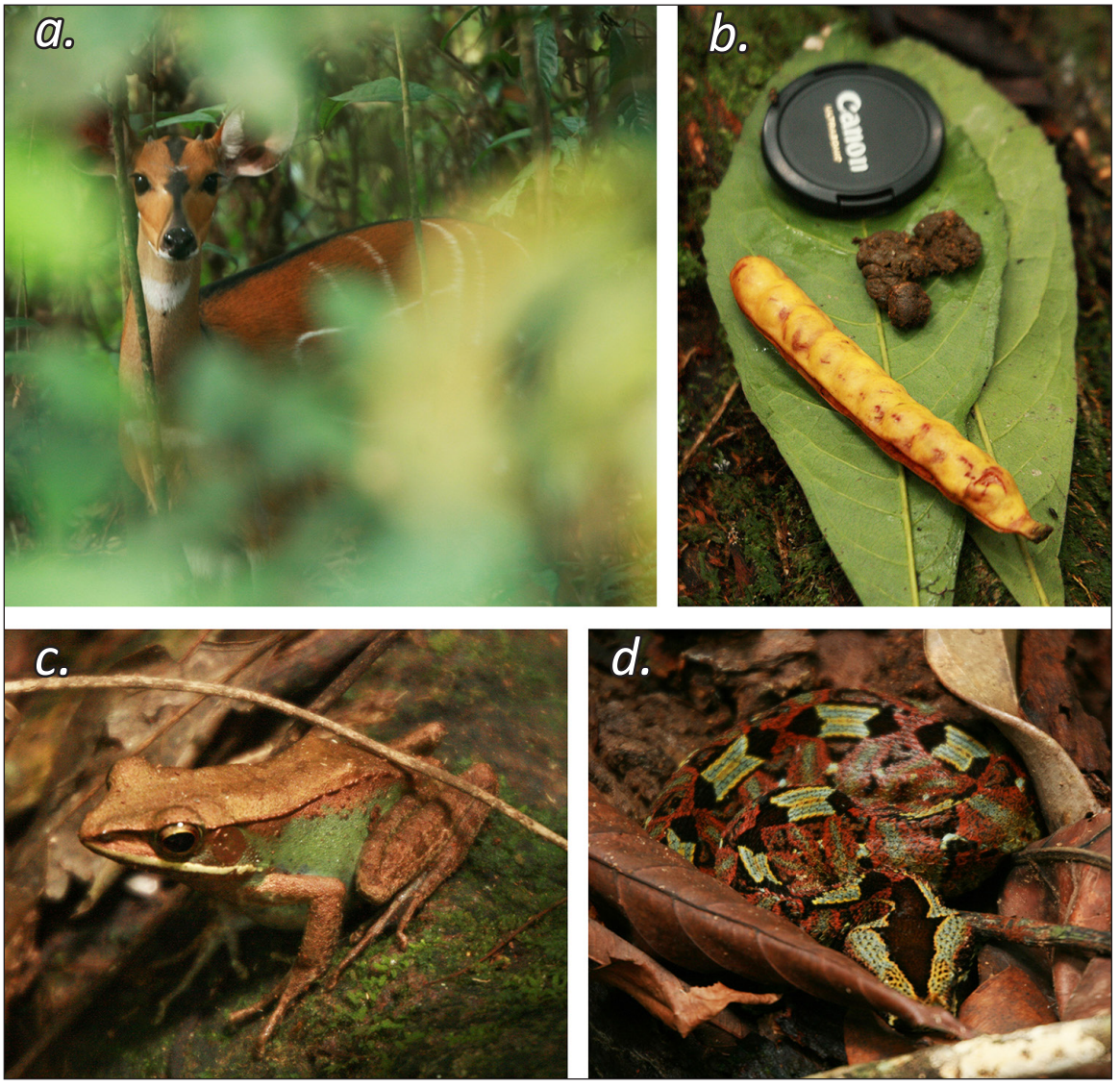

Figure 5. Direct and indirect evidence of other wildlife observed during the 2009 surveys. a) bay duiker; b) faecal remains and feeding traces of a monkey; c) white-lipped frog; d) rhinoceros viper. Photographs by Susana Carvalho.

area in 2018. However, agricultural activities were ubiquitous throughout the forest periphery. We encountered SOGHIPAH rubber and oil palm plantations all along the route to the Diécké Forest, and a large rice field adjoined the entrance to the classified forest area. We also found evidence of logging, including a red timber species – likely *Lophira alata*, which is currently classified as vulnerable in the IUCN red list (Haba & Couch 2018).

The 2018 survey of Mt. Medou revealed that the surviving patch of forest has been further reduced by agricultural expansion. Forest areas surveyed in 2006–2009 were deforested in 2018, and the tree upon which one of the camera traps was attached had been cut down. Hunting traces found in the area included two shotgun shells and a snare.

DISCUSSION

The Diécké Forest is considered an area of high conservation significance for flora and fauna alike, including the critically endangered western chimpanzee (Akobi & Poissonnier 2021; Fauna & Flora International 2021). Nevertheless, the last published chimpanzee survey took place in 2011, over a decade ago. Our report provides a much-needed update which we hope will be a useful

Table 5. Summary of traces of anthropogenic origin collected in 2011 by the WCF (144.8 km), compared with traces collected during the 2018 survey in the Korohouan classified forest area (21.7 km). Blank cells indicate data that were unavailable/not collected.

		2011 – Diécké Forest		2018 – Korohouan	
		n	**n/km**	**n**	**n/km**
Hunting	Total	210	1.45	137	6.31
	- Shotgun shells			118	5.44
	- Snares/traps			18	0.83
	- Camps			3	0.14
Fishing				2	0.09
Trails		182	1.26	4	0.18
Agriculture		43	0.3	1	0.05
Logging		7	0.05		
Other traces			0.02	5	0.23

starting point for future research and conservation efforts in this key area for biodiversity and western chimpanzees.

A total of seven chimpanzee traces were recorded during the five-day survey period. However, only three of these traces can be attributed to chimpanzees with certainty (Table 1). These values are considerably lower relative to both the 2006–2009 and 2011 records. Additionally, we found a total of six nut-cracking sites in the classified forest area, only two of which showed traces of relatively recent nut-cracking activity. The fact that all six sites had ample raw materials available, and all but one site had *Panda* and/or *Coula* trees that were productive and bearing fruit, eliminates a localized ecological explanation. The two sites were within 250 metres of each other, and all traces were around 1 year old. This pattern is not much different from the 2006 records that documented two, albeit different, active sites with month-old traces that were around 50 m apart. While new activity was observed at a site that was thought to be permanently abandoned in previous surveys, it was also evident that traces on tools at other previously recorded nut-cracking sites were becoming inconspicuous.

Given that the 2006–2009 Korohouan surveys were conducted in March-April and the present survey (2018) took place in November, it is possible that chimpanzee presence, and therefore nut-cracking activity, in this region of the Diécké Forest is seasonal. The 2011 WCF survey took place in March, but the targeted chimpanzee population survey using nest counts only covered the northeast portion of the Diécké Forest (Wild Chimpanzee Foundation 2012). While this provides some scope for optimism, the chimpanzee data when combined with results from other wildlife and human activities pose a much starker outlook.

Comparisons with data collected by the WCF in 2011 across the Diécké Forest suggest that other primate species and bovids have dropped by similar levels when adjusted for distance surveyed. Additionally, the forest around Camp Lethou is suffering from an inordinately high incidence of hunting when compared to the forest-wide data of 2011. Whether this reflects a trend across the entire Diécké Forest remains to be determined. Nevertheless, our findings emphasize the urgency for a dedicated study to collect additional data on chimpanzee presence and material culture in all areas of the forest in tandem with the distribution of human activities. With the population in the nearby forest of Bossou now down to three individuals (Didier Camara, Dore and Zogbila, pers. obs.), if the Diécké communities follow suit, the cultural heritage of Guinean nut-cracking chimpanzees (currently known to science) may become lost to us forever.

In reports of the 2006–2009 surveys, it was suggested that chimpanzees in the Korohouan area were favouring forest fragments outside the protected area, such as those around Mt. Medou to avoid threats from hunting activities. Studies involving other chimpanzee populations have also documented increased use of buffer zones relative to neighbouring protected areas (Tweh *et al.* 2018), while orangutan research has highlighted the importance of forest fragments to the survival

Figure 6. Material traces of human presence collected during surveys in the classified area. Items include one shoe, a plastic bottle, dozens of wires used for snares, and >100 shotgun shells. Photograph by Katarina Almeida-Warren.

of meta-populations (Ancrenaz *et al.* 2021). Such studies are bringing to light the value of human-modified landscapes to primate conservation (Galán-Acedo *et al.* 2019).

Our observations indicate that agricultural expansion and deforestation remains prevalent in the forest periphery. Added to the elevated levels of hunting pressure in the protected area, this is an indication that viable areas for chimpanzee habitation in the Korohouan vicinity are under increasing threat. Further research seeking to understand the direct impacts on chimpanzee communities both in the Diécké Forest and the forest periphery should provide valuable insights as to the thresholds of habitability by chimpanzees (and other wildlife). Diécké is one of many landscapes at the protected-anthropogenic interface and further research on the ground is crucial to inform conservation practices that support human-wildlife coexistence (Leblan & Soiret 2021).

The WCF report indicates that different parts of the Diécké Forest are affected by distinct types of anthropogenic disturbance to varying extents. This is likely due to the degree of accessibility of different regions of the forest, as well as variation in topographic and hydrological characteristics throughout the forest (Robertson 2001; Wild Chimpanzee Foundation 2012). However, this has yet to be formally investigated. Given that the evidence from Korohouan points to an overall lower biodiversity and an intensification of human activity relative to the 2011 assessment, it would be important to conduct follow-up forest-wide surveys to monitor changes in human activities and biodiversity in other parts of the forest and determine whether this reflects a localized or global trend. Critically, such surveys should also extend to buffer zones, as these may constitute important strongholds to the surviving chimpanzee populations (Galán-Acedo *et al.* 2019; Leblan & Soiret 2021), especially considering that over 80% of western chimpanzees are estimated to live outside protected areas (Heinicke *et al.* 2019b). It would also be paramount to investigate how humans, chimpanzees, and other animals use different habitat types to help better understand where conservation efforts are most needed and will be most effective.

During our visit to the Diécké Forest we witnessed that the Korohouan area continues to attract a high degree of commercial activity, particularly from

the palm oil and rubber industry. Recent news reports also allude to the commencement of logging operations in the Diécké Forest, as well as iron ore mining to the south. With convenient access to Liberia and transport routes to the coast and international trade, industrial operations in Diécké, as well as in other areas Guinée Forestiére rich in highly sought-after natural resources, are likely to proliferate for decades to come. This phenomenon is already becoming the norm for many chimpanzee communities, with over 60% of surveyed African ape populations currently affected by hunting, logging, and agricultural expansion, and 34% overlapping with active and prospective mining areas (Junker *et al.* 2024). The growing global demand for palm oil products is also predicted to cause irreversible damage to African ape populations, who overlap with almost all high oil palm suitability areas in Africa (Strona *et al*. 2018).

Future investigations into community perceptions of industrial activities and how they are currently affecting local livelihoods at the interface of biodiversity and resource richness, such as Korohouan, will generate much-needed empirical evidence of their impact beyond the environmental sphere. This will be paramount for driving prospective economic investments towards concerted cross-sector action spanning industry, conservation and human development that meets the needs of the local populations, ensures financial and food security, and empowers community-led, sustainable conservation efforts that build on Indigenous knowledge and foster human-chimpanzee coexistence (Mitani *et al.* 2024).

CONCLUSIONS

The Diécké Forest is one of the largest remaining near-pristine lowland evergreen forests of West Africa, in existence since ~2.5 million-years-ago. It is a Key Biodiversity Area for West Africa and is home to many endemic and threatened species. The chimpanzee population is one of only two communities known to have a nut-cracking tradition within the Republic of Guinea, yet both have distinct cultural heritages in terms of the material characteristics of the tools they use and the nut species they target. Due to the high density of natural resources present in the region, the Diécké Forest is presently at the epicentre of rapidly expanding smallholder and commercial human activities. Additionally, our survey indicates that hunting activities remain extremely high within the Classified Forest. These human activities are having a detrimental impact on biodiversity within the protected area as well as the forest periphery, where chimpanzee presence has also been documented in the past. With the predicted expansion and escalation of extractive industries and agricultural activities in the coming decades, the ancient Diécké Forest and all the communities that benefit from it, human and nonhuman alike, are at risk. We hope our research provides a helpful starting point for urgent and concerted conservation action.

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Field Report:

Establishing a Colony of Endemic, Critically Endangered Red-bellied Guenons (*Cercopithecus erythrogaster erythrogaster*) in a Newly Reconstituted Forest in Benin: A Personal Perspective

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Abstract: The red-bellied guenon (*Cercopithecus erythrogaster erythrogaster*) is an endemic, critically endangered monkey in West Africa. Here, I share my 30-year experience with this species. A group of 14 red-bellied guenons, which had been individually captured between 1994 and 2008 in the Ouémé floodplain in southern Benin, was cared for and observed. This group developed within 30 years into a viable population of about 40 monkeys living in two groups in a reconstituted rainforest, the *Sanctuaire des Singes*, in southern Benin. A total of 66 infants were born into the group. The intense group life of free-ranging, habituated monkeys is described in detail as well as their interactions with other forest species, local people, and tourists. Of particular interest is the observation of the replacement of a dominant male after 13 years, with ensuing infanticide of three neonates. The red-bellied guenon has become the flagship species for Benin nature protection, giving rise to modest ecotourism. The sustainability of this site depends on the acceptance by the local population and its use as a research and demonstration site by the International Institute of Tropical Agriculture (IITA), NGOs and the local university.

Key words: Conservation, red-bellied guenon, Dahomey Gap, Benin, introduction and establishment

Résumé: *Le singe à ventre rouge (*Cercopithecus erythrogaster erythrogaster*) est une espèce endémique, en état critique d'extinction en Afrique de l'Ouest. Ici, je partage mes expériences de 30 ans de contacte intime avec ces singes. Un groupe de 14 singes capturés entre 1994 et 2008 dans la pleine inondée de l'Ouémé au Sud-Bénin a été élevé et observé. Au bout de 30 ans, une population viable d'environ 40 singes, séparés en deux groupes, s'est développée, vivant dans une forêt pluviale ré-constituée, nommée 'Sanctuaire de singes'. Un total de 66 enfants est né. La vie familiale intense de singes sauvages, mais habitués, est décrite en détail, ainsi que les interactions avec d'autres espèces forestières, les villageois et touristes. L'observation du remplacement du mâle dominant après 13 ans par un jeune mâle, suivi d'infanticides de trois nouveau-nés est d'intérêt spécial. Ainsi le singe à ventre rouge est devenu l'espèce phare pour la protection de la nature au Bénin, source d'un écotourisme modeste. La durabilité de ce site dépend de l 'acceptance par la population locale et son usage comme site de recherche et de démonstration par l'IITA, les ONGs et l'université.*

Mots clés: Conservation, singe à ventre rouge, Sillon Dahoméen, Bénin, introduction et établissement

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INTRODUCTION

The red-bellied guenon, *Cercopithecus erythrogaster erythrogaster* (Gray 1866) (Cercopithecidae, Primates), is an endemic monkey of the Dahomey Gap with a small area of distribution in southern Benin and adjacent forests in Togo and Nigeria. The species has been studied only through surveys (Oates 1996; Hanon 2001; Assogbadjo & Sinsin 2002; Sinsin *et al*. 2002; Campbell 2005; Nobimè *et al.* 2008, 2009, 2011; Nobimè 2012; Agbessi *et al.* 2017; Ségniagbeto *et al.* 2018), particularly in forests in the Mono River valley in Togo and Benin (Houngbédji *et al.* 2012) as well as in forests in Nigeria on the border with Benin (Matsuda Goodwin *et al.* 2017). It inhabits small rain forest patches (mostly sacred forests of <5 ha), swamp forests, and seasonally inundated dense thickets (Assogbadjo & Sinsin 2002; Reitz 2016; Ganmou 2020), and has its largest population in Benin's Lama Forest (Nobimè & Sinsin 2003). The Nigerian subspecies, *C. erythrogaster pococki,* the white-throated monkey (with a grey belly) has a larger distribution in the forests of southern Nigeria, possibly with no range overlap with the red-bellied subspecies (Oates 1985, 2011). While at the species level *C. erythrogaster* is listed as Endangered (EN) by the International Union for the Conservation of Nature (IUCN) (Matsuda Goodwin *et al.* 2020a), the subspecies *C. e. erythrogaster* is classified as Critically Endangered (CR) due to the small size of its range, the continuous deforestation and habitat degradation even among sacred forests, and the killing for crop protection and bushmeat (Nobimè *et al.* 2011; Houngbédji *et al.* 2012; Zoffoun *et al.* 2019; Matsuda Goodwin *et al.* 2020b).

At the beginning of the experience described here, the range and conservation status for red-bellied guenons was much less clear. Haltenorth & Diller (1980) stated that 'W. Africa, probably S.W. Nigeria' could be the origin of individuals involved in trade. Kingdon (1997) described specimens in S.W. Nigeria and ranging toward the west had russet colored bellies.

My story with red-bellied guenons started in 1994 when my daughter acquired a young female from the Dantokpa Market in Cotonou. Together with my family, we had already maintained and raised mona (*Cercopithecus mona*) and tantalus (*Chlorocebus tantalus*) monkeys. In 1995, the primatologist John Oates, who had observed these monkeys in the Lama Forest the year before, and his student Reiko Matsuda Goodwin (see references) visited us. While the other monkeys either died or were released when we moved from the large town of Abomey-Calavi to the tiny village of Drabo Gbo, the red-bellied guenon came with us. In Drabo, I eventually bought 14 ha of land and converted these fallow fields to forests (Neuenschwander *et al.* 2015; Neuenschwander & Adomou 2017). All the while, I was employed by IITA as a specialist in biological control. In 2014, IITA received all title deeds and is now the owner of the property, now known as *Sanctuaire des Singes*.

I present here an informal account of the establishment of the *Sanctuaire des Singes* and a general description of the behavior and life events of its red-bellied guenon residents.

THE *SANCTUAIRE DES SINGES*

Location

The *Sanctuaire des Singes* in Drabo Gbo (6°30'N, 2°18'E) was founded in 1995 when I bought 2.5 ha of teak forest and agricultural land from the elders of Drabo Gbo, 30 km north of Cotonou, 12 km from the centre of the spreading town of Calavi, the second largest city of Benin. Up to 2005, more land was bought and today the sanctuary covers an area of 14 ha. It has become a well-developed, species-rich secondary forest, including about 10 ha in Drabo Gbo, the Orojamè (sacred forest of the Oro cult) in Drabo Fanto, a triangle of land of 2.5 ha further north, and the <1 ha sacred forest of Dodja (Figure 1; Neuenschwander *et al.* 2015; Neuenschwander & Adomou 2017).

Maintenance of monkeys

Initially, the monkeys were maintained in three partly interconnected, 2.0 m high cages of 55.8 m^3, 33.5 m^3, and 18.4 m^3, covered with chicken wire with a mesh size of 5.5 cm. Depending on need, a total of 107.7 m^3 could thus be partitioned into five cages. The monkeys were fed daily fruits, vegetables, green branches with fresh leaves of various trees and shrubs, and provided a basin with water. Once released into the forest, they could find earthen bowls with water in Cooun and *Grande Forêt*, while the bowls in the Orojamè were not replaced after having been stolen or broken. The monkey group around the house continues to receive fruits and vegetables twice daily; those in the *Grande Forêt* are not fed and live entirely off the forest.

In the first years, the caged monkeys received the deworming medications albendazole or praziquantel (on five occasions up to 1999, calculated for the weight of the animals, according to veterinary practice, and carefully disguised in a split banana;

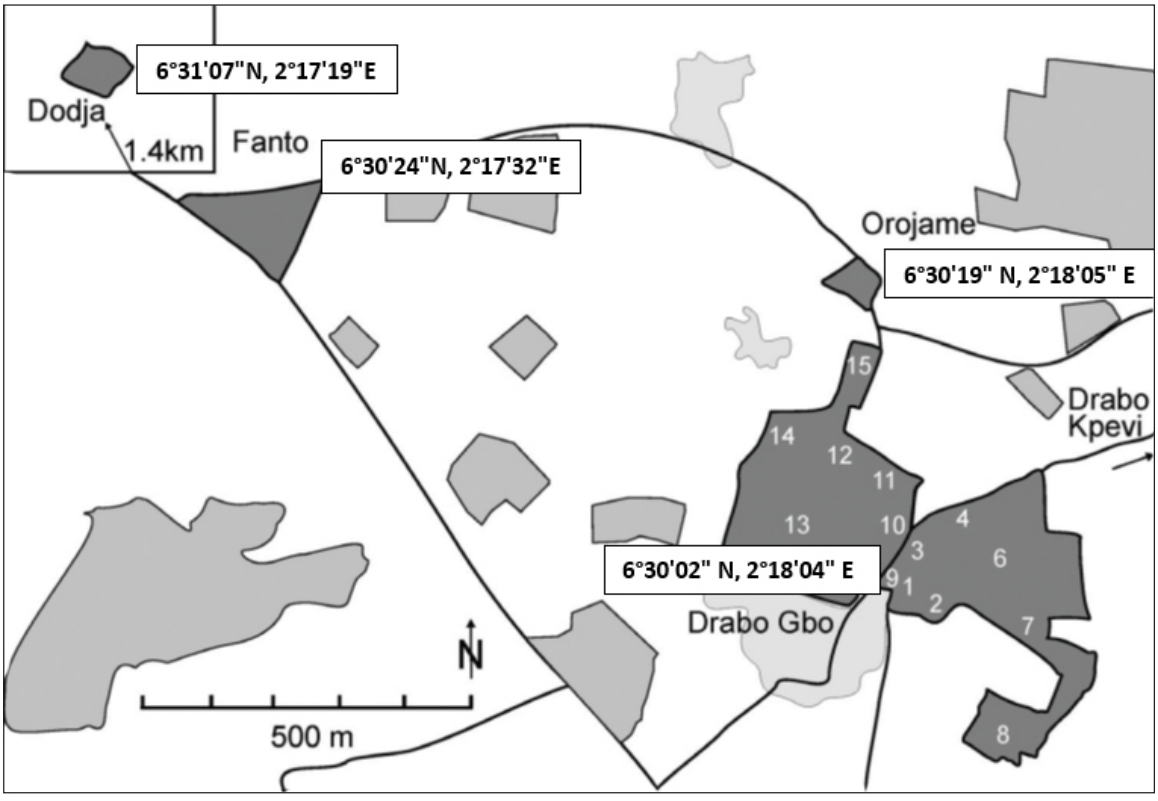

Figure 1. Map of the *Sanctuaire des Singes* at Drabo Gbo, with GPS data for entrance doors, year of purchase and start of forest management and major clearings: 1. nursery-garden 1997 (house constructed 1997-1998); 2. papa-garage 1999, 2000; 3. Lissanou 1999–2003; 4. mill 2000; 6. Cooun 2001, part of Cooun cleared in 2010; 7. corridor-Dansou 2004, 2010; 8. Emile 2001–2007 partly cleared 2012; 9. *Maison de Jeunesse* (MdJ house constructed 2005) 1998, cleared in 2013; 10. Tofinou 1998-2000; 11. Pierre 1999–2001; 12. Kakpo 2004; 13. *Grande Forêt* 1996, local fire in 2012; 14. AgoXwè 2000–2003; 15. Corridor north 1998, 2002–2003; Orojamè 1998; Fanto 1998–2000, partly cleared 2014; Dodja 2011, partly cleared 2016. The map features natural forests in grey with border line, wood lots light grey with border line, compact villages light grey, and unsurfaced roads as lines (see also Neuenschwander & Adomou 2017).

once supplemented with vitamins) and papaya seeds and leaves, traditional medicine with the same pharmaceutical properties. On the few occasions when animals were injured, no disinfection or other medical measures were attempted because the necessary holding of the animals was judged to be too stressful for them.

Ecotourism

The protected forests are clearly visible on Google Maps as *Sanctuaire des Singes* (including GPS data). Visitors are led through the forest by me or guards and shown the monkeys. For a 2-hour visit, foreigners pay a modest entry fee of about $6, Benin citizens $3, half for children, in order to support maintenance. For inhabitants of Drabo, visits are encouraged and free. Information is available on Facebook managed by IITA staff and assistant teachers (www.facebook.com/Sanctuaire-des-singes-de-Drabo-Gbo-de-lIITA-Bénin-10252330911910/).

OBSERVATIONS

History of introductions

The first red-bellied guenon, a young female ('Belly'), was acquired in 1994 from the Cotonou market with unknown origin ('Ouémé floodplain'). At that time, monkeys, pangolins, tortoises, chameleons, etc., were openly sold in the Dantokpa Market and at the road crossing near the Cathedral Notre Dame. Belly was moved to a large cage in the sanctuary in 1998. Several individuals in Adjohoun later captured young guenons near villages of the Ouémé floodplain (Togbota Aguè, Bonou, etc.), mostly by chasing the animals into fishing nets installed across pathways in dense bush or by luring them into cage traps. In those days, throughout the flood plain such captures were routinely made by the local populations to supply animals for the pet market in town.

A total of six females and eight males were

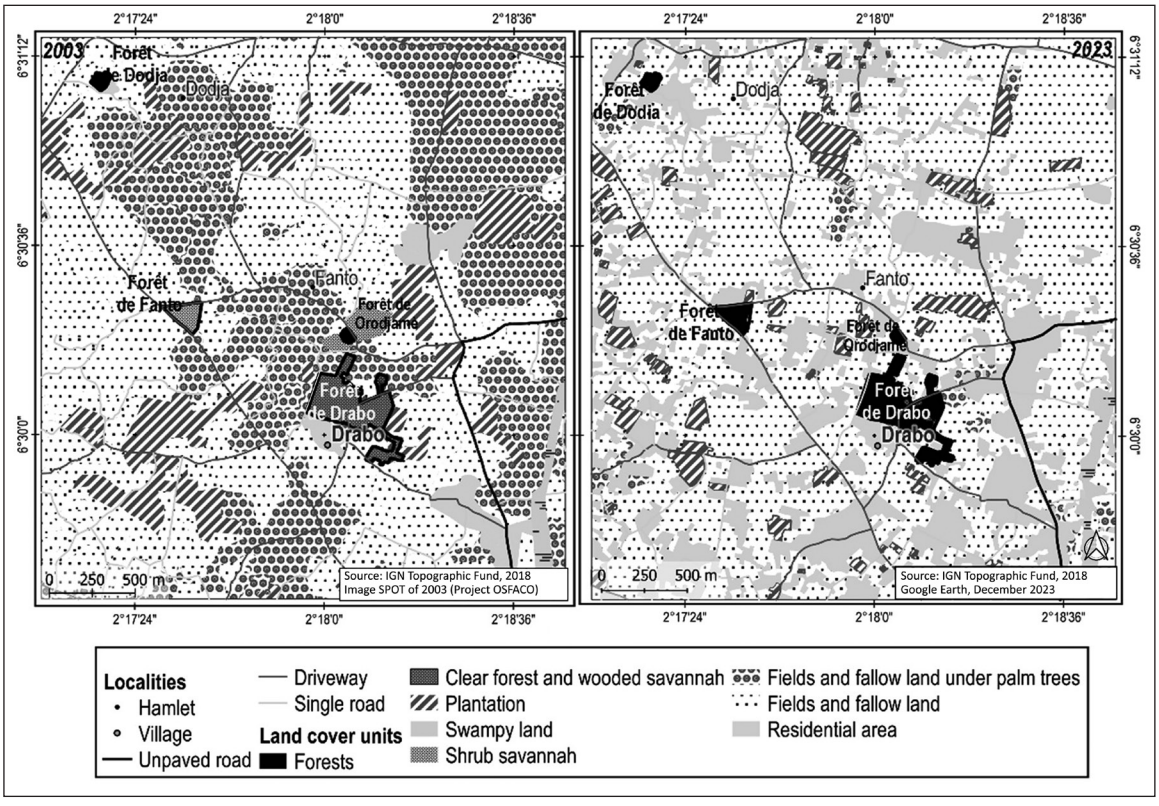

Figure 2. Land cover dynamics from 2003 to 2023 in the research area. Map prepared by Clément Adjire, Université Abomey-Calavi.

introduced, all from the Ouémé floodplain, with one exception, a male from Atiémé in the Mono province (Table, Supplementary Online Material*). Since the Government started to better control the forbidden sale and transport of live monkeys, no further captures and introductions were attempted or allowed.

In time, the paired monkeys reproduced and, a few weeks after birth, the infants began moving independently. They either moved to other cages or left the cages altogether, but returned to their mothers within hours. There, they grew and had infants of their own, but they always came back to the cages. From the age of two years onward, the monkeys could no longer pass through the cage wire but would sit on branches that crossed into the cage nearest their mothers (but not their fathers).

By 2019, most monkeys lived outside the cages. So, all doors were opened and the remaining monkeys were freed. They did not behave as expected. It sometimes took hours for a monkey to leave the cage, even if we lured it outside with bananas – often retrieved and taken back to the cage to eat. Evidently, they feared the unknown environment even though they had experienced it all their lives.

Past and Present Distribution

In 1995-1998, the only monkeys known to the villagers of Drabo Gbo were mona and tantalus monkeys, which occasionally foraged on the villagers' fruit tree crops. However, an elder from Ouéga, a village a few km south of Drabo, recounted how as a young man he had hunted red-bellied guenons in what we now call Cooun. The man explained further, that he had to stop this practice after his wife had given birth to twins, which according to vodun culture prevented him from killing monkeys.

Old villagers from Drabo Kpevi described how, as children, they had been afraid to enter the then dense forest of Drabo Gbo, i.e., the Cooun site that I had bought when it was a meadow. This lends some credit to the observation of forest-inhabiting red-bellied guenons in Drabo Gbo. Land cover maps of the region in 2003 (Figure 2) demonstrate that by that time the forest that would allow the presence of monkeys had shrunk to the sacred forests Orojamè at Fanto, and of Dodja, and perhaps the big *Cola gigantea* tree near the Legba square. Today, the entire sanctuary has dense forest, a good habitat for these monkeys, as a result of about 30 years of reforestation and intensive care to saplings.

At present, the main forests inhabited by red-

**http://primates.squarespace.com/storage/african-primates-journal/volume-181/NeuenschwanderSupplementaryMaterial.pdf*

bellied guenons are the ones known as *Grande Forêt* and Cooun, Papa, Garage, i.e, about 10 ha around the house (Figure 1). There are occasional sightings, by both guards, in the Orojamè, which is separated from the main forest by a 100 m gap. One red-bellied guenon, Louis, was seen briefly in Ouéga, a few km south of Drabo Gbo, before he returned again to the sanctuary after 9 days of absence. From Fanto and Dodja I have no secure observations. Some observations were reported by villagers, but these could also concern the much more wide-spread tantalus monkeys that often visit the sanctuary for a few days before disappearing again.

Behavioural observations

All caged animals were individually identifiable by staff and given names. Observations of their behavior were noted *ad libitum* in a daily journal, by me during my presence of 6-10 months each year or by two permanent staff (see Supplementary Online Material at http://www.primate-sg.org/african_primates/). Once released, the animals were more difficult to identify and most observations were no longer targeted on named individuals.

When the groups became large, counting the animals was difficult. The best results were obtained when a quietly advancing group of guenons moved to reach the dormitory tree around 6:30 to 7:00pm and by chance crossed a road over barbed wires or a narrow passage between trees. Observed against the sky, they could thus be counted.

Additional information was recorded, but not dated, and documented in the spreadsheet available in the Supplementary Online Material. Some of this information resulted from daily contacts with neighbors.

Births and deaths

Between 1999 and May 2024, a total of 66 births were recorded (Table 1; also see Supplementary Online Material). Only once did I succeed in observing a birth. In April 2005, the female, Asibè, was sitting on a horizontal branch 1 m above the ground near the house. Seemingly casual and fast, she bent forward and retrieved the infant, which appeared head first with its face towards the ventrum of the mother. The wet infant immediately clung to the mother as she licked it clean. While some newly born infants had red wounds or swelling on their faces, this one was clean and immediately active. The mother remained sitting, the umbilical cord still hanging from her vagina. One hour later, she withdrew the placenta, approximately the size of an avocado pit, and nibbled on it. It took her more than one hour to finally devour the placenta. As for the umbilical cord, it had meanwhile dried and dropped.

Generally, new mothers will hide for a few days, so most recorded dates of birth indicated in our records are estimates only. After delivery, the mother appears with the infant and can easily be observed by human visitors. All the members of the monkey group crowd around, touching the newborn.

The first birth, by Belly, occurred in 1999, but the infant died within days. Her next infant, Bellibè, was born in 2000. From 2002 onward, births in the group were recorded every year. In 2004, Asibè, who was 5 years old, gave birth in April to an infant who died that same month. Two months later, she snatched Bella's neonate from outside through the chicken wire, nursed it, and disappeared into the forest. In July, she returned with the dead infant. By October, Asibè had a second infant, a third in November 2005, and her fourth in March 2007. All were healthy. Her sister Lisa, had a single infant in 2007. Bella, who lost her infant in 2004, had infants in 2002, 2005, and her fourth in 2007. Adja, the newcomer, an old female, had two infants, one in April and another in September 2008. By 2017, the first infants were recorded in the *Grande Forêt* group. Henceforth, infants could no longer be assigned to named females. In conclusion, females typically delivered infants every two years, but at shorter intervals if an infant died. A maximum of four infants were registered per female.

Infant sex was sometimes difficult to assess. In fact, two purported females from Adjohoun were later determined to be males. Among the 66 recorded infants, only nine could be sexed with certainty: three females and six males.

There was a marked seasonality of births (Table 1); 54 (81.8%) of the 66 infants born in the last 30 years were born in the first half of the year. This is the rainy season. By contrast, across all years, no seasonality of deaths was apparent.

Longevity could be determined only for caged animals. Belly, born around 1990, died in 2011 at the age of 21 years. Bellibè, born in 2000, died in 2014 at the age of 14. Le Vieux, a male, born probably in 1995, died in 2011 at the estimated age of 16 years (see further details on mortality in the Supplementary Online Material).

In the cages, these monkeys occasionally were sick, exhibiting bare patches in their hair and apathic behavior. In the forest, by contrast, they invariably have clean, full, and healthy coats. More frequent than diseases were accidents, which we could monitor only for the caged monkeys. In 2005, we monitored an instance of wound-healing: le Vieux

Table 1. Number of infants born and monkeys died by month from 1994 to mid-2024. Temperature and rainfall data represent monthly mean temperature (C°) and monthly mean total rainfall (mm) from 2015 to 2022.

Month	Births	Deaths	Rainfall	Temperature
January	11	2	22.9	27.6
February	4	1	31.5	28.9
March	16	6	56.7	29.0
April	12	4	119.6	28.3
May	7	1	156.4	27.7
June	4	0	283.1	26.4
Rainy season total	54	14		
July	4	1	68.2	26.1
August	2	0	50.6	25.8
September	1	1	161.6	26.4
October	1	0	176.3	27.0
November	0	3	63.1	27.8
December	4	5	22.9	27.9
Dry season total	12	5		

inside a cage and Louis on the outside were fighting. Grabbing each other's hand and dragging the arms repeatedly across the chicken wire, both received serious wounds. On both males, the white bone showed through on a stretch of 5-10 cm on their arm, while the fingers remained mobile. The males finally withdrew, licking their wounds. They continued this for a week, sitting quietly, exposing their arm to the sun. Gradually, the dark hair of the arms returned and increasingly covered the red, uninfected wound. After two weeks, no damage could be seen and the two males returned to fighting much as before.

Family life, food, foraging

Play-mounting by youngsters could often be observed; but mating by adult males was seen only a few times. Similarly, giving birth was observed only once, as described above. With all infants, it is observed that the new mother is always accompanied by at least one other female, either a younger sister or an older daughter (Figure 3). These females tried to touch the infant; sometimes they were even allowed to carry it under the close supervision of the mother. However, at the smallest disturbance, the mother grabbed the infant, pulled it to her ventrum, and fled. Males had few contacts with their offspring. In the cages, if an infant clinged to the tail of its father, he would freeze until the infant left. If the father moved too much, the mother behaved aggressively toward him.

In the forest, red-bellied guenons frequently nibbled on leaves, particularly soft ones such as *Albizia* spp. and the fresh shoots of *Rhodognaphalon brevicuspe*, from which they licked sap, only to drop the shoot without consuming the leaves. They ate *Senna siamea* flowers and nibbled only briefly on the tough leaves of *Ficus exasperata* and 'sapotier' (*Chrysophyllum albidum*). Since the 'sapotier' trees in the forest did not yet produce fruit, the monkeys raided the free-standing trees in the village. Feeding was occasionally frantic, i.e., the monkeys used both hands to take food, sometimes displacing each other when they fed on fruits of *Flacourtia indica* (also eaten by humans), leaves of *Dialium guineense*, and - most markedly - branches of neem (*Azadirachta indica*). The latter is a well-known medicinal plant for humans; the monkeys stripped of its bark to eat. Of note, they did not feed on the abundant sweet fruits of *Carpolobia lutea* until these were offered to them. Nor did they eat the bittersweet fruits of *Ximenia americana*. They licked the sweet honeydew from the underside of leaves attacked by Homopterans, mostly whiteflies (Aleyrodidae). Hopping insects were chased, grabbed, and eaten – even the reportedly bad-tasting *Zonocerus variegatus* grasshoppers, which are abundant at the end of the

Figure 3. Red-bellied guenons from the *Sanctuaire des Singes*. a. An infant of less than 1 year. b. Mother and offspring. c. Mother with her infant and its two sisters. Photograph by Marc Bernard, Cotonou.

long dry season. Birds that accidentally entered a cage were played with and eventually killed, but not eaten. The same was observed for small geckos and other lizards. Water was obtained from several ponds, but also from clay jars placed far inside the forest. Increasingly, the house group drank the clean water from aquaria, where some males took an occasional swim. More recently, they even drank from the showerhead in my presence.

Young male and female guenons were often observed to play, roll on the ground, chase each other through the foliage, and repeatedly jump down from a high branch only to save themselves in the last moment by clinging to a branch or falling down on top of the cages. When a film crew of the national television services arrived for an event in the Maison de Jeunesse (MdJ), a group of youngsters exhibited especially impressive acrobatics around a low branch near the film crew for an hour without interruption - rather than play in the many hectares of forest nearby. Young males behaved similarly in front of tourist groups.

In the forest, individuals were often up to 100 m apart, maintaining contact through species-typical vocalizations, but generally they were quiet and unobtrusive. This is demonstrated by the fact that we have not seen them in all parts of Cooun's 4 ha forest, which has accessible paths. However, damage on maize, banana, 'sapotier', orange, and guava in fields all around the forest within about 50–100 m of its edge indicated that the monkeys had been foraging throughout and crossing the forest. They also followed tourist groups about half-way into the forest, then wait for their return.

In the 5 ha *Grande Forêt*, the unhabituated larger group with 25 individuals was often not seen, even when we worked for a full morning in the forest. Yet damage in surrounding gardens was noted and had to be compensated for, indicating that the red-bellied guenons traversed the entire forest.

Group size and group partitioning

The red-bellied guenon groups have an alpha male (Figure 4). The duration of the reign of these males could only be guessed at for the group around the house. While monkeys were kept in cages, no hierarchy could be established. Louis was a young male in 1999, but became active outside the cages in 2001. He was the dominant male up to 2008. Then le Vieux took over and was the alpha from 2009 to 2011. Since then, a male, born in the house group but not named, was the alpha for approximately 13 years. His dominance was displayed only when the monkeys were fed and he came first for feeding, chasing other members of the group including the younger males and females. In the forest, however, no aggressive behavior was observed. Bellibè, born in 2000, was alpha male in the forest group in 2011 until his death in 2014.

Tentative explorations by individuals, before returning back to the cages, were documented (see Supplementary Online Material). In 2007, the first three individuals were observed to penetrate the *Grande Forêt*, but returned soon after. Finally, two groups centered around dominant males developed and split. In 2007, the first infant was born in the forest group. At that time, there were 20 red-bellied guenons. The limits of the two territories ran along the road between my house and the MdJ. Fighting between groups was, however, infrequent. In those cases, the dominant male usually remained high up, while young and females, even those with infants, fought with open mouths and loudly vocalizing. However, actual physical contact was rare. On other days, incursions into the others' territory were made with no aggression observed. Head shaking, enhanced by the white throat, a sign of unease, was also exhibited toward too inquisitive visitors. Generally, looking directly into the eyes of these monkeys was responded to by head-shaking and they avoided eye contact with visitors.

In March 2024, the replacement of the alpha male could be observed in some detail in the house group. On 16 March 2024, the fourth infant of the year was born to the group of females that always stayed together. The same day, the alpha male mentioned above, was chased by a young male of unknown origin. The old male fled 500 m to the village, then was chased away and two days later was last seen on a mango tree on Emile inside the sanctuary. Assuming that this male had reached alpha status at age five, he was 18 years old at the time of his disappearance.

The new alpha male bit several females and an infant, but their wounds were not life threatening and remained red and dry. For several days, he chased the females with their infants nearby vocalizing and threatening. At the same time, youngsters played within his view without being disturbed. The females first kept together. On day four after the attack, a wounded infant was found abandoned behind a bank on the terrace of the MdJ. When retrieved, it shrieked so much that its mother returned and recovered it. On day six, this infant was, however, found dead, and on day seven another of the mothers appeared with full breasts but without an infant. One female with an infant hid for a few days, but on day twelve four females shared only one infant. One of the abandoned infants was

Figure 4. a. The dominant male in a rare moment of aggression. Photograph by Thomas Leaud. b. Young male red-bellied guenon. All other photographs by Peter Neuenschwander.

picked up by a genet two weeks later. Whether it was caught while still alive could not be ascertained. Occasionally, the male still chased the females. The mother with the last infant was seen sitting near the dominant male on the roof, leaning towards him, while in fact she had the opportunity to hide in the forest. Three weeks after the arrival of the new alpha male, the group was calmer and a new birth by a female of the *Grande Forêt* group, which was observed on a visit to the cages, did not elicit much reaction.

In the described manner, red-bellied guenons were counted on several occasions in 2023. The group in the *Grand Forêt* had 25 members, the house group 17. With 14 introduced monkeys, 19 documented dead animals (16 up to the end of 2023), and 66 births (only 61 up to 2023), we would expect 59 animals at the time of counting (end 2023), yet only 42 were seen. Over 30 years, a total of 17 out of 59, or 28.8%, were thus unaccounted for.

Interactions with other species

Red-bellied guenons had close contact with a pair of mona monkeys, which were maintained in adjacent cages in the initial years of this project. In 1998, a pair, Zio and Maman, along with young male Vincent, were received from Adjohoun. The next year, another male, Marcellin, was born. In 2000, 2001, 2002, and 2006, infants were born to Maman but by 2002 one of the young, Marcellin, plus the old Zio died. In 2006, Mamanbè died at age 6 years. In 2010, Maman, at the age of 16-17 years, escaped and disappeared without being seen again.

Mona monkeys and red-bellied guenons lived together in the sanctuary without apparent conflict. In one instance, in 2006, a mona monkey infant was carried around by a red-bellied guenon. In 2007, Zinvi, a young mona, was followed by red-bellied guenons when it raided trees and swam in an aquarium. In 2010, Maman, a mona female, was seen returning a red-bellied guenon infant to its mother.

Wild mona monkeys rarely visited the sanctuary, having arrived from the sacred forest of Akassato. In 2002, for instance, Louis, the largest red-bellied guenon male at the time, was chased from the 'sapotier' trees near the wall by roaming mona monkeys.

Tantalus monkeys were observed each year in the sanctuary, mostly a couple with one or two offspring. Large tantalus males frightened red-bellied guenons, who exploded in loud ka-ka calls. (In fact, Zin kaka is their Fon name in Togbota, Ouémé Valley). At times, the tantalus monkeys advanced close to the cages, but usually returned to the forest the same day. In 2023, however, a young tantalus monkey stayed for several days at the MdJ, visible by all, and gently played with red-bellied guenons.

Bushbabies (*Galagoides thomasi*) are common in the sanctuary. When red-bellied guenons congregated for sleeping, bushbabies were just waking and were seen in the same trees, though no direct interaction was observed between the two species, nor with the night-active Benin Potto (*Perodicticus potto juju*).

Gambian mongoose (*Mungos gambianus*) is common in the sanctuary, hunting in groups on the ground. Red-bellied guenons were seen following and observing them, though without any direct contact. This mongoose species is of no danger to the monkeys.

Three other small carnivores that were documented in the sanctuary, large-spotted genet (*Genetta maculata*), slender mongoose (*Herpestes sanguinea*), and African civet (*Civettictis civetta*) are, however, potential predators. In April 2024, a genet was observed with a young, perhaps dead, monkey. This was possibly an abandoned infant after the new dominant male had taken over as described above. No other interactions with predators were seen.

Two python species, *Python regius* and the much rarer *P. sebae*, are known from the sanctuary and are a potential danger to red-bellied guenons. When I showed a live, rolled-up royal python, picked up after rains on the road, to the monkeys, they produced loud, explosive and continuous ka-ka calls. The same calls were heard the next day, when I showed them only my brown patterned purse. Evidently, red-bellied guenons perceived pythons as a danger.

Three species of birds of prey, to which red-bellied guenons answered by hiding or calling, breed in the sanctuary: Black kite (*Milvus migrans*), African goshawk (*Accipiter tachiro*), and black sparrowhawk (*Accipiter melanoleucus*). The latter and female goshawks can capture infant monkeys. *Accipiter* spp. are particularly dangerous, because they sit still in the forest waiting for their prey to approach. Their attacks on pigeons were observed, but no attacks on red-bellied guenons were seen.

When in rut, Walter's duikers (*Philantomba walteri*), which are relatively common in the sanctuary, rush through the bush without paying attention to the monkeys. In 2013, red-bellied guenons observing duikers became afraid and did not return to the cages for a whole day.

Interactions with humans and ecotourism

Outside the sanctuary, mona and tantalus

monkeys are hunted by humans, but within the sanctuary we have never observed any attempt at shooting an animal.

In our daily interactions, we were bitten only in extreme situations, e.g., when we had to remove a dead or injured animal. Outside the cages, no monkeys (except Affli, see below, and a monkey freed from a trap) were ever touched by humans.

In 2012, an unnamed female died probably in a road accident, but her small infant, Affli, was saved and reared by humans. For the first time, children and adults had an opportunity to observe a monkey closely. As a result, Affli was popular and helped improve the acceptance of these monkeys. Unfortunately, it became ever more enterprising, played rough with small children, penetrated houses, and had to be caged again. Even though Affli in the cage had constant contact and played with other monkeys, it returned immediately to the village when released again. Affli was eventually given to the Botanic Garden of the university, where it played with students, but was caged again when it began steeling from women who brought the daily meals.

Increasingly, monkeys of the house group became less shy of humans. The animals, not content with the abundant water sources in ponds and jars, moved to aquaria and even the showerhead to drink clean water. They also increasingly took the whole terrace of the house into their possession. They openly "raided" maize fields and no longer cared when blind rifle shots were directed at them by a caregiver, engaged to protect the fields.

At present, approximately 3-5 groups of human visitors are received in the sanctuary each week. They typically find the sanctuary using Google Maps, and come to see the monkeys and the rainforest vegetation. Almost all visitors succeed in observing red-bellied guenons in the forest, often from close up. On one occasion, however, loud visitors could not spot a single monkey on the usual accompanied forest walk. As soon as these noisy visitors had left, red-bellied guenons congregated in the garage. This illustrates how well this species can hide in the forest when they do not want to be seen.

We have visitors from all over the world. In particular, the École Montaigne from Cotonou sends its pupils regularly to visit the sanctuary. Unfortunately, few young people come from local schools, though entry for them is free (Figure 5). The inhabitants of Drabo and surrounding villages, and the vodun elders I meet regularly, do not see a need to visit and are mostly not interested. Some newcomers, who bought land and installed themselves on the edge of the forest arrived in Drabo Gbo because of relatively low land prices, not for the love of the near forest. They expect urban conditions and complain about leaf fall on their roofs. Béninois, who do visit, however, are highly appreciative of their encounters with monkeys. The resulting income from ecotourism is modest, paying for about four months of official minimum salary (SMIG) for one guard.

Fortunately, the *Sanctuaire des Singes* belongs to IITA and is part of its research agenda. As long as I live in the village, support local organizations, and help in emergencies, the forest and its inhabitants thrive. It is hoped that IITA will eventually take over responsibility. Moreover, the sanctuary is integrated in the research activities of the Botanical Garden of UAC, the most important plant collection in the country, and I collaborate with NGOs, particularly the *Organisation pour le développement durable et la biodiversité* (ODDB) in the Ouémé flood plain. In 2023, six NGOs that are active in nature protection in Benin, honoured me in a celebration. Separately, the university of Abomey-Calavi, the biggest in Benin, declared the *Sanctuaire des Singes* a model for rehabilitating the dwindling sacred forests of the Ouémé flood plain. In addition to protecting the forest, we have offered schooling, including instructive visits to the sanctuary, to the children in Drabo for the last four years.

DISCUSSION

Scientific studies of the red-bellied guenon, first described in 1866, started only in the 1990s. Of course, the local people always knew this monkey and have a name for it. The distribution of the species is clearly linked to the presence of forests in the Dahomey Gap and with this the Pleistocene refugia. The main refuges of tertiary forest in the Quaternary are located in the Taï forest in Côte d'Ivoire and the Korup national park in Cameroon (Colyn *et al.* 1991; Maley 2001), where red-bellied guenons do not exist. Additional riverine refuges, where rainforest species like *C. erythrogaster* could survive, have been postulated and discussed (Booth 1958; Sinsin *et al.* 2002; Nobimè *et al.* 2008; Oates *et al.* 2022; Lambert *et al.* 2023). In fact, in the Ouémé flood plain, these guenons are equally at home in swamp forests and seasonally inundated dense thickets (Assogbadjo & Sinsin 2002; Reitz 2016; Ganmou 2020).

Today, rainforests in Bénin are located in an agricultural landscape embedded in human-induced so-called derived savannah (Mama *et al.* 2014) in a highly populated region with 250 people per km^2 (INSAE 2013). These sacred forests are islands of

Figure 5. Primates observing primates. A class of children visiting from Drabo. Photograph by Eustache Kinnenon, Drabo.

high biodiversity. They cover only 2% of the national territory, but harbor 20% of all plant species and 64% of threatened plants, according to IUCN criteria (Adomou *et al.* 2011). They lay mostly outside established nature reserves, making their protection the highest priority for nature conservation in Bénin (Adomou 2005; Neuenschwander & Sinsin 2011). The red-bellied guenon, which is limited to these forests and its surrounding thickets in swamps, has become the flagship species for Benin nature protection.

In general, reintroductions had mixed success (Guy & Curnoe 2013; Speiran *et al.* 2023). Of primate reintroduction projects, only 43% met benchmarks of success, such as post release survival for at least a year, transitioning to independence from human provisioning, and integration with wild populations, and only 14% were able to reach the more stringent conservation aim of becoming a fully self-sustaining wild population (Beck 2018). It is, however, noted that not all projects collected or published data on post-release outcomes. The IUCN therefore published guidelines for best practices in planning primate reintroductions (Baker 2002). Regenerating forests for primate conservation was particularly advocated (Millington *et al.* 2004).

From our experience, hand-raised monkeys like Affli can become good ambassadors for nature protection within the local community, but cannot overcome this human imprint and integrate into the wild population despite constant contact. Affli was rescued from certain death, but this does not in any way mean support for the pet trade.

What might have contributed to the success of the present 30-year effort? First, infants grew up in a group, tended by their mother and other females. The cages were spacious and situated in a forest. The infants escaped, but could return to their mothers, and thus could adjust to the forest environment, where food and medicinal plants were abundant. Gradually, they expanded their home range. The few animals that left the forest in search of new habitats could find their way back in an environment with gardens and fields. By comparison to other *Cercopithecus* spp. (Oates, 2011), group size in this study remained small.

Detailed knowledge about the life of West African guenons was gained mostly from few species (Jaffe & Isbell 2011; Oates 2011; Cords 2012; Lambert *et al.* 2023). The present observations on *C. erythrogaster*, which had not been studied in much detail before, mostly confirm previous observations on other *Cercopithecus* species. Unlike other guenons, however, the red-bellied guenons were never seen consuming vertebrate prey, even if they had such animals in their hands and played with them. Nobimè & Sinsin (2003) stress the importance of fruits of *Ceiba pentandra*, *Mimusops andongensis* and *Diospyros mespiliformis* trees, which do not yet fruit abundantly in the sanctuary. The same authors

found most infants are born in June-July, just outside the peak observed here. Janson & Chapman (2004) stress, how the availability of leaves, flowers, fruits, and seeds in tropical forests varies in time and affects behavior, demography, and dispersal of monkeys. Particularly, the availability of water changes the behavior (Pruetz *et al*. 2023), as seen so well in the dry season, when the red-bellied guenons came to the house for drinking. The possible searching for medicinal plants, as seen here when they debarked neem branches, is not discussed in the literature.

The observed grooming by other adult females (allomothering) was described for several other *Cercopithecus* spp. (Rudran 1978; Struhsaker & Leland 1979). That males reach maturity at six-plus years and females at five to six years, as well as interbirth intervals (Cords 2012) were confirmed here for *C. erythrogaster*. The description by Lambert *et al.* (2023) of the life style of guenons fits *C. erythrogaster.*

For mona monkeys in the Lama, population densities, as estimated from forest walks, reached up to 50 individuals per km^2 (Goodwin 2007). With the same census technique, a few individuals of *C. erythrogaster* per km^2 were recorded in other investigated forests in Bénin, Togo or Nigeria (Assogbadjo & Sinsin 2002; Houngbédji *et al.* 2012; Matsuda Goodwin *et al*. 2017). Yet, the 42 red-bellied guenons counted on about 10 ha in the sanctuary correspond to a ten times higher density, though based on total counts. While the closeness to human habitation and some provisioining certainly allows for higher population densities, some of the difference might also be caused by an undercounting of these shy animals in other localities, as confirmed by the observation with rambunctious visitors or our experiences in the *Grande Forêt*.

The home range of red-bellied guenons in the sanctuary of only about 10 ha is clearly much smaller than that of *Chlorocebus* spp., estimated at 64 ha on average (Pruetz *et al.* 2023). But populations of other species also survive in forests of less than 1 km^2 (Oates 2011), provided the surrounding human population accepts them. The question therefore arises about the carrying capacity of the forests of the sanctuary, considering that only the house group receives additional food. It would seem important that some members of the species from the dense population in the sanctuary succeed in reaching other forests in the area. Of particular interest here is the *Forêt Statale* near Dodja (close to the NW-corner of Figure 2), an extensive commercial plantation with teak (*Tectona grandis*) and *Gmelina arborea* stands of various ages interspersed with natural vegetation. Up to now, observations there and in the sacred forest of Dodja have not identified the presence of *C. erythrogaster*; but given the fact that the first camera traps placed in the *Sanctuaire des Singes* also did not record red-bellied guenons (M. Houngbédji, pers. comm.), the camera trap studies may need to be pursued more vigorously. Among the quarter of guenons unaccounted for, many probably died unobserved; but some might have reached new habitats and dispersed to other forests beyond the Orojamè.

Regarding ecotourism, its dangers and benefits are clearly outlined in Hansen *et al*. (2023) and Alexander *et al.* (2023). The local human population in Drabo Gbo has mostly accepted the presence of monkeys, provided crop damages are compensated for, which is a relatively small burden. It is therefore hoped that the security and protection of the forest will continue in the future through IITA protection under the heading of biodiversity conservation for the benefit of agriculture (McNeely & Scherr 2001; Neuenschwander *et al.* 2023). The *Sanctuaire des Singes* may be considered alongside the over 150 field stations worldwide that serve as Earth observatories with richer biodiversity than in their surroundings (Eppley *et al.* 2024).

For this establishment to be sustainable, the following challenges have to be overcome:

1. Many more exchanges, discussions, and guided visits to the forest, with the inhabitants of Drabo Gbo, who have up to now refused to visit the sanctuary, and education of their children in ecology are needed.
2. As the red-bellied guenons have become ever more fearless, it must be avoided that they become as aggravating to the villagers as Affli became. As a first step, feeding has been reduced. Some feeding remains, however, crucial to assure that visitors encounter monkeys. Long term, the population needs to disperse to other forests.
3. Sustainable protection of this sanctuary – as of any nature reserve – remains a challenge in view of the enormous human population pressure. The land itself belongs now to IITA and is assured by legal title deeds. IITA, the local university, and NGOs collaborate and use this forest as a research site. Despite all legal and customary protection, the survival of this biodiversity hot spot still depends on support by the local population, acceptance by the government, donors, and local champions to defend and popularize the site.

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Brief Communication:

The Great Ape Conservation Film Project: Using Film to Create Lasting Conservation Impacts for Great Apes and Communities

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Can originally-created films[1] play a key role in engaging local audiences—students, teachers, and adults—to build awareness, understanding, and empathy to create a more positive co-existence with great apes and their habitats? With the current state of threats to primate survival, specifically the great apes living within the Western African country of Cameroon, primate conservation is of the utmost importance. Innovative, collaborative, and community engaging primate conservation efforts are needed. What must that look like? We, GLOBIO, believe film can play a defining role in this effort. We set out to determine the role films could play and establish factors determining their successful creation, development, and distribution.

The perceived power of wildlife films to change attitudes and behaviors is largely based on anecdotal evidence (Wright 2010; Blewitt 2011a). There is ongoing discussion regarding the value of such films to create pro-conservation impacts and behaviors. The Great Ape Conservation Film Project (GACFP) was created to move this discussion from anecdotal to data-based evidence. The GACFP is a multi-year, multi-phase, film-driven conservation education project with two intended goals: to create actual on-the-ground attitude change in those living within the targeted primate(s) range and to establish a data-driven confirmation of film's value in conservation. It is a partnership between GLOBIO, a US-based media conservation nonprofit, and Ape Action Africa (AAA), a local NGO near Yaoundé, Cameroon, to address the ever-increasing threats to great apes and their habitats in that country. Long-term, the project intends to determine if films can be used as a key conservation tool to inspire cultural change toward valuing wild great apes and their habitats by those communities directly impacted.

How can film play a central role in primate conservation? Over the past decade, this question has increasingly been asked by both academics and practitioners on the ground searching for primate conservation answers. Limited data show that films should be incorporated as a part of an overall conservation education program. If produced in concert with trained local conservation educators, these films may have a significant impact. However, it has been assumed that the program must incorporate other educational materials and group discussion so that the desired conservation message can be clearly defined and reinforced.

Additionally, current and historic local cultural norms should be considered for appropriate audience reaction to – and engagement with – the films. This is where questionnaires provide valuable information as they communicate perceptions, beliefs, knowledge, and attitudes of the individuals who will be not only watching the films, but will be part of the creation of the films as well. The AAA Education team was critical in communicating cultural issues and raising awareness, too. Equally important, considerable referencing and evaluation was conducted to ensure the hiring of a Cameroonian translator/interpreter to accompany and support the team throughout the project.

To answer the question about film's role in primate conservation, the GACFP has been designed in three-phases to be implemented over five years. Understanding and embracing flexibility

[1] For this article, "film" also means video. As most earlier research and cited sources use the term film, we have maintained its use for clarity.

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Figure 1. A simple yet often overlooked step in questionnaire completion is the training of facilitators to ensure that teachers know how to complete questionnaires. The project's locally trained questionnaire facilitator, Mbezele Albertine Francesca (L) was instrumental in carrying out the instruction portion of the process. Photograph by Gerry Ellis/GLOBIO.org.

of approach and timeline were critical to our thinking from the start. As a direct result of the data collected and observations on the ground, the second phase has been modified to include the four-part lesson plans (described below). Thus, our initial timeline is extended one additional year for further implementation and evaluation.

During phase one in 2023, GLOBIO and AAA's Education Team researched and identified a target audience of teachers and students within the direct geographic influence of Ape Action Africa and developed an assessment to identify their knowledge and perceptions of, as well as attitudes towards, great apes. The development of an assessment in the form of a questionnaire was a complicated endeavor that involved educational, social, and cultural awareness and knowledge; several individuals with expertise in evaluation and questionnaires assisted in this process. For example, with crucial input from AAA, the word questionnaire was used instead of the word survey. This intentional switch in word choice is a direct result of the strong British influence within the Cameroonian education system where there is heightened emphasis on right and wrong. Because the word "survey" is often associated with the word "test," this association, in the students' minds, might cause undue pressure and skew any data collected. In conjunction with the creation of questionnaires, a four-day questionnaire facilitator training was developed after the hiring of local community members, promoting capacity building and local community engagement (Figure 1).

In February of 2024, the GLOBIO team traveled to AAA's primate sanctuary in Cameroon. For two weeks, the GLOBIO team worked and collaborated with the AAA Education team and conducted a four-day questionnaire facilitator training workshop for five local community members, two women and three men. The workshop, with the use of a local French interpreter, consisted of familiarization of the questions as well as how to conduct teacher questionnaires in local schools which included questionnaire delivery and role-playing scenarios. Furthermore, the questionnaire facilitators were trained in the use of tablets to conduct the questionnaires. On two of the four days, the GLOBIO team and the questionnaire facilitators traveled to different schools around Mefou Park conducting teacher questionnaires (Figure 2). The GLOBIO team gathered supplemental information and data that provided insight into educational and cultural beliefs and values.

In Cameroon, the GLOBIO team observed multiple occurrences of primate lessons in local schools presented by an AAA Education Officer. Three previously unknown elements immediately

were apparent. First, a four-part lesson plan had been developed by AAA based on the illustrated booklet, *Mama P*, produced and distributed by PASA (Pan African Sanctuary Alliance) to member sanctuaries. The booklet advances the story of an orphaned young chimpanzee, who was rescued from poachers, to adoption and care at a great ape sanctuary. The four-part lesson plan steps through four key areas of awareness and understanding: physical similarities between great apes and humans, threats to great apes and how they can be protected, shared emotions between great apes and humans, and conservation jobs and opportunities to help great apes. Second, the conservation information delivered in the four-part lesson plan was limited to the students; repeatedly, our team watched classes turned over to the AAA Education Officer followed by teachers exiting the classroom, in many cases physically leaving school grounds. Consequently, none of the primate conservation content being delivered was experienced and, therefore, embraced by teachers nor was information extended into other curriculum teachings. Equally important, through informal questioning, we discovered that the content from the conservation lessons were not migrating into the students' home environment. This discovery was pivotal as it provided us with an opportunity to not only expand the reach of the primate lessons, but to add yet another layer to the project as well. Third, the established lesson plan and *Mama P* booklet presented the perfect opportunity to assess and evaluate the potential impact of film. By pairing short 5-7 minute films to each of the four-parts, we could evaluate several assumptions made by our team. Those assumptions are as follows:

- Films must be shown as part of a conservation education program that incorporates other education materials and group discussion so that the

Figure 2. GLOBIO trained facilitators were critical to conducting teacher questionnaires in local schools in Cameroon. Questionnaire facilitator, Bessa Joseph Stephane (R) and local partner Ape Action Africa Education Officer, Charles Amougou (L) speak with local Cameroonian headmaster while students observe the process. Photograph by Gerry Ellis/ GLOBIO.org.

desired conservation message can be clearly defined and reinforced.

- The novelty of showing a film will motivate teachers to stay in the classroom, at least during the period of time the film is shown; therefore, the teachers would be exposed to the primary focus of that lesson.
- Films can be used as a "refresher" of previously delivered conservation information.
- The four films created could be edited into a single 20-25 minute film and presented in students' home villages or by invitation to the school as a "Movie Night," thereby engaging parents and adults in what their children are learning in school

The use of film in conservation education has multiple advantages. Film draws on human's fundamental attraction to visuals; it is, also, novel in most non-Western settings, is cross-cultural, and can eliminate gender and age barriers (Blewitt 2011b). Additionally, film supports visual learners and reduces language barriers presented by new conservation content and text. The Great Ape Film Conservation Project strives to move the conversation from anecdotal to data-driven as well as more accurately measure and evaluate film's conservation impact. Because data supporting this assumption are not conclusive, can films stand alone? And, if supplementary resources are needed, what must they be?

As we reflect on what we have observed, learned, and experienced during phase one, it is evident that on-the-ground observations are absolutely necessary. These observations included deliberate listening, watching, collaborative discussions, and flexibility. Our project evolved as the data and on-the-ground observations determined and modified the next steps. As we saw the need for films to supplement the current four-part lesson developed by AAA. We observed a disconnect between teachers, students, and adults; to bridge this disconnect, the films will be created to engage all audiences, overflow into current school curriculum, and promote continuing conversations outside the school setting. We will involve and engage local students, teachers and adults in all phases of film creation: scripting, filming, narrating, and post-production. Our project will further evolve as we continue collaboration with AAA and other primate conservation organizations. The Great Ape Conservation Film Project is prepared for the long-term commitment to testing and evaluation, editing and re-editing of film content, and continued collaboration.

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The GACFP's collaborative reach is significant; there are numerous individuals who were instrumental in the review, design, and development of the initial teacher and student questionnaires. Two individuals spent a significant amount of time providing insight, feedback, and support with special consideration of cultural and social issues lending to word choice and questionnaire design. They are Laurie Cummins, Community Engagement Manager at GRACE, and Dr. Kathayoon Khalil. Special thanks to the staff of Ape Action Africa as well as the teachers and students of the surrounding community.

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Obituary:

Christophe Boesch

Renowned Primatologist with Intimate Knowledge of Chimpanzee Behavior and Advocate for the Protection of Chimpanzees (1951 - 2024)

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Born in 1951 in St. Gallen, Switzerland, Christophe Boesch studied Biology at the University of Geneva. He conducted research under the supervision of Diane Fossey on mountain gorillas in the Virunga National Park, Rwanda, and returned from Africa infected with the virus of great ape research. After hearing rumors of nut-cracking chimpanzees in Côte d'Ivoire, he traveled in 1976 for the first time to Taï National Park (TNP) to find remains of cracked nut shells in the forest. Craving to study this behavior, he convinced Hans Kummer to support his quest of studying chimpanzee behavior for his PhD. Supported with money from the Swiss National Foundation, Christophe and his wife Hedwige returned in 1979 to TNP and began the long-term study on Western chimpanzees (*Pan troglodytes verus*) known today as the Taï Chimpanzee Project (TCP) (Boesch & Wittig 2019; Boesch & Boesch-Achermann 2000).

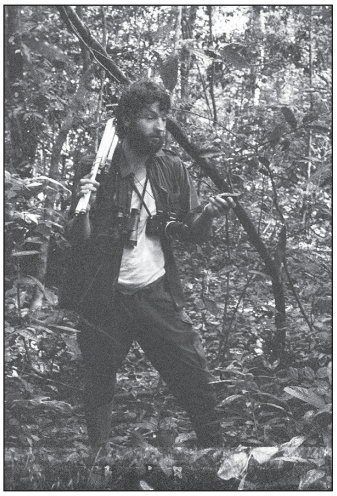
Christophe Boesch in 2013 after the film "Chimpanzee" has been released. (c) Markus Wächter.

The first years were extremely hard. Christophe and Hedwige first saw only black shapes, disappearing into the rainforest. In the beginning it was looking at nut-cracking workshops of the chimpanzees, hearing the chimpanzees hammering and even, with careful approaching, a deserted nut cracking site when arriving. With tremendous determination and patience, Christophe and Hedwige overcame the chimpanzees' fear and habituated them to the presence of human observers. During these first years, Christophe discovered that the Taï chimpanzees used hammers of different materials (stone or wood) depending on the hardness of the nut, that they would transport the hammers over long distances and pick them up on the way to the workshop, and that female chimpanzees in Taï are more efficient nut crackers than males (Boesch & Boesch 1981, 1982, 1984a, 1984b). These findings earned him his Ph.D. from the University of Zürich (Switzerland) in 1984.

Having set up shop in the middle of TNP, Christophe and Hedwige Boesch continued their research on the chimpanzees throughout Christophe's Ph.D. research. They observed the chimpanzees hunting for monkeys using collaborative tactics. Chimpanzee – as hunter – was more efficient when hunting these arboreal monkeys in groups. Each member of the hunting party would enact a different role, and the collaboration would be rewarded by sharing the meat amongst the hunters after the hunt (Boesch & Boesch 1989, 1994a, 1994b).

With the birth of their two children, Lukas (*1983) and Lèonore (*1988), it became clear for them that they would need help living in TNP and following the chimpanzees through the forest. Gregoire Nohon became their first employee, first as the children's nanny but very soon showing a keen interest in the chimpanzees' behavior. After a visit to the Gombe chimpanzees in Tanzania in 1990 (Boesch 1996), Christophe decided to implement an observation protocol for research staff. Gregoire, and a few years later Honroa Kpazahi, became the first staff members at TCP collecting chimpanzee data.

In 1991, after 12 years in North camp of TCP, Christophe became Assistant Professor



Christophe in the forest during the first years of his studies in Tai (undated photo, courtesy of Hediwge Boesch).

in the Zoology Department of Stephen Stearns at the University of Basel, Switzerland. While the family moved to Basel, Christophe went back to observe the chimpanzees as often as his job allowed. The first students arrived at TCP, they and Christophe habituated a second chimpanzee community south of his original North group, and the local field assistants became the backbone for continuous research efforts.

In recognition of his merits for understanding the evolution of human behavior, Christophe Boesch received in 1997 the call to join the Max Planck Institute for Evolutionary Anthropology (MPI EVA) in Leipzig, Germany, as founding director for primatology. This position allowed Christophe finally to unfold his full scientific creativity. He became a driving force for our understanding of animal cultures and brought together chimpanzee researchers to set up a comparison of behavioral diversity across and within chimpanzee field sites (Whiten *et al.* 1999; Boesch 2012; Luncz *et al.* 2012).

Flaring political unrest in Côte d'Ivoire (2001-2011) convinced Christophe to launch additional chimpanzee research sites in other African countries. He habituated chimpanzees in the Loango National Park, Gabon, in 2005. The extraordinary tool use behavior of the Ozouga chimpanzees, using a combination of two tools to access the honey of underground bee nests (Boesch *et al.* 2009; Estienne *et al.* 2017), gave Christophe the idea to establish the Pan African (PanAf) Project – to study chimpanzee cultures across all of Africa. Starting in 2010, the PanAf became a huge success, probing chimpanzee cultures and ecology with the same short term sampling protocol across 46 study sites (Boesch *et al.* 2020). This research showed the cultural variation of chimpanzees across Africa, but also that human impact had eroding effects on their behavioral variability (Kühl *et al.* 2019). Because of Christophe's research on chimpanzee cultures, cultural diversity has become one factor of the IUCN in assessing conservation status of chimpanzees (Carvalho *et al.* 2022).

The huge human pressure on the chimpanzees in TNP made Christophe very aware that all this knowledge about the chimpanzees comes with great responsibility. Over the years, he had experienced how chimpanzees disappeared or were killed by illegal hunting in the fields close to and in TNP. He saw chimpanzees dying from diseases, some naturally present in the forest and others originating in humans (Köndgen *et al.* 2008). His original study group went through a demographic decline from about 80 to about 20 in 30 years (Wittig & Boesch 2019). Thus, early in his career, it became evident to him that he needed to protect the chimpanzees to be able to study their behavior. As a result, he founded the Wild Chimpanzee Foundation (WCF) in 2000, a non-governmental organization to protect wild chimpanzees in West Africa. He was able to show that TCP, as a long-term research project, repels illegal human activity in TNP and that densities of chimpanzees and other wildlife is higher in the research area than in the rest of the National Park (Campbell *et al.* 2011; Kouamé N'Goran et al. 2013). Under the leadership of its president Christophe Boesch, WCF became a driving force behind chimpanzee conservation in Côte d'Ivoire, Liberia and Guinea. He and WCF were instrumental in

During Christophe's retirement symposium (first row left to right): Inza Kone (DG CSRS), Christophe Boesch, Honora Kpazahi (Head of Staff TCP), Tondossama Adama (DG OIPR), Camille Dji (former staff member), Zoro Gone Bi (coordinator TCP) and Gregoire Nohon (Head of Staff WCF).

Photo courtesy of MPI EVA, TCP

Christophe Boesch advocating for the protection of chimpanzees in Abidjan (2013). Photo courtesy of WCF.

creating Grebo-Krahn National Park in Liberia (2017), Moyen-Bafin National Park in Guinea (2023), and Cavally Forest Reserve in Côte d'Ivoire (2024).

After his retirement from the directorship of the MPI EVA in 2019, Christophe invested all his energy in the conservation of chimpanzees. He was a true champion of chimpanzee protection. He won the St. Andrews Prize for the Environment in 2015 and was a Finalist for the Indianapolis Prize in both 2021 and 2023.

On January 14, 2024, fate struck. It did not strike in a forest in Africa, but in his adopted home of Leipzig. Christophe Boesch, "Le père de la primatologie en Côte d'Ivoire," as the president of the African Primatological Society, Inza Kone, called him afterwards, passed away. The void he leaves is immense, but his passion for the chimpanzees will continue in the countless students he has trained and infected with the virus for great ape research and conservation.

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Announcements

Announcing the Global Mammal Parasite Database

The Global Mammal Parasite Database (GMPD) is a repository of data on the parasites and pathogens of primates and other mammals. The GMPD has long been a collaborative effort, resulting in multiple large grants and dozens of publications.

The organizers of the GMPD are now looking to invite into our network primatologists and their teams from primate-habitat countries, while also building new collaborations to analyze these samples with cutting-edge genomic and statistical methods. Primatologists who participate in this effort will be (i) given access to the parasite data from the samples they provide to use as they wish, (ii) members of a new "GMPD Primatology Consortium" with the consortium serving as a co-author on key papers that analyze the full dataset, and (iii) members of a community committed to open access of data and global collaboration.

We have developed a protocol for systematically collecting and screening fecal samples from wild primates for a wide range of viruses, bacteria, helminths, and protozoa. Following screening, the results would be returned to the team collecting samples to analyze as they wish, and they would be invited to be included in the GMPD Primatology Consortium, which will be included as a co-author on resulting manuscripts and may be directly involved in analyses.

The project's results will also be used as part of broader macroecological analyses of the predictors of parasitism in primates and humans. For examples of macroecological projects, please check "Applications" in the current version of the Global Mammal Parasite Database.

We ask that primatologists collect fecal samples from individually identified wild primates, aiming to collect at least one sample each from at least 80% of the individuals in sampled social groups. We will provide all the materials to collect the samples and pay for shipping back to our collaborating laboratories. We may also be able to provide additional support for field equipment, such as GPS devices, if needed by a primatology team.

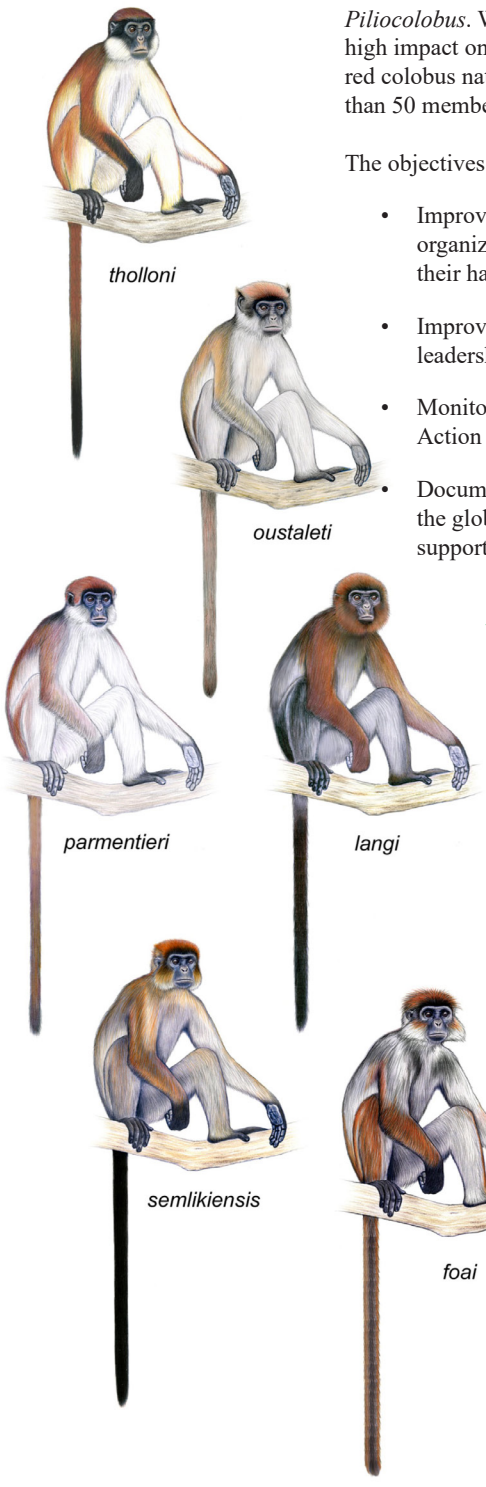
We will ask that field primatologists also complete two short questionnaires to accompany the samples to provide information about the individuals and the groups in which they live.

For those interested in participating: please contact Melody Xiao (melody.xiao@duke.edu) AND Dr. Charles Nunn (clnunn@duke.edu) with your CV, a brief description of your field site, information on the populations of primates you have access to for sampling (species and locations), the number of groups you could sample in each population, and the total number of samples you expect to be able to obtain over a six month time period. We will include this information in grant applications. If you are interested in being a part of an effort to collect preliminary data for the grants in 2024-25, we will send a memorandum of understanding that includes specific logistical information (including sampling protocol and rights to the data), along with the necessary supplies.

- Melody Xiao and Charles Nunn

If you're seeking collaborators for African primate projects (such as the one featured above), submit an announcement for a future issue of *African Primates*. Contact wallis@africanprimates.net.

RCCN-DRC Red Colobus Group



The Democratic Republic of Congo (DRC) is home to 7 taxa of the genus *Piliocolobus*. With the aim of catalyzing the global effort and making a high impact on the conservation of red colobus monkeys, we created the red colobus national group for DRC under RCCN. This group has more than 50 members.

The objectives of the group are presented below:

- Improve communication between individuals, researchers, organizations, institutions working on red colobus monkeys or in their habitat range in the DRC;
- Improve DRC young primatologist training, coaching and leadership and encourage them to work on red colobus monkeys;
- Monitor the implementation of the Red colobus Conservation Action Plan (ReCAP) across the DRC;
- Document and communicate on their findings and difficulties with the global network (RCCN) and receive technical and financial support.

We invite you to join this group of amazing researchers and conservationists.

Please email Florence Aghomo coordinator of the RCCN at florence@redcolobusnetwork.org or Jean-Claude Kyungu, coordinator of the RCCN-DRC group at jeanclaude.maiko1@gmail.com to join the group.

Website: https://www.redcolobusnetwork.org/
Twitter: @RedColobusCN
Facebook: Red Colobus Conservation Network
Instagram: Red Colobus Conservation

Announcements

A YEAR OF UPDATES

IUCN SSC PRIMATES
SECTION ON HUMAN-PRIMATE INTERACTIONS

HUMAN-PRIMATE-INTERACTIONS.ORG

2024

2023

Feb **Mission Statement**

The SHPI is an interdisciplinary group that aims to understand the complex nature of human–primate interactions. We provide conservation practitioners with tools to manage interactions to minimise negative exchanges and promote coexistence in landscapes of increasingly rapid change

Jan **Reading List**

Ethnography, inclusivity and ethics in conservation

Nov **Position Statement**

Regarding primates in agroecosystems

Sept **Recommendations for Responsible Primate Tourism**

Documents for (1) tourists, (2) tourism professionals and (3) case studies

July **New Logo + New Website**

human-primate-interactions.org

IUCN SSC PRIMATES
SECTION ON HUMAN-PRIMATE INTERACTIONS

June **Position Statement**

Regarding the capture of wild primates for biomedical and pharmaceutical research

by Chloe Chesney

To learn more about the IUCN SSC Primate Specialist Group's Section on Human-Primate Interactions, visit their web site at human-primate-interactions.org

ACCB is a regional forum for addressing conservation challenges and for presenting new research in conservation science and practice.

With over 300 delegates in attendance, ACCB 2024 is the single largest gathering of African conservationists.

Stay Connected with #ACCB2024

The Society for Conservation Biology - Africa Region (SCB-AR) is excited to announce that the 4th ACCB will take place at the College of African Wildlife Management, Mweka, in Moshi, Tanzania, from October 19-21, 2024. Join us as we celebrate conservation and its frontliners in Africa!

The Africa Congress for Conservation Biology (ACCB) will convene a vibrant conservation academic community, local community leaders, practitioners, policymakers, national protected area authorities, artists, students, and journalists to share research lessons and tools learned over the years that showcase successful conservation practices in Africa. With possibly over 300 delegates in attendance, ACCB 2024 may be the single largest gathering of African conservationists.

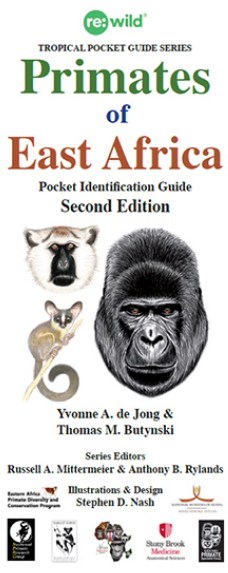
The 2024 ACCB venue, the College of African Wildlife Management - Mweka, is a 60-year-old African premier wildlife management training College that has trained over 11,000 Africa's conservation practitioners. Located in Moshi in Northern Tanzania, the ACCB 2024 brings you to the gateway of Kilimanjaro National Park, home to Africa's highest mountain, Mount Kilimanjaro.

Early Bird Registration Now Open!
Register by 20 August 2024 for the best rate!
https://whova.com/portal/registration/accbc_202410/

Spread the word to primatologists far and wide!

Visit https://conbio.org/mini-sites/accb-2024 for details on registration and conference schedule.

Announcements



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2023

TROPICAL POCKET GUIDE SERIES

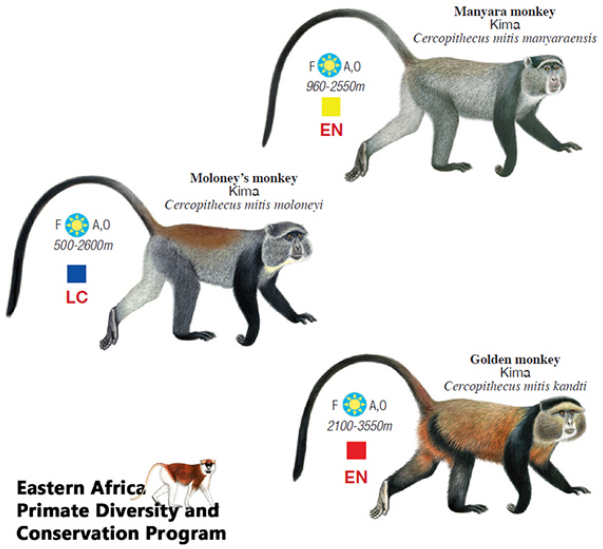
Primates of East Africa

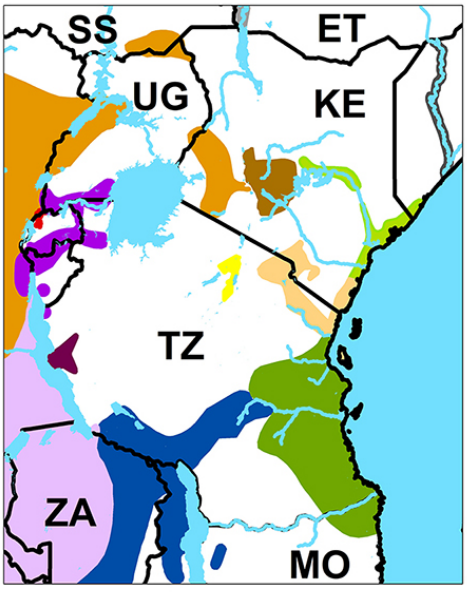
Second Edition

Yvonne A. de Jong &
Thomas M. Butynski

Illustrations & Design Stephen D. Nash

73 Taxa - 35 Maps - 13 Vocal Profiles - Checklist





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Download a free PDF of this checklist from the *African Primates* web site:
http://www.primate-sg.org/african-primates-volume-18/

The International Primatological Society's Heritage Fund

The International Primatological Society's Heritage Fund was launched in late 2021 with the aim of creating a permanent endowed fund that can generate dividends each year. Donations to the Heritage Fund establish the principal endowment, and the dividends generated by it will provide stable long-term funding toward IPS activities, including grants. Thus, the larger the fund, the more dividends there will be.

Heritage Fund donation categories are: $1,000-2,999 (bronze); $3,000-3,999 (silver); $4,000-4,999 (gold); >$5,000 (platinum). Founders will have the option to be recognized or to remain anonymous. All Founders will receive an acknowledgement.

The IPS is a non-profit organization (401.3.c) and, therefore, meets all requirements for charitable donations according to the U.S. tax system. The Heritage Fund is also suitable for estate planning. For that, please contact the Treasurer.

Please help support the IPS, the only international primatological society that unites regional and national primatological societies from around the world. More details are available at the web site.

Plan now! The next meeting of the International Primatological Society, Antananarivo, Madagascar, 10-16 August 2025. Check the IPS web site for details soon: https://internationalprimatologicalsociety.org/

The Masters and Genin African Primatology Fund

The fund was established to honor the memories of Judith Masters and Fabien Genin who were tragically killed in South Africa. Both Masters and Genin were extraordinary researchers and dedicated teachers and mentors.

Judith Masters was a research professor at the University of Fort Hare, South Africa where she headed APIES (the African Primate Initiative for Ecology and Speciation). Judith's research focused on the diversification and evolution of strepsirrhine primates. Included in her over 100 publications was the book Leaping Ahead: Advances in Prosimian Biology coedited with Fabien Genin and Marco Gamba. The volume contains papers presented at the 2007 International Conference on Prosimians held in Ithala, South Africa which Judith and Fabien organised. Judith and her collaborators have been working on revising the taxonomy of the dwarf galago. Judith was the co-founder and co-chair of the Primate Ecology and Genetics Group (PEGG) of the South African Primatology Society.

Fabien Genin, originally from Toulouse, France, was a frequent collaborator of Judith's. He studied the ecology of strepsirrhine primates in Africa and Madagascar focusing specifically on ecophysiology, behavioural ecology and bioacoustics. Fabien also had a faculty appointment at University of Fort Hare. Both Judith and Fabien were incredibly devoted to their students and to the promotion of primatology in Africa. Their involvement with IPS was expressed in their frequent attendance at our congresses, their efforts in promoting the attendance and participation of their students, and their willingness to host an IPS congress in South Africa

Judith Masters and Fabien Genin left us, but their work remains and will never be forgotten. The Masters and Genin African Primatology Fund is devoted to continuing the work they started by supporting research by African and Malagasy primatology students.

You can donate to the fund at the IPS web site.

3rd Congress of the African Primatological Society (APS 2024)

September 25th - 28th, 2024

Potchefstroom, South Africa

Overall theme : Integration of Research and Conservation in African Primates

Activities : Keynotes speeches, overview of the implementation of Taxa-based primate conservation action plans, panels, workshops, symposia oral and poster communication, elective general assembly, post-congress training for junior academia and practitioners

Featured speakers : Rachel Ikemeh, Josia Razafindramanana, Joanna Setchel, Beth Kaplin, Ekwoge Abwe, Jonah Ratsimbazafy, Gladys Kalema-Zikusoka, Inza Koné, Sian Waters, Colleen Downs, Trudy Turner, Russ Mittermeier, Leandro Jerusalinsky...

Information, abstract submissions, and registration : www.csrs.ch/aps2024

Contact : aps2024@csrs.ci

Sponsors : Arcus Foundation, Margot Marsh Biodiversity Foundation, CSRS, ReWild, North-West University, San Diego Zoo

The SSC Network is Recognised by Guinness World Records®

The IUCN Species Survival Commission (SSC) proudly announces that Guinness World Records® has recognised it as the "largest volunteer conservation-science network."

This prestigious recognition was possible thanks to the dedication of thousands of volunteer experts from nearly every country in the world. Together, they work tirelessly to achieve the vision of "a just world that values and conserves nature through positive action to both prevent the loss and aid recovery of the diversity of life on Earth."

Guinness World Records is the global authority on record-breaking achievements, documenting and celebrating superlative accomplishments that are the best in the world. Each record title must fulfill all of the following criteria: measurable, breakable, standardisable, verifiable, based on one variable, and the best in the world.

#WeAreSSC – the world's largest volunteer conservation-science network – is committed to building knowledge about the status of species and their threats. The network provides vital advice, develops policies and guidelines, facilitates conservation planning and implements actions on the ground to protect the planet's biodiversity.

The largest volunteer conservation-science network is the IUCN Species Survival Commission (SSC), which had 10,072 members as of 1 May 2024. The organization is headquartered in Switzerland and is currently chaired by Jon Paul Rodríguez.

Established in 1949 by the International Union for Conservation of Nature (IUCN), the primary purpose of the SSC is to amass the expertise of local scientists all around the world to collate data and trends regarding the status of particular species. This helps to inform the most effective conservation action and government policy, as well as the IUCN's highly regarded Red List of Threatened Species. To date, the IUCN and its partners have assessed more than 157,000 species.

The SSC membership resets every four years at the IUCN World Conservation Congress with the current period due to end in 2025. The previous cohort, amassed from 2017 to 2021, reached a peak of 10,602 volunteers by 31 July 2021.

The SSC's volunteer scientists hail from almost every country on the planet (186 to be precise). Of these, the greatest number are based in West Europe, representing more than one-quarter of the total cohort. In second place is South and East Asia, with 21.5%, and in third is North America and the Caribbean at 19.3%.

Dear fellow primates,

We welcome you to the IX Iberian Primatological Congress to take place November 21 - 23 in the beautiful town of Vila do Conde, Portugal. We hope that you will have a wonderful time during our event where you can learn about us and other primates, exchanging experiences, creating networks and even finding new friends.

Important dates

- 15 August – Deadline for abstract submission
- 16 September – Feedback from abstract assessment
- 27 September – Early Bird registration

Iberian Primatological Conference

Beyond Boundaries: Integrating Primate Research

For more information, please go to: https://apprimatologia.pt/IX_Iberian_Primatological_Conference/pt

Recent Publications

Anca, E.D. & J. Wallis. 2024. Plastic pollution and human-primate interactions: A growing conservation concern. *Cambridge Prisms: Plastics* 2: e10, 1-8.

Anderson, J. A., D. Lin, A.J. Lea, R.A. Johnston, T. Voyles, M.Y. Akinyi, E.A. Archie, S.C. Alberts & J. Tung. 2024. DNA methylation signatures of early-life adversity are exposure-dependent in wild baboons. *Proceedings of the National Academy of Sciences – PNAS* 121(11): p.e2309469121-e2309469121.

Arseneau-Robar, T.J., J.A. Teichroeb, A.J.J. Macintosh, T.L. Saj, E. Glotfelty, S. Lucci, P. Sicotte & E.C. Wikberg. 2024. When population growth intensifies intergroup competition, female colobus monkeys free-ride less. *Scientific Reports* 14(1): 14363-12, Article 14363.

Bambi, M., G. Galla, C. Donati, G. Rovero, H.C. Hauffe & C. Barelli. 2024. Gut microbiota variations in wild yellow baboons (*Papio cynocephalus*) are associated with sex and habitat disturbance. *Scientific Reports* 14(1): 869-869, Article 869.

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* This is not an exhaustive list and focuses primarily on publications from peer-reviewed journals published since the last issue of the journal. Priority is given to research and conservation of wild African primates. To have your new publications listed in this section of future *African Primates*, please send an e-mail notice to wallis@africanprimates.net. This section may not appear in every issue.

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Twitter: twitter.com/ABCGconserve

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Facebook: facebook.com/groups/AfricanPrimates/
Twitter: twitter.com/africanprimates

African Primatological Society
Facebook: facebook.com/African.Primatological.Society/
Twitter: twitter.com/AfricanPs

African Wildlife Foundation
Website: www.awf.org
Facebook: facebook.com/AfricanWildlifeFoundation
Twitter: twitter.com/AWF_Official

Amboseli Baboons
Website: www.amboselibaboons.nd.edu
Facebook: facebook.com/Amboseli-Baboon-Research-Project-296131010593283
Twitter: twitter.com/AmboseliBaboons

Barbary Macaque Awareness and Conservation
Website: www.barbarymacaqueconservation.org
Newsletter: Contact sian@barbarymacaque.org
Facebook: facebook.com/BarbaryMacaqueAwarenessandConservation

The Bioko Biodiversity Protection Program (BBPP)
Website: www.bioko.org
Facebook: English - facebook.com/pages/Bioko-Biodiversity-Protection-Program/107673299261496; Spanish - facebook.com/BiokoBiodiversidad
Twitter: twitter.com/Bioko_BBPP
Instagram: instagram.com/bioko_BBPP/

The Bonobo Conservation Initiative (BCI)
Website: www.bonobo.org
Facebook: facebook.com/bonobodotorg
Twitter: twitter.com/Bonobodotorg

The Bonobo Project
Twitter: twitter.com/Bonobo_Project

Budongo Conservation Field Station
Website: www.budongo.org
Facebook: facebook.com/pages/Budongo-Conservation-Field-Station/111160629076237
Twitter: twitter.com/budongochimps

Bugoma Primate Conservation Project
Twitter: twitter.com/BugomaPrimates

Bulindi Chimpanzee and Community Project
Website: bulindichimpanzees.weebly.com/
Facebook: facebook.com/bulindichimpanzees
Twitter: twitter.com/bulindichimps
Instagram: instagram.com/bulindichimps/
YouTube: youtube.com/bulindichimpanzees

Cameroon Primatological Society
Twitter: twitter.com/Camer_primates

Canadian-Cameroon Ape Network
Facebook: facebook.com/cancamapenetwork/
Twitter: twitter.com/CanCamApeNetwrk

Centre de Conservation pour Chimpanzes
Website: www.projetprimates.com/en/
Facebook: facebook.com/CentreDeConservationPourChimpanzes
Twitter: twitter.com/projectprimate

Chimp Eden (JGI Sanctuary, South Africa)
Website: www.chimpeden.com/
Facebook: facebook.com/JGISA
Twitter: twitter.com/jgisachimpeden

Chimpanzee Sanctuary & Wildlife Conservation Trust (Ngamba Island)
Website: www.ngambaisland.org/
E-newsletter contact: info@ngambaisland.org
Facebook: facebook.com/ngambaisland
Twitter: twitter.com/ngambaisland

Colobus Conservation
Website: www.colobusconservation.org
Facebook: facebook.com/pages/Colobus-Conservation/137445029669543
Twitter: twitter.com/Team_Colobus

Comoe Chimpanzee
Facebook: facebook.com/comoechimpanzeecp/

Comoé Monkey Project
Facebook: facebook.com/ComoeMonkeyProject

Conservation through Public Health
Facebook: Conservation Through Public Health facebook.com/pages/Conservation-Through-Public-Health/115176086614; CTPH Gorilla Conservation Camp: facebook.com/pages/CTPH-Gorilla-Conservation-Camp/239975179417714
Twitter: twitter.com/CTPHuganda

Cross River Gorilla Project
Website: www.crossrivergorillaproject.co.uk/
Twitter: twitter.com/crossriverGP

Eastern Africa Primate Diversity and Conservation Program
Website: www.wildsolutions.nl/
Twitter: twitter.com/WildSolutions

Ebo Forest Research Project
Website: www.eboforest.org
E-Newletter contact: ekwoge@eboforest.org

Filoha Hamadryas Project
Website: filohahamadryasproject.org/
Facebook: facebook.com/filoha

Connections: E-News, Web Sites, and Social Media

Fossey Gorilla Fund
Website: www.gorillafund.org/
Facebook: facebook.com/savinggorillas
Twitter: twitter.com/SavingGorillas

The Gishwati Foundation
Website: www.gishwati.org
Facebook: facebook.com/GishwatiFoundation/

Gorilla Doctors
Website: www.gorilladoctors.org
Facebook: facebook.com/gorilladoctors/

Gorillas Across Africa
Facebook: facebook.com/GorillasAcrossAfrica

Gorilla Rehabilitation and Conservation Education (GRACE) Center
Website: www.gracegorillas.org
Facebook: facebook.com/gracegorillas
Twitter: twitter.com/GRACEgorillas
Instagram: instagram.com/gracegorillas
YouTube: www.youtube.com/channel/UCK2iQu8NDbxtkxEd4xqaMag

Goualougo Triangle Ape Project
Website: www.congo-apes.org/
Facebook: facebook.com/Goualougo-Triangle-Ape-Project-282194681876/

Great Ape Survival Partnership (GRASP)
Website: www.un-grasp.org
Facebook: facebook.com/graspunep?ref=stream
Twitter: twitter.com/graspunep

Guenon Conservation Community
Facebook: facebook.com/pages/Guenon-Conservation-Community/

HELP Congo (Chimpanzee Sanctuary)
Website: www.help-primates.org/
Facebook: facebook.com/HELP-Congo-29693148237/

Imfene Education and Conservation (Baboons)
Facebook: facebook.com/ImfeneOutreach

International Gorilla Conservation Programme
Website: www.igcp.org
Facebook: facebook.com/theIGCP
Twitter: twitter.com/IGCP

International Primate Protection League
Website: www.ippl.org
Facebook: facebook.com/InternationalPrimateProtectionLeague
Twitter: twitter.com/ipplprimate

International Primatological Society – Conservation
Website: www.internationalprimatologicalsociety.org

IUCN SSC Primate Specialist Group Section for Human-Primate Interactions
Webpage: www.human-primate-interactions.org/
Facebook: facebook.com/peopleprimate
Twitter: twitter.com/peopleprimate

Jane Goodall Institute
Website: www.janegoodall.org
Facebook: facebook.com/janegoodallinst/
Twitter: twitter.com/JaneGoodallInst

Kasanka Baboon Research Project
Website: www.kasankababoonproject.com
Twitter: twitter.com/KindaCamp

Kasokwa-Kityedo Forest Project
Facebook: facebook.com/KasokwaKityedo/

Kibale Chimpanzee Project
Facebook: facebook.com/kibalechimpanzeeproject/
Blog: https://kibalechimpanzees.wordpress.com/

Kyambura Gorge Chimpanzee Community
Facebook: facebook.com/Kyambura-Gorge-Chimpanzee-Community-119478481457652/

La Société Francophone de Primatologie – SFDP
Twitter: twitter.com/LaSFDP

Le Projet Gorille Fernan-Vaz (Gabon)
Website: www.gorillasgabon.org/
Facebook: facebook.com/gorillasgabon
Twitter: twitter.com/gorillasgabon

Liberia Chimpanzee Rescue & Protection
Website: www.liberiachimpanzeerescue.org
Facebook: facebook.com/liberiachimpanzeerescue.org
Twitter: twitter.com/liberiachimps
Instagram: instagram.com/liberiachimprescueprotection

LimbeWildlifeCentre
Facebook: facebook.com/pages/Limbe-Wildlife-Centre/504832002861894
Twitter: twitter.com/LimbeWildlife

Loango Chimpanzee Project
Twitter: twitter.com/loangochimps

Lola ya Bonobo
Website: lolayabonobo.org
Twitter: twitter.com/lola_ya_bonobo

Lukuru Foundation
Website: www.lukuru.org
Facebook: facebook.com/LukuruFoundation

Lwiro Sanctuary
Website: www.lwiroprimates.org
Facebook: facebook.com/lwiroprimates
Twitter: twitter.com/lwiroprimates

Connections: E-News, Web Sites, and Social Media

Mandrillus Project
Website: www.projetmandrillus.com
Twitter: twitter.com/mandrillusP

Mbeli Bai Study
Twitter: twitter.com/mbelibai

Ngogo Chimp Project
Website: www.ngogochimpanzeeproject.org/
Facebook: facebook.com/NgogoChimps/
Twitter: twitter.com/ngogochimps

Nigerian Montane Forest Project
Facebook: facebook.com/groups/4829132147/
Twitter: twitter.com/Ngel_Nyaki

Nyungwe Chimpanzee Project
Facebook: facebook.com/nyungwechimpanzeeproject

Pan African Sanctuary Alliance
Website: www.pasaprimates.org
E-newsletter contact: info@pasaprimates.org
Facebook: facebook.com/pasaprimates/
Twitter: twitter.com/pasaprimates

Pandrillus (Primate Sanctuary, Nigeria)
Website: www.pandrillus.org/
Facebook: facebook.com/Pandrillus/

Partners for Red Colobus
Facebook: facebook.com/Partners-for-Red-Colobus/
Instagram: instagram.com/partners4redcolobus

PEGG – The South Africa Primatology Association
Website: www.peggweb.com/index.php
Facebook: facebook.com/PEGG-The-South-African-Primatology-Association-112433812122602/

Red-bellied Guenon
Facebook: facebook.com/Cercopithecuserythrogastererythrogaster

Red Colobus Conservation Network
Twitter: twitter.com/redcolobusCN

Samango Monkey Project
Facebook: facebook.com/groups/samango/

Second Chance Chimpanzee Refuge Liberia/ Save the Abandoned Chimps (Liberia)
Facebook: facebook.com/abandonedchimps

Simien Mountains Gelada Research Project
Website: geladaresearch.org/
Twitter: twitter.com/GeladaResearch

Tacugama Chimpanzee Sanctuary
Website: www.tacugama.com/
Facebook: www.facebook.com/Tacugama
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Tai Chimp Project
Twitter: twitter.com/TaiChimpProject

Uaso Ngiro Baboon Project
Website: www.baboonsrus.com/6.html

Ukpe-Sobo Chimps
Twitter: twitter.com/UkpeC

Vervet Monkey Foundation
Facebook: facebook.com/groups/vervet
Twitter: twitter.com/VervetMonkeys

West African Primate Conservation Action (WAPCA)
WAPCA News contact: andrea.dimpsey@wapca.org
Website: www.wapca.org/
Facebook: facebook.com/WAPCA
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Wild Chimpanzee Foundation
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All correspondence should be sent to: wallis@africanprimate.net.

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African Primates, a journal of the IUCN SSC Primate Specialist Group, publishes research articles, field reports, review articles, position papers, book reviews, and other news focused on the nonhuman primates of Africa. We welcome submissions focused on behavior, ecology, taxonomy, or conservation. The journal is produced in both print and digital versions and is provided free of charge. The aim of *African Primates* is to promote conservation of Africa's primates by:

1) enhancing interest in Africa's primates and increasing knowledge about them that is relevant to their survival;
2) transmitting information about factors and situations that promote or work against conservation of African primate species or populations; and
3) providing a forum for discussion and debate regarding all aspects of knowledge relevant to conserving Africa's primate fauna and their habitats.

African Primates encourages submission of relevant information in the form of research findings, field survey results, advances in field and laboratory techniques, field action alerts, and book reviews, as well as notification of events, funding opportunities, grassroots efforts such as letter-writing campaigns, and recent publications in other formats (including reports and theses). All submissions should be sent to the Editor-in-Chief; research articles will be peer-reviewed before acceptance for publication. Contributors may consult past issues of *African Primates* for stylistic guidance. (Previous volumes are accessible through the PSG website. See http://www.primate-sg.org/african_primates/.)

The following guidelines are recommended:

- Manuscripts (not to exceed 15 pages) should be in English **only**, double-spaced, with 1-inch margins. All articles must include an English abstract. If possible, please provide a French abstract.
- Authors submitting manuscripts in a language that is not their first are encouraged to seek guidance from a speaker of that language to insure the manuscript is well-written.
- Manuscripts should be produced with PC-compatible software (e.g., Microsoft Word) and submitted as an e-mail attachment in *.doc; *docx, or *.rtf format. All reviews and revisions will be conducted via e-mail.
- Use metric units only and define all abbreviations.
- Current taxonomic classifications should be used. If species or subspecies' names have undergone recent revision, please include mention of recent names as a service to readers adjusting to new naming conventions.
- Tables, figures, and photographs are encouraged. All require accurate and concise captions listed on a separate sheet.
- Research articles should be accompanied by a map indicating location of any place names mentioned in the text. Please include a map legend.
- All photographs must be of high quality and submitted electronically. Each should be labeled on a separate page with a caption and photographer credit.
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- References should be provided in an alphabetical list and conform to the format used in previous issues of *African Primates*. Examples are shown below.
- Each author should provide name, affiliation, address, telephone and/or fax number, and E-mail address.

Please use the following formats:

Book:
Groves, C.P. 2001. *Primate Taxonomy*. Smithsonian Institution Press, Washington, D.C.

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Book Chapter:
Eniang, E.A. 2003. Effects of habitat fragmentation on the Cross River gorilla (*Gorilla gorilla diehli*): Recommendations for conservation. In *Primates in Fragments: Ecology and Conservation*. L.K. Marsh, ed. Kluwer Academic/Plenum Publishers, New York. Pp. 343–363.

Unpublished Report:
Hearn, G.W., W.A. Morra, M.A. Ela Mba & C. Posa Bohome. 2001. The approaching extinction of monkeys and duikers on Bioko Island, Equatorial Guinea, Africa. Unpublished report of the Bioko Biodiversity Protection Program, Arcadia University, Glenside PA.

Government Document:
Ministry of Environment and Natural Resources. 1994. *The Kenya National Environment Action Plan (NEAP)*. Ministry of Environment and Natural Resources, Nairobi, Kenya.

It is recommended that contributors consult recent issues of *African Primates* for more details on the journal's format and content.

Please submit all manuscripts and materials electronically to: wallis@africanprimates.net

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Research Articles

Field Report

Brief Communications