Original Article

Distribution and Conservation Status of Catarrhine Primates in Côte d'Ivoire (West Africa)

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Abstract

Côte d'Ivoire holds 18 catarrhine taxa, with 3 endemic to Côte d'Ivoire and neighbouring Ghana. Nine of the taxa occurring in Côte d'Ivoire are listed as threatened at the global level. However, information on their conservation status within the country is available for only a limited number of taxa. In order to assess the current distribution of primates and their conservation status, we conducted foot surveys and interviews in protected forests in the southern part of Côte d'Ivoire. Our data suggest that 22 out of 23 surveyed forests have lost 25–100% of the primate taxa expected to occur in these areas. The only exception is the Taï National Park where all of the expected primate taxa were encountered. Based on our surveys, we propose an updated national list according to the IUCN Red List criteria for all diurnal primate species of Côte d'Ivoire.

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Introduction

The forests of West Africa are home to more than 25% of Africa's mammals, including more than 20 species of primates [Myers et al., 2000]. Because of the high level of species diversity and endemism, the forest ecosystems from Guinea to Nigeria have been recognized as one of the world's 25 most threatened ecosystems [Myers et al., 2000] (http://www.biodiversityhotspots.org/xp/hotspots/west_africa/Pages/

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default.aspx). With 22 taxa, among them 18 catarrhines, Côte d'Ivoire holds the second highest primate diversity in West Africa after Nigeria [Oates, 2011]. Three of these taxa are endemic to Côte d'Ivoire and neighbouring Ghana: Miss Waldron's red colobus *(Procolobus badius waldroni)*, Roloway monkey *(Cercopithecus diana roloway)* and white-naped mangabey *(Cercocebus atys lunulatus)*.

Several of the primate taxa of Côte d'Ivoire are listed as threatened at a global level by the IUCN [2011]. One of them *(Cercopithecus d. roloway)* is among the 25 most endangered primates [Mittermeier et al., 2009]. *Procolobus b. waldroni* was thought to be extinct [McGraw et al., 1998; Oates et al., 2000]. In 2005, McGraw [2005] reported some indirect evidence (a tail, a skin and a photograph) that a handful of individuals may still live in a 'forêt villageoise' or community forest near Lagoon Ehy in the extreme south-east of Côte d'Ivoire, which lacks any legal protection.

Although several Ivorian primate taxa have been well studied in the western part of the country, particularly in the Taï National Park, where long-term field studies are ongoing, primates in other parts of the country have been scientifically neglected. Only a few surveys have been conducted in the eastern part of the country [McGraw et al., 1998; Oates et al., 2000; McGraw, 2005; Koné et al., 2006; Gonedelé Bi et al., 2006, 2008].

The overall threats affecting primates in Côte d'Ivoire are intensive habitat degradation and poaching [Oates, 2011]. The situation became critical with the depletion of the conservation policy over the last decade because of political and social instability in the country. In Côte d'Ivoire, hunting and the trade of bush meat and other hunting products have been prohibited since 1974. However, wildlife use and trade increased in the recent decade due to lack of control and application of the legislation. There is no time frame for reviewing species conservation status in Côte d'Ivoire. No effort has been made to list species conservation status at a national level. The national list of species conservation status is based on IUCN list data at the regional level. It is, however, imperative to rank taxa according to the risks they face. These ranks can be used to set priorities for management at the local and national levels [Breininger et al., 1998]. In this paper, we present data on the distribution and conservation status of catarrhine primates of Côte d'Ivoire based on surveys conducted in different forests in the southern part of this country within the last few years (2000–2008). For the older surveys, it is difficult to judge accurately how representative of the current situation they are, but most likely the situaton has become even worse given the political instability in the country within the last few years. These surveys, however, contain the best available and most up-to-date data for Côte d'Ivoire primates. Based on these data, we evaluated the status of Côte d'Ivoire's primates according to IUCN Red List criteria and propose an updated classification for the Ivorian national level.

Methods

Survey Sites

All surveyed forests belong to the Guinean forest zone in the southern part of Côte d'Ivoire, with the exception of Soko, Dinaoudi and Tabagne forest groves. These three are located in a region referred to as a transitional zone between the Sudanese and the Guinean zone with vegetation varying from woodlands to grasslands (fig. 1). The survey included 5 national parks (Taï, Azagny, Banco, Marahoué and Iles Ehotilé), 9 forest reserves (Monogaga, Niégré, Dassioko, Bolo
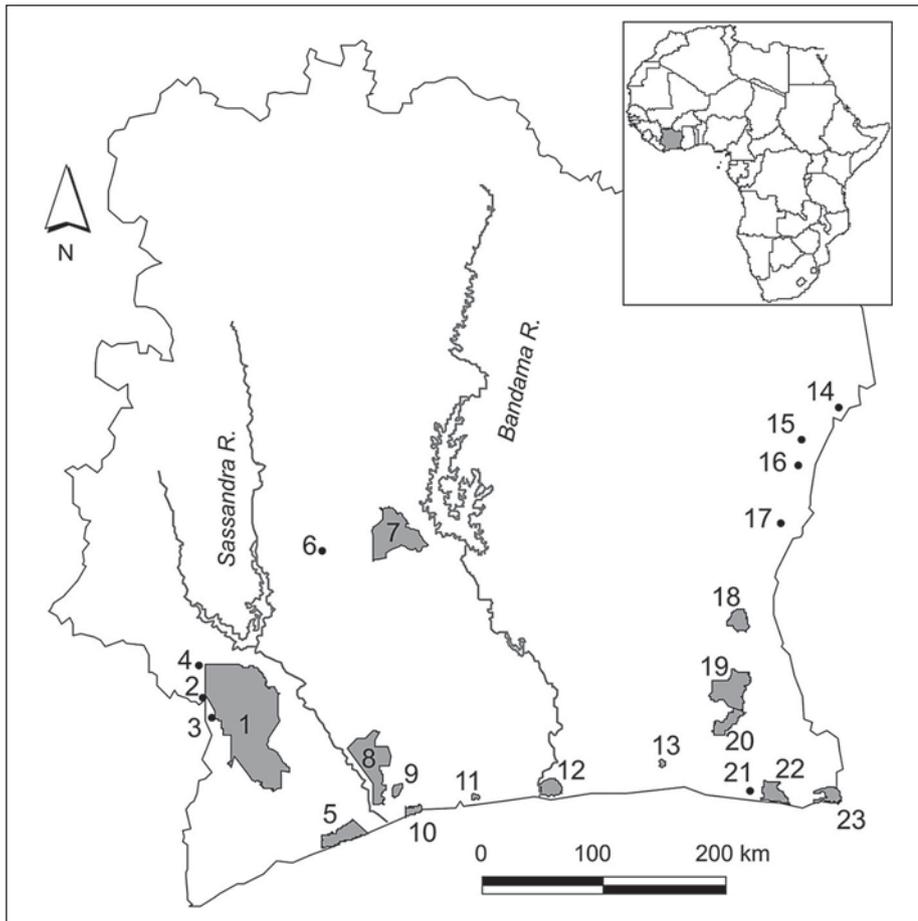
Fig. 1. Survey sites. NP = National park; FR = forest reserve; CF = community forest; FG = forest grove. Western region (west of Sassandra River): 1 = Taï NP; 2 = Gouléako II CF; 3 = Kabéoula CF; 4 = Djidoubaye CF; 5 = Monogaga FR; interfluvial region (between Sassandra and Bandama rivers): 6 = Guelitapia FG; 7 = Marahoué NP; 8 = Niégré FR; 9 = Bolo Ouest FR; 10 = Dassioko FR; 11 = Port Gauthier FR; eastern region (east of Bandama River): 12 = Azagny NP; 13 = Banco NP; 14 = Soko FG; 15 = Tabagne FG; 16 = Dinaoudi FG; 17 = Transua FG; 18 = Bossématié FR; 19 = Mabi FR; 20 = Yaya FR; 21 = N'Gana N'Gana FR; 22 = Ile Ehotilé NP; 23 = Tanoé CF.

Ouest, Bossématié, Yaya, Mabi, N'Gana N'Gana and Port Gauthier), 4 forest groves (Soko, Dinaoudi, Guelitapia and Tabagne) and 5 rural community forests or 'forêts villageoises' (Kabéoula, Djidoubaye, Gauléako II, Tanoé Forest and Transua). Forest groves and community forests are small forested areas. Forest groves are protected by local traditional taboos, and community forests are informally protected by the local community. However, both lack any legal protection. In contrast forest reserves are, at least on paper, legally protected by the government. Irrespective of their protection status, in our study we called all surveyed forests and sites reserves.

Biogeographically the Guinean zone of Côte d'Ivoire can be separated into 2 or 3 regions, with the Sassandra and Bandama Rivers as barriers (fig. 1). Five of our survey sites belong to the western region (west of Sassandra River) and 18 to the eastern region (east of Sassandra River).

The eastern region can be further divided into the interfluvial or central region (7 sites between the Sassandra and Bandama Rivers) and the east of the Bandama River region (11 sites). For most diurnal primate taxa, respective sister taxa are found in the western and eastern regions. Only 2 taxa occur in both regions: the chimpanzee *(Pan troglodytes verus)* and olive colobus *(Procolobus verus)*.

Data Collection

We conducted our surveys between 2000 and 2008 and collected data on the presence and absence of diurnal primate taxa. Two types of data collection were performed: (1) foot surveys in the forests to gather direct evidence of species presence and (2) interviews with hunters or poachers, local people and officials. For each survey, we formed 2–3 teams each composed of a researcher and a local guide recruited among former hunters or biomonitoring agents (table 1).

Foot Surveys

Given the relatively large number of sites selected for our surveys, and the fact that we had to examine multiple locations at most sites, we could not afford investing time and effort in cutting new paths through the forests. Instead, we generally used old logging roads or existing paths created either by hunters or for biomonitoring purposes (table 1).

During the surveys we walked slowly and quietly at about 1 km/h for an average of 9 h/day. We spent 3–28 days in each of the forests, with an average survey time of 8 days. We walked the paths back and forth, noted any visible or acoustic sign of the presence of primates and determined their position with a global positioning system. We began early in the morning at 6.30 h and continued until 12.00 h; after a 2-hour rest we proceeded with the survey until 17.30 h. Once an individual monkey or a group of monkeys was detected, we stayed with it and observed it as long as possible with binoculars [for details, see Gonedelé Bi et al., 2008, 2010]. We used Kingdon [1997] for the identification of species and subspecies and followed the taxonomy of Grubb et al. [2003].

Interviews

Interviews were conducted with local, government-employed forestry staff members, villagers and hunters and old, 'retired' hunters, if necessary with the aid of a local translator. Interviews consisted of questioning people regarding their knowledge about primate species. They were asked to give an exact description of the species and mimic their calls. Afterwards photographs and/or drawings were shown to them to confirm taxon recognition. Information on the presence of a taxon was accepted when there was concordance between local name, description, call of species given by the interviewee and the subsequent picture identification.

We also asked the local people about primate species formerly occurring in the region gathering information about past and present presence of primates in the reserves and in neighbouring forest fragments. Restaurants in villages neighbouring the respective forests were visited to gather information on the primate species that were offered as bush meat.

Classification

A taxon was classified as present at a certain site if identification occurred during forest surveys, or if we found it on sale as bush meat in nearby villages. Information from interviews was highly diverse with respect to reliability. In particular, reports from hunters were often not confirmed by our subsequent surveys. A taxon was therefore classified as 'possibly' present if it was mentioned as present only in interviews. Since we noted just presence-absence of primates in most cases, our survey method did not allow for estimates of population densities.

From published data we extracted the number of primate species and the species assemblage which could be expected for the respective reserves. As data sources we used distribution information from Booth [1956], Dorst and Dandelot [1972], Tahiri-Zagrët [1976], Lernould [1988], Kingdon [1997], McGraw [1998], McGraw et al. [1998], McGraw [2005], Oates et al. [2000] and Oates [2011]. We then compared the presence or absence of respective taxa as found in our surveys with their expected presence based on historical distribution data and calculated an estimated percentage of taxa lost for each site based on the ratio of the number of taxa absent by

Table 1. Presence (P) and absence (A) of expected primate taxa in reserves of Côte d'Ivoire (taxonomy according to Grubb et al. [2003] with the exception of Dollman's colobus)

Taxon	Taï NP	Kabéoula CF	Gouléako II CF	Djidoubaye CF	Monogaga FR	Guelitapia FG	Marahoué NP	Niégré FR	Bolo Ouest FR	Dassioko FR	Port Gauthier FR	Azagny FR	Banco NP
Region	W	W	W	W	W	E i.f.	E i.f.	E i.f.	E i.f.	E i.f.	E i.f.	E i.f.	E
Size, km²	4,550	0.2	0.08	0.12	396.6	0.04	1,010	973	77	79.8	25	194	30
Survey paths	T	HP	HP	HP	HP OP	OR	BR HP	BR HP OP	HP	BR HP	BR HP	BR HP	BR HP
Size of team	2	2	2	2	2	1	3	2	1	3	2	2	2
Number of interviews	15	5	4	6	17	4	13	16	14	15	10	16	8
Survey period	12.–27.11.2000	11.–13.3.2006 2.–3.6.2007	14.–15.3.2006 5.–6.6.2007	17.–21.3.2006 8.–10.6.2007	18.4.–4.5.2004 6.–20.1.2008	10.–12.12.2000 12.–14.5.2007	15.–31.12.2003 3.–19.6.2007	2.–18.4.2004 12.–24.2.2006	5.–19.5.2004	27.7.–2.8.2004 11.–22.2.2007	22.–30.7.2005 24.–30.1.2008	21.5.–24.6.2004 8.–20.2.2008	15.–27.4.2003 25.2.–6.3.2008
Cercopithecus p. buettikoferi	P	PP	PP	AA	PP								
Cercopithecus c. campbelli	P	PP	PP	AA	PP								
Cercopithecus d. diana	P	AA	AA	AA	AA								
Cercopithecus n. martini	P	AA	AA	AA	AA								
Cercocebus a. atys	P	AA	AA	AA	PP								
Procolobus b. badius	P	AA	PP	AA	AA								
Colobus polykomos	P	AA	AA	AA	AA								
Cercopithecus p. petaurista						PP	PP	PP	P	PP	PP	PP	PP
Cercopithecus c. lowei						PP	PP	PP	P	PP	PP	PP	PP
Cercopithecus d. roloway						AA	AA	AA	A	AA	AA	AA	AA
Cercocebus a. lunulatus						AA	AA	AA	A	PP	AA	AA	AA
Procolobus b. waldroni						AA	AA	AA	A	AA	AA	AA	AA
Dollman's colobus						AA	AA	AA	P	AA	AA	AA	
Colobus vellerosus													AA
Procolobus verus	P	PP	PP	AA	PP	PP	PP	PP	P	PP	PP	PP	PP
Pan t. verus	P	AA	AA	AA	PP	AA	PP	PP	P	PP	AA	PP	PP
Cercopithecus sabaeus							PP				PP		
Papio anubis							PP						
Observed/expected per site	9/9	3/9	4/9	0/9	5/9	3/8	6/10	4/8	5/8	5/8	3/8 (+1)	4/8	4/8
Taxa lost per site, %	0	66.7	55.6	100	44.4	62.5	40	50	37.5	37.5	62.5 (50)	50	50

Table 1 (continued)

Taxon	Soko FG	Tabagne FG	Dinaoudi FG	Transua CF	Bossématié FR	Mabi FR	Yaya FR	N'Gadan-N'Gadan FR	Ile Ehotilé NP	Tanoé CF	Observed/expected per taxon	Sites per taxon %
Region	E	E	E	E	E	E	E	E	E	E		
Size, km^2	0.2	0.8	0.04	0.3	220	598	241	20	5.5	120		
Survey paths	OP	OP	OP	OP HP	BR HP OL	BR HP OL	BR HP OL	HP	BR HP	HP OL		
Size of team	1	1	1	2	3	3	3	2	3	3		
Number of interviews	7	8	6	10	15	14	16	10	12	13		
Survey period	21.–27.12.2000 12.–15.6.2003	5.–10.2.2001 18.–25.6.2003	28.–30.12.2000 27.–30.6.2003	18.–25.3.2008	6.–12.8.2004 2.–8.11.2008	18.8.2004 10.–15.11.2008	15.–18.8.2004 12.–20.11.2008	2.–5.3.2006	5.–20.7.2003 16.–22.10.2004	22.–28.2.2006 15.2.–12.3.2008		
Cercopithecus p. buettikoferi											4/5	80.0
Cercopithecus c. campbelli											4/5	80.0
Cercopithecus d. diana											1/5	20.0
Cercopithecus n. martini											1/5	20.0
Cercocebus a. atys											2/5	40.0
Procolobus b. badius											2/5	40.0
Colobus polykomos											1/5	20.0
Cercopithecus p. petaurista	PP	PP	AA	P	PP	PP	PP	P	PP	PP	17/18	94.4
Cercopithecus c. lowei	PP	PP	AA	P	PP	PP	PP	P	PP	PP	17/18	94.4
Cercopithecus d. roloway	AA	AA	AA	A	AA	AA	AA	A	AA	PP	1/18	5.6
Cercocebus a. lunulatus	AA	AA	AA	A	AA	AA	AA	A	AA	PP	2/18	11.1
Procolobus b. waldroni	AA	AA	AA	A	AA	AA	AA	A	AA	A?	0/18	0
Colobus p. dollmani											1/7	14.3
Colobus vellerosus	PA	AA	PP	A	AA	AA	AA	A	AA	PP	3/11	27.3
Procolobus verus	PP	PP	PP	P	PP	PP	PP	P	PP	PP	22/23	95.7
Pan t. verus	AA	AA	AA	A	PP	PP	PP	A	AA	AA	11/23	47.8
Cercopithecus a. sabaeus	PP							A	PP		4/5	80.0
Papio anubis											1/1	100
Observed/expected per site	4/9	3/8	2/8	3/8	4/8	4/8	4/8	3/8	4/8 (+1)	6/8		48.4 ± 19.9
Taxa lost per site, %	55.6	62.5	75.0	62.5	50	50	50	62.5	50 (37.5)	25		

W = Western region (west of Sassandra River), E i.f. = eastern region, interfluvial between Sassandra and Bandama Rivers; E = eastern region (east of Bandama River); ? = only indirect evidence; NP = national park; FR = forest reserve; FG = forest grove; CF = community forest; T = transect; HP = hunters' paths; OL = old logging road; OP = old paths; BR = biomonitoring road; size of team = number of observers; P = taxon was present; A = taxon was absent for respective survey period, e.g. PP = present in both survey periods and PA = present in first survey period, absent in second.

the number of taxa expected to be present. For the whole survey area we expected the following 18 diurnal taxa to occur: *Cercopithecus nictitans martini*, *Cercopithecus petaurista petaurista*, *Cercopithecus petaurista buettikoferi*, *Cercopithecus diana diana*, *Cercopithecus d. roloway*, *Cercopithecus campbelli campbelli*, *Cercopithecus campbelli lowei*, *Cercopithecus aethiops sabaeus*, *Cercocebus atys atys*, *Cercocebus a. lunulatus*, *Papio anubis*, *Procolobus verus*, *Procolobus badius badius*, *Procolobus b. waldroni*, *Colobus polykomos*, *Colobus vellerosus* and *Pan t. verus*.

As an additional taxon we included Dollman's black-and-white colobus to our data set. This is a variety of black-and-white colobus occurring in a narrow zone between the Sassandra and the Bandama Rivers [Gonedelé Bi et al., 2006]. Its taxonomic status is debated as it most likely represents a hybrid form between *C. polykomos* and *C. vellerosus* [Groves, 2001; Grubb et al., 2003; Oates and McGraw, 2009].

Results

In total we surveyed 23 reserves and interviewed 42 government-employed forestry staff members, 92 villagers and 120 hunters. In total, we found evidence for the presence of all 18 expected catarrhine taxa in one or the other reserve (table 1). Based on their biogeographical position and on published data, we expected 8–10 taxa (8.3 ± 0.6, mean ± SD) for individual reserves. However, we found only 4.1 ± 1.8 taxa on average per reserve. Our data suggest that 21 of the 23 (91.3%) reserves have lost at least some of their catarrhine taxa (with loss across different reserves ranging from 25 to 100%; table 1). The only exception was the Taï National Park (9 of 9 taxa present). No primate taxon of southern Côte d'Ivoire is still present in all the reserves where it once occurred.

Individual Taxa

The presence of *Procolobus b. waldroni* was reported by hunters in 4 reserves out of 9 where it occurred historically (4/9). However, we did not find any indication of its presence in 3 out of the 4 reserves. In the Tanoé Forest, the reserve where McGraw [2005] found some indirect evidence for its presence, we never saw a red colobus. In 2006 we only found a skin of this taxon in one of the villages adjacent to the Tanoé Forest, and in 2008 we once heard a call similar to that of a red colobus but we were not able to confirm the species. We therefore classified the species as absent in all 4 forests where it once occurred. The presence of *Cercocebus a. lunulatus* was reported by hunters in almost all reserves (15/18) within its historical range, but we were able to confirm its presence in only 2 localities. *Cercopithecus d. roloway* was reported by hunters from only 6 reserves (6/18), but again, we could confirm its presence only for the Tanoé Forest. Within the reserve several groups comprising 6–22 individuals were found during 22 survey days. Dollman's black-and-white colobus was reported by the local people and hunters in all 4 reserves within their historical range (4/4). However, its presence could only be confirmed in 1 locality (Bolo Ouest Forest Reserve; 1/4) [Gonedelé Bi et al., 2006]. Geoffroy's black-and-white colobus *(C. vellerosus)* was reported by local people and hunters in several reserves, but reports could be confirmed for only 3 sites (3/12; Soko, Dinaoudi and Tanoé Forest [Gonedelé Bi et al., 2008; Gonedelé Bi et al., 2010]). We found Diana monkeys *(Cercopithecus d. diana)*, Stampfli's putty-nosed monkeys *(Cercopithecus n. martini)* and King colobus *(Colobus polykomos)* only in the Taï National Park, i.e. in 1 of the 5 expected sites (1/5). Additionally, 2 other taxa, Upper Guinea red colobus *(Procolobus b. badius)*

and sooty mangabeys (*Cercocebus a. atys*) were found in only 2 of 5 forests where they were expected (2/5). *Pan t. verus* was present in 11 of 23 reserves where it was expected (11/23). In contrast to the rarity of the above taxa, 5 taxa were frequently found in the reserves: Campbell's and Lowe's monkeys (*Cercopithecus c. campbelli, Cercopithecus c. lowei*), eastern and western lesser spot-nosed monkeys *(Cercopithecus p. petaurista* and *Cercopithecus p. buettikoferi)* and *Procolobus verus*. We encountered them in almost all of the visited reserves (21/23, 22/23 and 22/23, respectively), and they were also reported by local people to be present in adjacent forests.

The 2 remaining taxa, *Papio anubis* and *Cercopithecus a. sabaeus*, represent primates of the savannah zone. They were expected to occur in only 1 or 2 reserves, which are located at the border between the savannah and forest zones. *Papio anubis* was indeed only found in the Marahoué National Park and *Cercopithecus a. sabaeus* in Marahoué National Park and in Soko Forest Grove. However, we also could confirm *Cercopithecus a. sabaeus* in 2 reserves at the coast where they were not expected [Gonedelé Bi et al., 2009].

Of the defined taxa in both the western and eastern regions, it is the smaller-bodied taxa (body mass <7 kg) that still occur in most of the reserves within their expected ranges (80–94.4% of the reserves, respectively, for *Cercopithecus p. buettikoferi* and *C. c. campbelli* in the west and *C. p. petaurista* and *C. c. lowei* in the east). The situation for the larger monkeys (body mass >7 kg) appears particularly dire in both regions.

Discussion

Of the 18 diurnal primate taxa that were expected to occur in the region, we were able to confirm the presence of 17. The existence of *Procolobus b. waldroni* remains questionable. Of the 17 taxa, 12 have been locally extirpated from more than 52% of the surveyed forests. Exceptions are Campbell's and Lowe's monkeys, eastern and western lesser spot-nosed monkeys and olive colobus, which are still widespread.

There are only 2 reserves that still harbour more than 70% of their expected taxa, the Taï National Park in the western realm and the Tanoé Community Forest in the east. These reserves actually constitute the most important refuge for primates within Côte d'Ivoire, in particular since most of the primate taxa represent sister taxa of different biogeographical regions and thus different evolutionary units. All other reserves have most likely already lost between 38 and 100% of their primate taxa. Most of the eastern reserves are small and have been neglected in terms of monitoring. Recently, these reserves have received growing interest particularly in response to the threats that their primates are facing. A survey by Conservation des Espèces et Populations Animales and Recherche et Action pour la Conservation des Primates de Côte d'Ivoire is presently being conducted in this part of the country to determine the conservation status of 3 highly endangered species in the region.

Reasons why the Taï National Park has not lost its primate taxa to the same degree as other forests are possibly its size and the permanent presence of researchers in certain parts of the forest, which might discourage hunters to enter that particular area. However, in other parts of the Taï National Park, where no researchers are present, the situation for the survival of primates might be as bad as in other reserves [Refisch and Koné, 2005]. For Tanoé Community Forest, the reason might be that

the forest is naturally inundated for most of the year, which makes its access difficult and impracticable [Gonedelé Bi et al., 2008].

Data Reliability

Due to our long experience in primate monitoring in Côte d'Ivoire's forests, the data on the presence of certain taxa are highly reliable. But confirmation of absence of certain taxa is more difficult to achieve [McArdle, 1990; Solow, 1993; Hirzel et al., 2002; Rivadeneira et al., 2009]. In fact, monkeys become cryptic in areas where they suffer severe hunting pressure, which affects detection probability [Bshary, 2001; Refisch and Koné, 2005]. Therefore, our 'absence' data may have a lower quality than our 'presence' data. Furthermore, although reports from hunters have been widely accepted in surveys in West Africa [Oates et al., 2000; McGraw, 2005], in our study some reports of hunters on primate presence were vague or relied on experiences several years ago.

Reasons for the Decline of Primate Populations

We can only speculate about the causes for the decline of primate populations in Côte d'Ivoire, but in general they are most likely the same as in many other African primate range countries: fragmentation, conversion and degradation of forests and large-scale bush meat hunting [Cowlishaw and Dunbar, 2000; Cowlishaw et al., 2009; Oates 2011]. Reserves become isolated islands in a sea of human transformed habitats, and some of the surveyed reserves are already too small to sustain viable primate populations. However, even the larger reserves are not protected against human encroachment with all its negative effects for the forests and the primates.

In the beginning of the 1980s, FAO-UNEP [1981] estimated that the forest cover in Côte d'Ivoire declined from 132,000 km^2 of the total moist forest zone area to 42,000 km^2. Relying on National Oceanic and Atmospheric Administration satellite images from the end of the 1980s, Päivinen et al. [1992] estimated that, at that time, forest cover was only 27,000 km^2. Also Chatelain et al. [1996] reported that 79% of unprotected forests were eliminated on their 10,000 km^2 study area in the period from 1975 to 1995. The remaining forest is now composed of protected areas which are continuously in decline [Dibi N'da et al., 2008]. In the absence of control or effective application of legislation, different parts of these forests are now replaced by plantations. This situation is particularly detrimental to the majority of the primate populations of the region, which stricly depend on forest cover.

The lack of efficient protection of the remaining forests exposes them to all sorts of illegal activities including hunting, which constitutes an important threat to the primates and other animals. Althought hunting is prohibited throughout the country, it is commonly practised [Caspary and Mono, 1998]. A widespread market for bush meat has developed in the informal sector and represents an important component of household economies [Refisch and Koné, 2005]. Hunting in Côte d'Ivoire's protected areas has contributed to the large-scale defaunification of most of these forests. Reserves such as Niégré, Monogaga, Dassiéko, Bossématié and Azagny have been made accessible by a network of paths built and used by poachers. Studies in other tropical forest regions have shown that bush meat hunting affects large-bodied primate species more than smaller species [Peres, 1990]. A similar effect can be assumed for Côte d'Ivoire where we found that forests lost more of the larger taxa (body mass >7 kg).

Table 2. Proposed conservation status of the primates of Côte d'Ivoire based on the IUCN Red List threat categories [IUCN, 2011]

Species	Status IUCN 2011	Proposed status national level
Critically endangered		
Procolobus badius waldroni	CR A2cd	CR A2acd
Endangered		
Cercopithecus diana roloway	EN A2cd	CR A2acd + B1ab
Pan troglodytes verus	EN A4cd	EN A4acd
Procolobus badius badius	EN A2cd	EN A2acd
Cercocebus atys lunulatus	EN A2cd	CR A2acd
Vulnerable		
Cercopithecus nictitans martini	VU A2cd	EN A2acd
Cercopithecus diana diana	VU A2cd	EN A1acd
Colobus polykomos	VU A2cd	EN A2acd
Colobus vellerosus	VU A2cd	CR A2acd
Low risk		
Procolobus verus	NT	NT
Cercopithecus petaurista buettikoferi	LC	LC
Cercopithecus petaurista petaurista	LC	LC
Cercopithecus campbelli campbelli	LC	LC
Cercopithecus campbelli lowei	LC	LC
Cercocebus atys atys	NT	VU A1acd
Not listed		
Dollman's colobus	not listed	CR A1acd
Not assessed in our study		
Perodicticus potto potto	LC	DD
Galago senegalensis senegalensis	LC	DD
Galagoides demidoff	LC	DD
Galagoides thomasi	LC	DD
Cercopithecus aethiops sabaeus	LC	
Papio anubis	LC	
Erythrocebus patas	LC	

All the abbreviations used in the table refer to the definition of the IUCN [IUCN, 2001].

National Classification of Ivorian Primates according to IUCN Threat Categories

According to the IUCN Red List of 2011 [IUCN, 2011], one of the taxa in the region is classified as 'critically endangered' *(Procolobus b. waldroni),* 4 are classified as 'endangered' *(Cercopithecus roloway, Cercocebus a. lunulatus, Procolobus b. badius, Pan t. verus),* 4 are classified as 'vulnerable' *(Cercopithecus n. martini, Cercopithecus d. diana, Colobus polykomos, Colobus vellerosus)* and the remaining 12 taxa are at 'low risk' or not listed (table 2). This list represents the status of these taxa at a global level and cannot be applied at the Côte d'Ivoire level with regard to the threats that they are facing in this country. Hence, on a national level we proposed that 5 of the primate taxa are 'critically endangered' *(Procolobus b. waldroni, Cercocebus a.*

lunulatus, Cercopithecus d. roloway, Colobus vellerosus, 'Dollman's colobus') and 5 other are 'endangered' (*Colobus polykomos, Pan t. verus, Procolobus b. badius, Cercopithecus d. diana, Cercopithecus n. martini;* table 2). The 5 critically endangered taxa underwent an observed, estimated, inferred or suspected population size reduction by ≥80%, and a decline in their extent of occurrence and their area of occupancy over the last 10 years. All of these taxa have been locally extirpated in 80–95% of the reserves where they were reported a decade ago. For the remaining forests where they actually occurred, their population size seems to have sharply declined so that their viability remains questionable.

The 5 endangered taxa were found to be locally extinct in 52–80% of the surveyed forests where they were previously reported to occur in their occurrence range in the last decade. Based on this evidence, it is obvious that the observed or suspected population sizes of these taxa have been reduced by ≥50% over the last 10 years and their extent of occurrence and area of occupancy has declined. The Taï National Park is the only forest where a viable population of these taxa actually occurs.

The remaining diurnal taxa are listed as of 'least concern'. However, with the reduction of the forest cover, the fragmentation of forest habitat and the intensive hunting pressure on these taxa, it is most likely that they must be listed 'near threatened'.

Conclusion

The rapid decline of Côte d'Ivoire's forests coupled with extensive hunting has had a negative impact on the survival of Côte d'Ivoire's fauna, including primates. The forest cover is now restricted to protected areas and very few fragmented community forests, both of which are facing great human pressure in the form of agriculture and hunting. The conservation status of most of the primates has severely declined, due to a loss and severe fragmentation of the forest habitat and the extreme reduction in population size within the last few years. Urgent conservation actions for wildlife, and particularly for primates, need to be undertaken in each of the three biogeographic regions of Côte d'Ivoire to avoid the ultimate loss of biodiversity.

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