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Communication

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PLATINUM OPEN ACCESS

The diversity and conservation of mammals in the Dodo Coastal Forest in southwestern Côte d'Ivoire, western Africa: a preliminary study

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Abstract: To improve the knowledge of non-volant mammal diversity and conservation prospects in the Dodo Coastal Forest (DCF) in southwestern Côte d'Ivoire, we conducted reconnaissance surveys and interviews, and deployed remote cameras. We calculated visual encounter rates (vER) and sign ER (sER) of mammalian taxa and hunting signs, mapped their locations and tested the hypothesis that sightings and signs of primates occurred closer to the river Dodo in and near the gallery forest. We sighted nine taxa, including threatened King Colobus (Endangered, EN), Olive Colobus (Vulnerable, VU), Lowe's Monkey (VU), the Eastern Lesser Spot-nosed Monkey (VU), and White-bellied Pangolin (VU), with vER of 0.04, 0.12, 0.04, 0.12, 0.04, respectively. We confirmed 14 other taxa with signs including threatened Western Chimpanzee (CR), Pygmy Hippopotamus (Endangered, EN), Bosman's Potto (VU), and Black-bellied Pangolin (VU), with sER of 0.51, 0.04, 0.08, 0.04, respectively. The most frequently encountered signs were of the Red River Hog at 1.73 signs/km, and the Bushbuck at 0.63 signs/km. Remote cameras captured images of these two taxa at image capture rates (ICR) of 0.044 and 0.022, respectively. Images of the African Buffalo were captured at ICR of 0.044. The 23 confirmed taxa include seven primates, four rodents, three carnivores, six even-toed ungulates, two pangolins and a Tree Hyrax. The mean distance from the river Dodo to the sightings and the signs of the primates was significantly shorter than that of other taxa. This supports our hypothesis. There was a high level of hunting signs (sER = 0.63) indicating that intensive hunting pressure is menacing the fauna. We recommend that authorities take actions against poaching, install a surveillance program, and curtail charcoal-making to ensure the conservation of the threatened mammals of the DCF.

Keywords: Chimpanzee, encounter rates, gallery forest, King Colobus, river Dodo.

Abbreviations: CF - Classified Forest | CR - Critically Endangered | D - Total distance covered | *d* - distance from the River Dodo to observations (sightings and signs of animals) | DCF - Dodo Coastal Forest | EN - Endangered | FM - Fecal matter | FO - Food remains | FP - Footprints | GPS - Global Positioning System | ICR - Image Capture Rates | IUCN - International Union for Conservation of Nature | N - Frequency of each taxon | NHP - Non-human primates | NPM - Non-primate mammals | NT - Near Threatened | RAI - Relative Abundance Index | RS - Resting Site | sER - sign encounter rates | vER - visual encounter rates | VOC - Vocalization | VU - Vulnerable.

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INTRODUCTION

The forests in Côte d'Ivoire represent the core of the Upper Guinean Forest of western Africa (Bakkar et al. 2004), and they have been experiencing continuous degradation and fragmentation. Between 1981 and 1990, the deforestation rate in Côte d'Ivoire was about 7.6% per year (850km^2/yr), the highest among tropical countries. By 1990 this country had lost about 92.5% of the original 1,50,000km^2 of dense forest, which now consists of about 6.9% of the total area of the country (Chatelain et al. 2004; CILSS 2016). Land conversion is particularly uncontrolled in rural areas, where landowners carry out large-scale conversion of forests into farmlands and plantations, and also sell land for logging and mining purposes. In such a context, the survival of wildlife is greatly threatened (McNeely 2003; Bakayoko et al. 2004; McGraw 2005; Kassé et al. 2006; Wright et al. 2006; Yaokokoré-Beibro et al. 2010; Adou et al. 2011), and anthropogenic activities can lead to extirpation of animal species. It is also clear that hunting poses a great threat to taxa that can survive in disturbed habitats (Matsuda Goodwin et al. 2017a).

Protected areas have played a significant role in the conservation of threatened wildlife and continue to play an important role, however, because a number of threatened species have been locally extirpated from many protected areas, community forests that receive no official protection are increasingly important for wildlife conservation (Porter-Bolland et al. 2012; Butchart et al. 2015; Matsuda Goodwin et al. 2017a). Also, the efficacy of protected areas as conservation sites has been questioned due to the sociological and ecological pressure on these areas during two episodes of civil war experienced by the country (UICN/BRAO 2008; Daskin & Pringle 2018). Thus, improving our knowledge of the faunal diversity outside protected areas has become important, and this knowledge is crucial to understanding the ecosystem services that animals offer (Ahumada et al. 2011; Torres-Porras et al. 2017). Such information is necessary to make sound management decisions to plan conservation programs and determine what types of focused conservation actions should be taken.

Like other unprotected forests in Côte d'Ivoire, the coastal forest at the mouth of the river Dodo, the DCF, has undergone unprecedented changes in land use during the last decade or so (CILSS 2016). Formerly intact dense rainforests have been cleared and fragmented to create farms and plantations for oil palm, rubber, cocoa, coffee, and coconut and the production of charcoal. These anthropogenic activities such as hunting, pet trade, habitat destruction, and habitat degradation threaten faunal diversity (Schipper et al. 2008). The loss of some fauna can cause an irreversible trophic cascade that tips over the ecosystem balance (Estes et al. 2011).

With the exception of studies of marine turtles (Bamba 2002; Peñate 2007), which found at least three species, the faunal diversity of the DCF remains unknown. This preliminary study aims at improving knowledge of the diversity of non-volant mammals, their relative abundance, and spatial distribution in the unprotected coastal forest at the southwestern edge of Côte d'Ivoire. The gallery forest is often the only persisting forest when the surrounding habitat is severely disturbed, and it is an especially important habitat for primates (Galat-Luong & Galat 2005; Granier & Awotwe-Pratt 2007). Thus, we will test the hypothesis that more primates and their signs will be found near the river compared to other mammals. The implications of this study for conservation efforts are also considered.

MATERIALS AND METHODS

Study site

Our study site was the DCF, which lies between 4.500^{0}N–7.183^{0}W and 4.600^{0}N–7.050^{0}W with an area of 4.694ha. It is located at the mouth of the river Dodo at the southwestern edge of Côte d'Ivoire (Fig. 1). The nearest large city, Grand-Béréby, is 18km east of the DCF. The annual rainfall varies from 1700–1900 mm and the mean annual temperature is 24–27 °C (Bohoussou et al. 2018). River Dodo is 56km long with its source in the formerly classified forest (CF) of Haute Dodo and empties into the Atlantic Ocean at Mani-Bérébу Village, where it forms the village's sacred wetland forest (Teugels et al. 1988). Villagers perform various ceremonies and trees are somewhat protected, but hunting is allowed. The DCF is one of the few remaining coastal community forests in this region, but it receives no official protection. The forest is limited to the south by the sea and is characterized by the heterogeneity of the habitat. It includes the fallow, rain forest, mangrove, gallery forest, savanna, and coastal thicket that create different ecological niches exploited by a variety of fauna (Teugels et al. 1988). The village is mainly composed of two ethnic groups: the indigenous Kroumen group and the migrants. Both groups practice subsistence farming, hunting, and artisanal fishing.

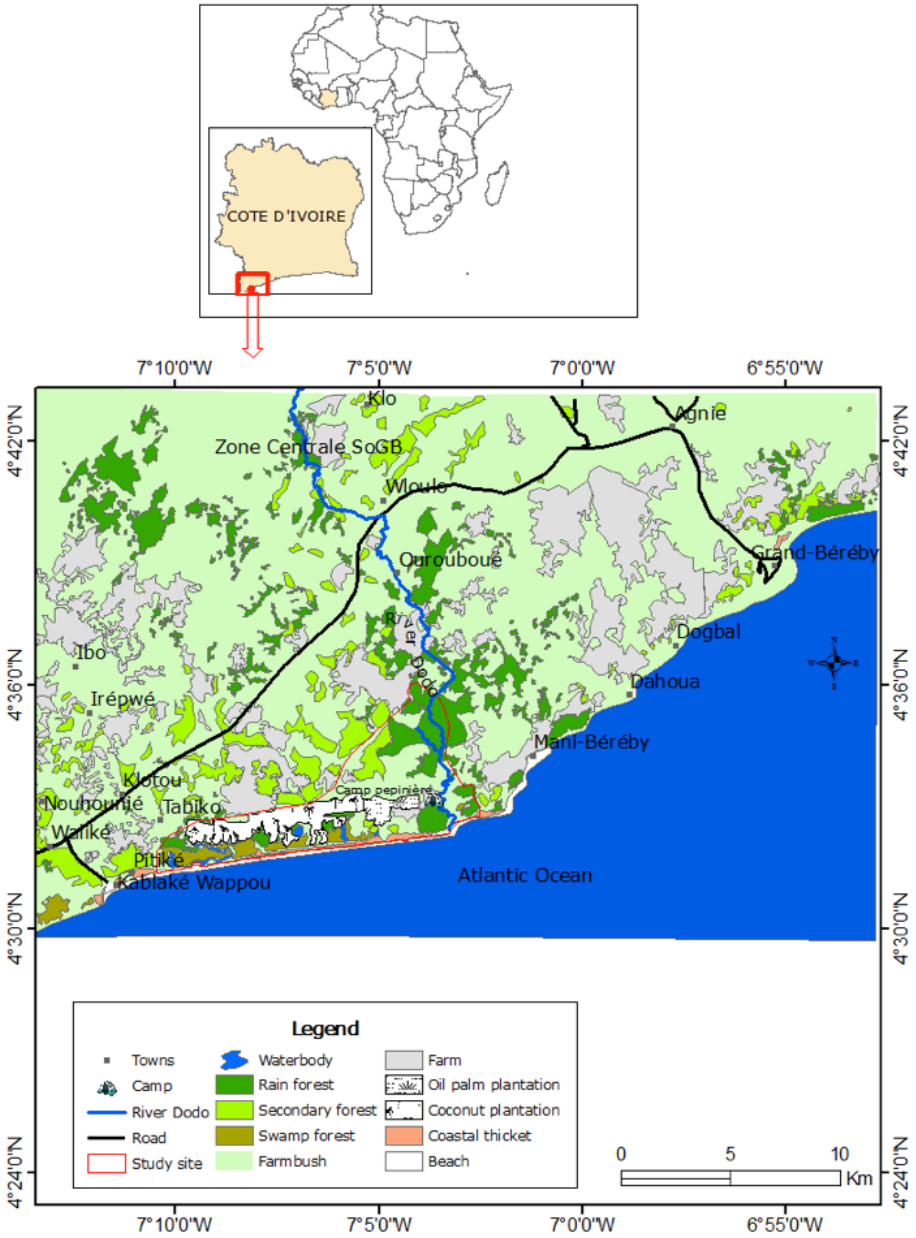

Figure 1. Dodo Coastal Forest (DCF) in southwestern Côte d'Ivoire.

Data collection

We conducted 25.42km of reconnaissance (recce) surveys from 06.00–11.30 h and 15.30–17:00 h between 15 April 2018 and 30 May 2018 (28 days total). We did not use the line transect sampling method, because it requires at least 60 sightings of each taxon for a reliable abundance estimate (Buckland et al. 2001). Recce surveys consisted of walking at a given compass bearing which was in a direction more or less perpendicular to river Dodo, but observers walked following a path of least resistance. We reduced bias by trying to cover the entire study area with an equal interval of one kilometer between paths (Kühl et al. 2008). We recorded the taxon, date, time, GPS coordinates, and distance from the recce origin, and the distance from the river. When we observed chimpanzee nests we also recorded the stage of the nest following Kühl et al. (2008). Additionally, we conducted semi-structured interviews to grasp the local knowledge on the diversity of mammals that still occur and have occurred in the past. The interview is an important method that obtains supplementary information to survey and camera trapping methods. This is particularly true when those methods may fail to detect some rare taxa (Béné et al.

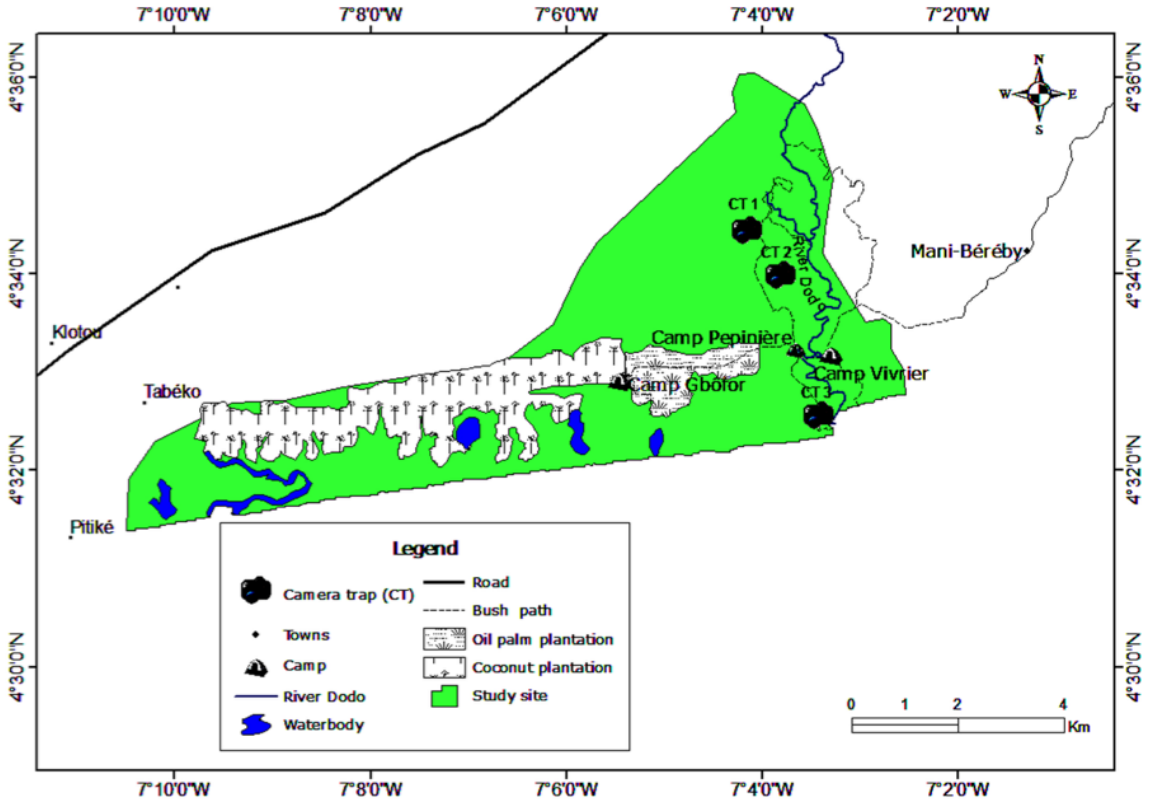

Figure 2. Remote cameras' positions.

2018). We conducted interviews within 2.5km of the study site. The interviewees were asked to give the number and local names of mammalian species that are known to occur in the forest, those observed during the last six months, and wherein the forest they observed them (Matsuda Goodwin et al. 2017b).

Furthermore, we deployed three remote cameras (Bushnell Trophy Cam 119875) at the ground level. More specifically, they were set along the bush paths and under fruiting trees where there was a high probability of capturing images of elusive animals (Cove et al. 2013). The cameras were deployed for 45 days in total (3 cameras x 5 days x 3 locations). To cover different locations in the study site, we moved each camera to other locations at the interval of five days which was defined as a trapping session. The locations of cameras during three trapping sessions are shown in Fig. 2. We compiled the list of mammals that occur at the study site by reviewing the data from the interviews, recce surveys, and remote cameras. Then we verified the most up-to-date conservation status of the confirmed taxa via IUCN Red List version 2018 and also by consulting experts.

Data analysis

To determine relative abundance we calculated encounter rate (ER) of a given taxon using the equation: ER=N/D, where N is the frequency of group sighting or the signs of each taxon while D is the total distance covered during recce walks. We calculated ER for visual sightings (vER) as well as ER for indirect signs (sER) (e.g., vocalization, food remains definitely assignable to certain taxon) of the taxa. Similarly, we also calculated encounter rates of hunting signs (e.g., shotgun cartridge, poacher's camp).

We tabulated presence-absence of taxa from images obtained from remote cameras, and calculated image capture rates (ICR = number of image captured/camera days) for each taxon (Kolowski & Forrester 2017), but we did not obtain the Relative Abundance Index (RAI) as our 45 camera days were fewer than the required 100 (Rovero et al. 2014).

To examine the relationship between the distance from river Dodo to the sightings and signs of the mammalian fauna (*d*) and during the recce surveys, we plotted the geographic coordinates of the sightings and signs using QGIS 2.14 and computed the mean distance of each taxon to the river. Given the importance of

gallery forests to the non-human primates (NHP), we tested the hypothesis that *d* of the NHP is shorter than d for the non-primate mammals (NPM). Because the NPM samples did not have a normal distribution based on the Shapiro-Wilk test for normality, we used the Welch Two Sample t-test (Package MASS) (Ripley et al. 2017) to compare the means of non-primate mammals with the mean of all primates as the difference of *d* for the chimpanzees and other primates was not significant. The significance was tested at a two-tailed level. We then created a graph that contrasts *d* between the two groups using ggplot2. All statistics were done using R Studio version 1.1.453 and R version 3.4.4 (R Core Team 2018).

RESULTS

Diversity and ER of taxa and hunting sign ER obtained by surveys

The result of recce surveys is shown in Table 1. We visually confirmed the presence of nine taxa (four Primates, one Carnivora, one Pholidota, three Rodentia) through recce surveys. Among these we observed five threatened taxa: the King Colobus *Colobus polykomos* (EN) (Gonedelé et al. in press), the Olive Colobus *Procolobus verus* (VU) (Oates et al. in press), Lowe's Monkey *Cercopithecus lowei* (VU) (Wiafe et al. in press), the Eastern Lesser Spot-nosed Monkey *Cercopithecus petaurista petaurista* (VU), and the White-bellied Pangolin *Phataginus tricuspis* (VU) (Waterman et al. 2014a) with vER of 0.04, 0.12, 0.04, 0.12, 0.04, respectively. The Olive Colobus and the Eastern Lesser Spot-nosed Monkey were two of the three most frequently observed taxa in addition to the Common Kusimanse *Crossarchus obscurus* (vER = 0.12), which was the only Carnivora taxon sighted during the surveys. Three rodent taxa have been sighted with vER from 0.24 for the Striped Ground Squirrel *Xerus erythropus* to 0.04 for the Savannah Cane Rat *Thryonomys swinderianus* and the Giant Pouched Rat *Cericetomys gambianus*.

Encounters with indirect signs confirmed the presence of 14 other taxa (three Primates, two Carnivora, one Pholidota, one Hyracoides, one Rodentia, six Artiodactyla). Those taxa included four threatened taxa: the Western Chimpanzee *Pan troglodytes verus* (CR) (Humle et al. 2016), the Pygmy Hippopotamus *Choeropsis liberiensis* (EN) (Ransom et al. 2015), the Bosman's Potto *Perodicticus potto potto* (VU) (Svensson et al. in press), and the Black-bellied Pangolin (VU) (Waterman et al. 2014b) with sER of 0.51, 0.04, 0.08, 0.04, respectively (Table 1). The most frequently encountered signs were those of the Red River Hog at 1.73 sign/km, and the Bushbuck at 0.63 sign/km, respectively. Although the chimpanzee was not sighted, its presence was verified by its arboreal night nests and remains of partially-eaten fruits (their tooth marks are markedly different from other primates). Night nests were the most commonly found signs of the chimpanzee. Eight nests were observed that produced 0.31 nest/km. All the nests were in stage III, which indicates that all the leaves of the nest became dry, but the structure was still intact. Chimpanzee signs were most frequently encountered in the gallery forest along river Dodo (Fig. 3). We found 16 empty shotgun cartridges (0.63 sign/km) in the forest during recce walks. Outside surveys, the chimpanzee vocalization was mostly heard while they were raiding crops in cocoa and banana plantations.

Diversity of mammalian taxa obtained by remote cameras

Remote cameras captured the images of three mammalian taxa: Red River Hog *Potamochoerus porcus*, African Buffalo *Syncerus caffer*, and Bushbuck *Tragelaphus scriptus*, which were detected by indirect signs during surveys. For each species an image of individuals obtained from camera traps is provided: *P. porcus* (Image 1); *S. caffer* (Image 2) and *T. scriptus* (Image 3). The image capture rates (ICR) of these taxa were 0.044 for both *S. caffer* and *P. porcus*, and 0.024 for *T. scriptus* (Table 1).

Interview results

Table 1 also shows the result of interviews. Interviewees indicated that three additional taxa, Sooty Mangabey *Cercocebus atys*, the African Leopard *Panthera pardus pardus*, and the Black Duiker *Cephalophus niger*, although rarely, occurred at the DCF. Neither recce surveys nor remote cameras, however, confirmed their presence. Interviewees stated that they most often hunt animals when they raid the cocoa, coconuts, and other crops in the plantations, farms, and at the beach.

The locations of animal sightings and signs in and near the gallery forest

Thirty seven out of 50 (74.0%) animal sightings and signs occurred at less than one km from river Dodo. In particular, 95.8% of the sightings and signs of the primates occurred within this range (Figss. 3, 4). The mean distance (*d*) from river Dodo to the sighting locations and signs of the chimpanzee was 585.3m (range = 0–3,591.2m, sd = 998.2m) while *d* for other

Table 1. Mammalian taxa and parameters obtained through surveys, interviews, and remote cameras.

Order	Taxon	Common name	Local name (Kroumen)	Interview result	vER (freq./ km)	sER (sign/ km)	Type of signs	ICR	IUCN Red List current status
Primates	*Pan troglodytes verus* (Blumenbach, 1799)	Western Chimpanzee	Wê	Common	0	0.51	FO, nest	-	CR
Primates	*Perodicticus potto potto* (P.L.S. Müller, 1766)	Bosman's Potto	Tonroutchitchê	Common	0	0.08	VOC	-	VU
Primates	*Galagoides demidoff* (G. Fischer, 1806)	Demidoff's Dwarf Galago	Nenomiagnié	Common	0	0.08	VOC	-	LC
Primates	*Cercopithecus lowei* (Thomas, 1923)	Lowe's Monkey	Toiyourrô	Common	0.04	0.24	VOC	-	VU
Primates	*Procolobus verus* (Van Beneden, 1838)	Olive Colobus	Tawahou	Common	0.12	0		-	VU
Primates	*Cercocebus atys* (Audebert, 1797)	Sooty Mangabey	Kéré	Rare	0	0	N/A	-	EN
Primates	*Colobus polykomos* (E.A.W. Zimmermann, 1780)	King Colobus	Blôho	Common	0.04	0	N/A	-	EN
Primates	*Cercopithecus petaurista petaurista* (Schreber, 1774)	Eastern Spot-nosed Monkey	Djibetoua	Common	0.12	0	N/A	-	LC
Carnivora	*Civettictis civetta* (Schreber, 1776)	African Civet	Boué	Common	0	0.12	FM, FP	-	LC
Carnivora	*Crossarchus obscurus* (Cuvier, 1825)	Common Kusimanse	Hanlan	Common	0.12	0.16	FP	-	LC
Carnivora	*Lutra maculicollis* (Lichtenstein, 1835)	Spot-necked Otter	passô	Common	0	0.12	FM, FP	-	NT
Carnivora	*Panthera pardus pardus* (Linnaeus, 1758)	African Leopard	Dji	Rare	0	0	N/A	-	VU
Pholidotes	*Phataginus tetradactyla* (Linnaeus, 1766)	Black-bellied Pangolin	Houê	Rare	0	0.04	FP, RS	-	VU
Pholidotes	*Phataginus tricuspis* (Rafinesque, 1821)	White-bellied Pangolin	Hêbegnant	Common	0.04	0	N/A	-	VU
Hyracoides	*Dendrohyrax dorsalis* (Fraser, 1855)	Tree Hyrax	Wéya	Common	0	0.12	VOC	-	LC
Rodentia	*Atherurus africanus* (Gray, 1842)	Brush-tailed Porcupine	Clo	Common	0	0.12	FM, FP	-	LC
Rodentia	*Cricetomys gambianus* (Waterhouse, 1840)	Giant Pouched Rat	Tahouadou	Common	0.04	0.04	VOC	-	LC
Rodentia	*Thryonomys swinderianus* (Temminck, 1827)	Savannah Cane Rat	Gbian	Common	0.04	0	VOC	-	LC
Rodentia	*Xerus erythropus* (Desmarest, 1817)	Striped Ground Squirrel	Kélétcha	Common	0.24	0.08	VOC, FO	-	LC
Artiodactyla	*Choeropsis liberiensis* (Morton, 1849)	Pygmy Hippopotamus	Nonwê	Rare	0	0.04	RS	-	EN
Artiodactyla	*Tragelaphus scriptus* (Pallas, 1766)	Bushbuck	Lidjonhon	Common	0	0.63	FM, FP	0.022	LC
Artiodactyla	*Philantomba maxwellii* (C.H. Smith, 1827)	Maxwell's Duiker	Kouêlê	Common	0	0.12	FP	-	LC
Artiodactyla	*Cephalophus niger* (Gray, 1846)	Black Duiker	Liro	Common	0	0	N/A	-	LC
Artiodactyla	*Hyemoschus aquaticus* (Ogilby, 1841)	Water Chevrotain	Gnioklê	Common	0	0.04	FP	-	LC
Artiodactyla	*Syncerus caffer nanus* (Sparrman, 1779)	African Buffalo	Toué	Common	0	0.31	FM, FP	0.044	LC
Artiodactyla	*Potamochoerus porcus* (Linnaeus, 1758)	Red River Hog	Bôyou	Common	0	1.73	FM, FP	0.044	LC

Abbreviations: vER - visual encounter rate | sER - sign encounter rate | CR - Critically Endangered | EN - Endangered| VU - Vulnerable | NT - Near Threatened | LC - Least Concern | VOC - Vocalization | FM - fecal matter | FP - footprints | FO - food remains | nest - sleeping nest | RS - Resting site | ICR - Image Capture Rate.

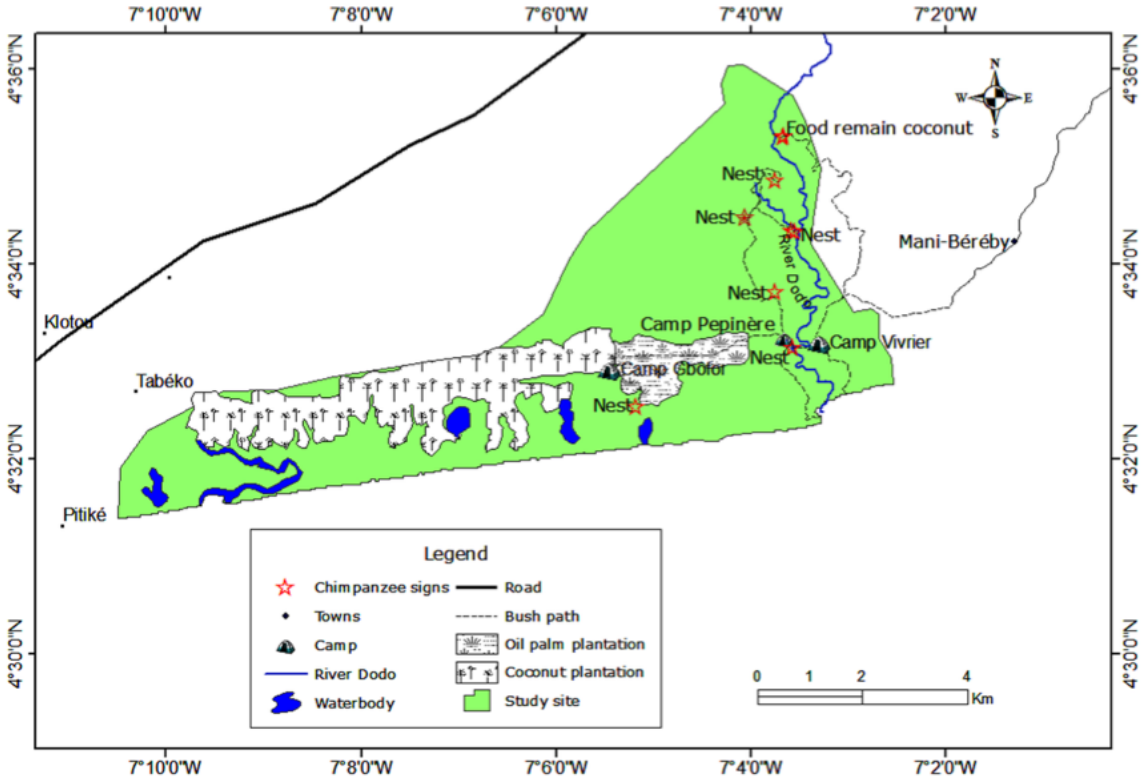

Figure 3. The locations of Chimpanzee signs.

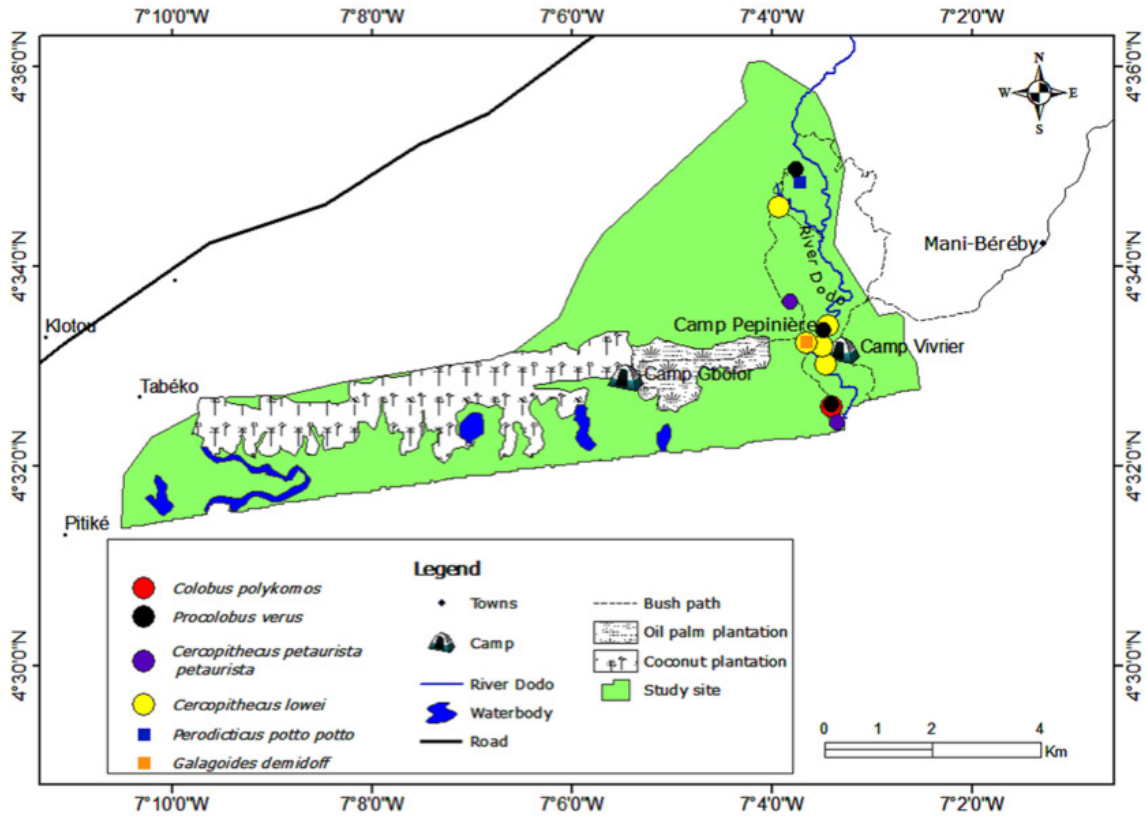

Figure 4. The locations of other primate sightings and their signs.

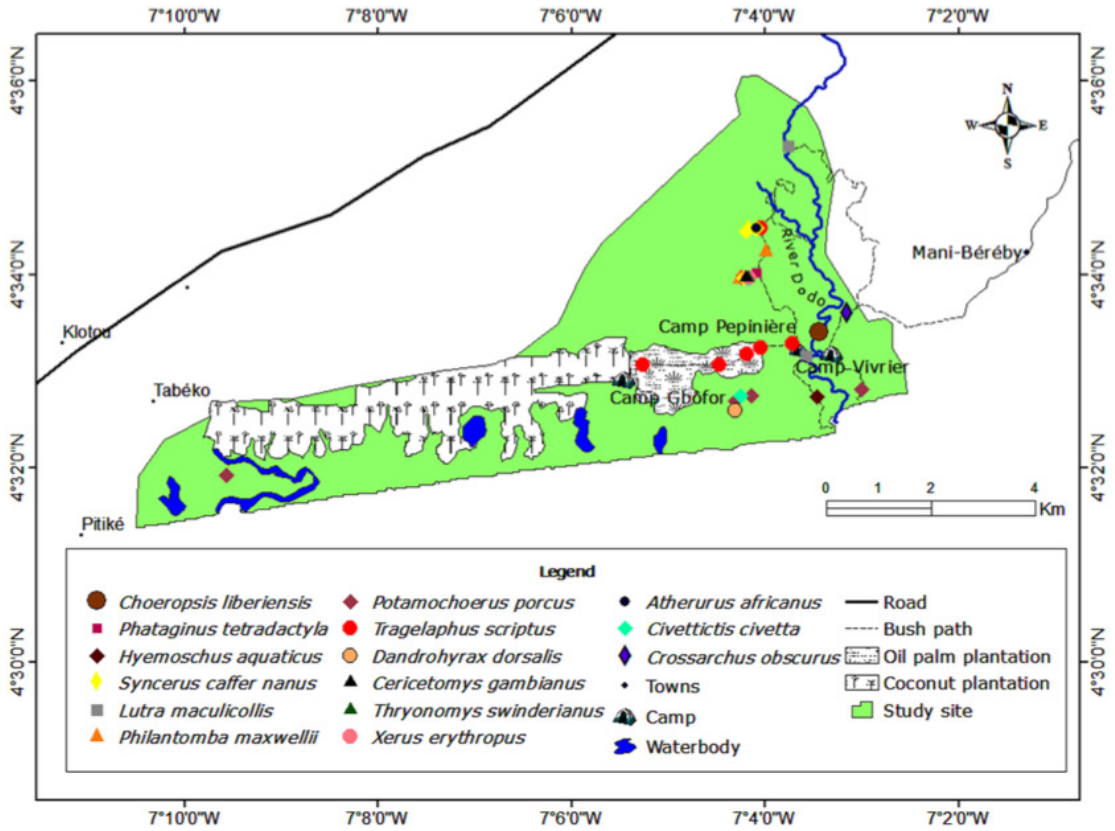

Figure 5. The locations of non-primate mammal sightings and their signs.

primates was 241.3m (range = 0–825.1m, sd = 264.5m), but the difference was not significant (t = -1.154, df = 12.538, p = 0.271) (Fig. 6). In contrast, more than 25.0% of the signs of non-primate mammals (NPM) occurred farther away from the river (Fig. 5). The d for non-human primates (NHP) (d = 413.3m, range = 0–3,591.2m, sd = 735.4) was significantly shorter (t = -2.3233, df = 30.873, p = 0.027) than that of non-primate mammals (NPM) (d = 1,479.1m, range = 0–11,678.1m, sd = 2,210.3m) (Fig. 6). Removing the outliers did not change this outcome (d for other primates = 188.2 m; d for the Chimpanzee = 312.1m; d for NPM = 1,071.1m).

DISCUSSION AND CONCLUSION

Our study at DCF in southwestern Côte d'Ivoire has confirmed the presence of 23 non-volant mammalian taxa including nine threatened taxa. One of them is Critically Endangered, the Western Chimpanzee and two Endangered, and the King Colobus and the Pygmy Hippopotamus.

The confirmed presence of the Western Chimpanzee and the King Colobus testifies to the need for targeted conservation actions at this forest. Indeed, the chimpanzee has become extirpated from a number of protected areas in Côte d'Ivoire. Viable populations of the ape are now restricted to a handful of national parks and reserves (Campbell et al. 2008). Even in these protected areas, the number of nests has recently become extremely low (Kühl et al. 2017). Surprisingly, sER (0.51) of the chimpanzee at the DCF was higher than that observed in the peripheral areas of Taï National Park (sER = 0.30). The high ER of the chimpanzee at DCF may be because the number of chimpanzees has been always high due to the local taboo against hunting the apes. Or it may be that the Leopard, described by Boesch (1991) a primary predator of the chimpanzee, has been extirpated from our study site.

As for *C. polykomos*, the combined effects of hunting and deforestation have led to the local extirpation of this species in many protected areas in Côte d'Ivoire (Gonedelé Bi et al. 2014; Bitty et al. 2015). Even though vER of the King Colobus was low, the presence of this species in the DCF is good news for the species.

Although legally prohibited in Côte d'Ivoire since 1974 (Caspary & Momo 1998), commercial hunting, is a common practice throughout the villages bordering this

Image 1. Individual of the Red River Hog *Potamochoerus porcus* captured by a camera traps at Dodo Coastal Forest.

Image 2. Individuals of the African Buffalo *Syncerus caffer* captured by camera traps at Dodo Coastal Forest.

Image 3. Individual of the Bushbuck *Tragelaphus scriptus* captured by camera traps at Dodo Coastal Forest.

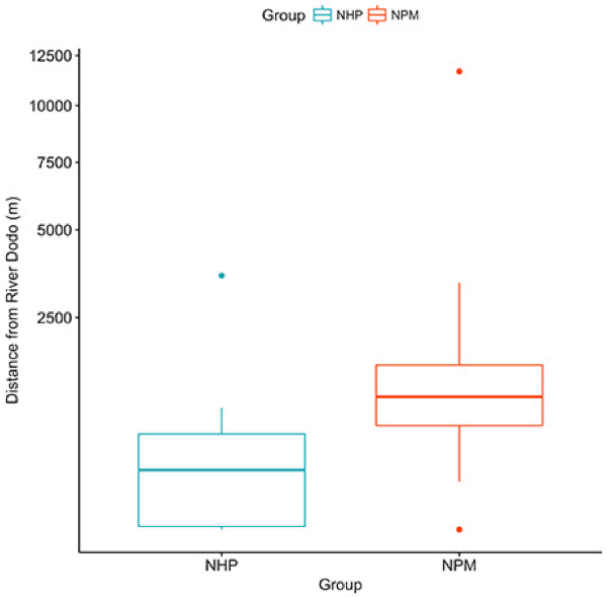

Figure 6. The mean distance (d) from the river Dodo to the sightings and signs of non-human primates (NHP) (d= 413.3, range =0–3591.2m, sd = 735.41) was significantly shorter (t = -2.3233, df = 30.873, p = 0.02692) than that of non-primate mammals (NPM) (d=1479.1m, range = 0–11,678.1m, sd = 2,210.3m). The difference between the chimpanzee sign distance (d=585.3m, range = 0–3591.2m, sd = 998.2m) and that of other primates (d =241.3m, range = 0–825.1m, sd = 264.5m) was not significant (t = -1.154, df = 12.538, p = 0.27).

coastal forest. In the DCF, however, the villagers mostly hunt mammals for their local consumption. Fortunately, commercial bushmeat trade is not a large part of the village economy. Still, we found a high level of hunting signs in the forest. During the surveys, the observed signs of hunting occurred in the gallery forest. Poaching appears to be the most serious threat to all the primates in our study site.

The fact that most sightings and signs of primates occurred in and near the gallery forest indicates the importance of the riverine ecosystem to the primate community. The most common tree species (e.g., *Parinari excelsa* (Chrysobalanaceae); *Sacoglottis gabonensis* (Humiriaceae); *Panda oleosa* (Pandaceae); *Klainedoxa gabonensis* (Irvingiaceae)) and large lianas (e.g., *Saba senegalensis* (Apocynaceae)) found in the gallery forest provide important foods for the primates. In fact, gallery forests are often the last refuges for threatened primates and have the potential to act as corridors (Bermejo 1999; Mbora & Meikle 2004; Gautier-Hion & Brugière 2005; Lees & Peres 2008; Shanee et al. 2013). Protecting, expanding, and improving the health of the gallery forest is one of the best ways to safeguard the threatened primates of DCF.

We found that DCF is also home to the Pygmy Hippopotamus, a locally and globally Endangered species. Given the declining trend of the population size of this species at the rate of 20% over two generations (26 years), and its small total population size (about 4000 individuals), the presence of the species here gives us hope (Mallon et al. 2011, FFI and FDA 2013; Ransom et al. 2015). A study at Gola National Forest and Gola Rainforest National Park in Sierra Leone and Liberia found that the most suitable habitat for this species was in community-owned landscape with a high density of the herbaceous plant, *Triumfetta cordifolia* (Tiliaceae)

rather than in protected areas (Hillers et al. 2017). *T. cordifolia* is relatively abundant in the DCF wetland and since international concern for the Pygmy Hippopotamus has recently increased in the last decade or so (Conway et al. 2015), DCF has potential to attract tourists using the Pygmy Hippopotamus as an umbrella species (and primates). Revenue from tourism can have a significant positive effect if such a program is carefully planned to prevent pathogen transmission and other negative effects (Muehlenbein & Wallis 2014; Wright et al. 2014).

The current threatened status of the two African Pangolin species that occur in the DCF is Vulnerable. In contrast, the Asian pangolins (genus *Manis*) categorized as Critically Endangered and are among the most threatened species (Heinrich et al. 2016). Although we lack quantifiable data from West Africa, an estimate from Central African forests show that 0.4–2.7 million pangolins per annum have been hunted and the number of pangolins hunted has increased by 150% in the last 40 years (Ingram et al. 2018). Similarly, pangolins have become sought-after species in markets in Côte d'Ivoire and elsewhere in West Africa (Boakye et al. 2015; Challender et al. 2015). The pangolins recorded in DCF were extremely difficult to observe. Because population and behavioral-ecology data are lacking for these species, there is a need for a thorough study throughout their distribution ranges (Sodeinde & Adedipe 1994; Ingram et al. 2018).

Although almost all, if not all, mammalian populations that occur in the DCF are negatively influenced by anthropogenic disturbances (farming, hunting, timber extraction, mining, etc.) each taxon appears to have a different level of vulnerabilities to different factors. The Sooty Mangabey, the African Leopard, and the Black Duiker appear to have been extirpated from the DCF, but each of these taxa might have different primary causal factors for their demise (Nzooh et al. 2003). The Sooty Mangabey is a large-bodied semi-terrestrial primate that forages fallen fruits, ranging in a large social group (McGraw et al. 2014). Their noise attracts the attention of hunters and trapping them by wire snares can easily decimate a small population. Thus, this species was probably extirpated primarily due to trapping and hunting. Meanwhile, the Black Duiker is a solitary forager that forages for fallen fruits. This species is larger in body size with a narrower ecological niche, requiring a larger area, than Maxwell's Duiker, which is a generalist forager (Hofmann & Roth 2003). As a result, it is possible that hunting and trapping and forest reduction equally contributed to the local extirpation of this species. The leopard is also a solitary diurnal predator that requires a large area to hunt prey animals (Jenny & Zuberbühler 2005), but villagers are afraid of them and do not hunt them. But forest reduction and poaching that has reduced prey densities might have been the primary causal factors of their extirpation from DCF.

This study confirmed five even-toed ungulate taxa (Red River Hog, bushbuck, African Buffalo, Maxwell's Duiker, Water Chevrotain *Hyemoschus aquaticus*). The signs of their presence were the most frequently found mammalian signs in this forest. Again, the fact that moderate densities of these taxa occur here may be attributed to an ecological release that has occurred after the extirpation of the leopard from the area (Brashares et al. 2010).

Evaluating mammalian diversity based on a direct comparison of ICR of remote cameras in different forests is controversial, because variations in the methods (e.g., height of the cameras, duration of image capture, the angle of the lens) may significantly influence the outcome (Kelly & Holub 2008; Cove et al. 2013). Our ICRs (0.022, 0.044) were much lower in comparison with 0.125 ICR obtained by a study conducted at the former Haute Dodo CF (Sanderson et al. 2005). Only by conducting a longer study deploying a greater number of cameras we can verify whether our low ICR is due to the short duration of each session at each location or a reflection of the low mammalian diversity.

Some protected areas are now failing to secure the future of several endangered wildlife (Campbell et al. 2008; Beresford et al. 2011; Matsuda Goodwin et al. 2017b; Kühl et al. 2017). As a result, community forests are becoming more and more important for wildlife conservation. The fact that the DCF contains nine threatened taxa gives us optimism that this forest may be able to act as an ecological source for the nearest protected areas if they are rehabilitated, increasing the linkage and connectivity to larger forests (Bennett 1998).

Endowed with threatened taxa, DCF is one of the most important community forests for biodiversity conservation in southwestern Côte d'Ivoire. As stated above, DCF also has a potential to be developed as an ecotourism site with a stretch of an attractive beach and the forest and wetland that boasts of enigmatic mammals. We recommend that the local authorities urgently take actions to protect DCF. Conservation measures should involve enhancing law enforcement against poaching and installing a surveillance program. Law enforcement against charcoal production also needs to be improved. Currently, charcoal production sites exist close to the dense rainforest and hunters use the

sites as camps within the forest. If charcoal producers and hunters are given alternative means, even partially, to earn their living (e.g., working as eco-guides), such activities could be substantially reduced. Furthermore, a conservation education program targeting the villagers and students will allow a better understanding of the importance of the forest and the ecological services that animals provide for the regeneration of the forest.

The confirmed presence of a number of emblematic taxa in the DCF instills hope for the conservation of its biodiversity. Global demand for oil palm, coffee, and cocoa, however, continues to push the region's industrial-scale agriculturalists to exploit the remaining forests. We reiterate that maintaining and rehabilitating the healthy ecosystem, especially along river Dodo, and creating a tourism-centered reserve at DCF will ensure its long-term effective protection.

This preliminary study was limited in scope and it is likely that many taxa were missed. For example, our study did not record any Insectivora or Lagomorpha species. Nevertheless, this paper has demonstrated that the community forests like the DCF may harbor a higher diversity of fauna than nearby "protected areas" that have gone through much destruction and deserve conservation resources. More thorough research, with surveys over a longer duration of time and a greater number of cameras, is required to more accurately assess mammalian diversity. Research on Chiroptera is also needed to better understand the full diversity of wildlife in this forest.

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Résumé: Pour mieux connaître la diversité des mammifères non volants et comprendre les perspectives de conservation dans la Forêt Côtière de la Dodo (DCF) au sud-ouest de la Côte d'Ivoire, nous avons mené des enquêtes, des prospections puis examiné des images de pièges photographiques. Après avoir calculé les taux de rencontres visuelles (vER), les signes de présence (sER) des taxons de mammifères et les signes de chasse, nous avons cartographié leur emplacement et testé l'hypothèse selon laquelle les observations des signes de primates sont élevés près de la Dodo, à l'intérieur et près de la forêt galerie comparé aux autres taxons. Nous avons observé neuf taxons dont ces taxons menacés : le Colobe Magistrat (CR), le Colobe vert (VU), le Cercopithèque de Lowe (VU), le Cercopithèque blanc-nez (VU) et le pangolin à petites écailles (VU) dont les vER sont respectivement de 0,04; 0,12; 0,04; 0,12 et 0,04. Nous avons confirmé 14 autres taxons avec des signes incluant ces taxons menacés: le Chimpanzé d'Afrique de l'Ouest (CR), l'Hippopotame nain (EN), le Pottos de Bosman (VU) et le pangolin à longue queue (VU), avec un sER de 0,51; 0,04; 0,08 et 0,04 respectivement. 23 taxons ont été confirmés dans la DCF. La distance moyenne entre la rivière Dodo et les observations des primates était plus courte que celle des autres taxons. La chasse intensive avec 0,63 indice/km menace les mammifères de la DCF. Les images des pièges photographiques sont le Guib harnaché, le Buffle d'Afrique et le Potamochère roux à des taux de capture de 0,022; 0,044 et 0,044, respectivement. Nous recommandons aux autorités de prendre des mesures contre le braconnage, de réduire la production de charbon de bois et d'instaurer un programme de surveillance pour assurer la conservation des mammifères menacés de la DCF.

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