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Mandrill (*Mandrillus sphinx*) Presence in Southeast Cameroon Confirmed by Camera Traps and Indigenous Knowledge

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Abstract

Determining primate geographic ranges is essential for understanding their ecology and developing their conservation policies, but it is particularly challenging for rare, cryptic, or widely distributed species. Science-based methods and Indigenous and local knowledge have mutually contributed to addressing this conundrum. Here, we report on a new camera-trap record of a solitary mandrill (*Mandrillus sphinx*) in Nki National Park, southeast Cameroon, and interviews with Baka people about encounters with mandrills. We placed 481 camera traps for 32,644 total days, obtaining one video of an adult male mandrill on 19 April 2021, 20.2 km north of the Dja River. We also interviewed 30 Baka people from two neighboring villages about their experiences of observing mandrills. Seven interviewees responded that they had observed mandrills in this area: three reported solitary males, and four reported large groups. All observations were in areas >30 km south of the villages and >20 years ago. The results suggest the presence, but also the rarity, of mandrills in this area, where only solitary males may range outside the species geographic distribution, possibly temporarily. However, we cannot conclude that large groups of mandrills are absent in this area because people are not allowed to stay in the park, so the Baka people's knowledge of the remote areas has been severely limited. To determine the accurate distribution of primates and develop effective conservation actions, we need collaborative research and conservation platforms that further connect Indigenous and local people with scientists.

Keywords Baka · Camera trapping · Distribution · Local knowledge · Interview · Nki National Park

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Résumé
La détermination des aires de répartition géographique des primates est essentielle pour comprendre leur écologie et élaborer des politiques de conservation, mais elle est particulièrement difficile pour les espèces rares, cryptiques ou largement répandues. Les méthodes scientifiques et les connaissances autochtones et locales ont mutuellement contribué à résoudre cette difficulté. Nous présentons ici un nouveau cas de mandrill solitaire (Mandrillus sphinx) enregistré à l'aide de caméra pièges dans le parc national de Nki, au sud-est du Cameroun, ainsi que des entretiens avec des Baka au sujet de leurs rencontres avec des mandrills. Nous avons placé 481 caméras pendant 32 644 jours au total, obtenant une vidéo d'un mandrill mâle adulte le 19 avril 2021, à 20,2 km au nord de la rivière Dja. Nous avons également interrogé 30 Baka de deux villages voisins sur leurs expériences d'observation des mandrills. Sept personnes interrogées ont répondu qu'elles avaient observé des mandrills dans cette zone : Trois ont rapporté des mâles solitaires, et quatre ont rapporté de grands groupes. Toutes les observations ont eu lieu dans des zones situées à plus de 30 km au sud des villages et il y a plus de 20 ans. Les résultats suggèrent la présence, mais aussi la rareté, des mandrills dans cette zone, où peut-être seuls les mâles solitaires quittent la distribution géographique de l'espèce, éventuellement de manière temporaire. Cependant, nous ne pouvons pas conclure que de grands groupes de mandrills sont absents de cette zone, car les gens ne sont pas autorisés à séjourner dans le parc, et les connaissances du peuple Baka sur les zones reculées ont donc été sévèrement limitées. Pour déterminer la distribution exacte des primates et développer des actions de conservation efficaces, nous avons besoin de plateformes collaboratives de recherche et conservation qui relient davantage les scientifiques et les populations autochtones et locales. ***The publisher did not copy edit the abstract translation.**

要旨
霊長類の地理的分布範囲を決定することは、種の生態について理解し、保全策を立案するために不可欠であるが、希少種、見つけにくい種、あるいは分布範囲が広い種については、特に困難である。これまでの研究において、この難題を解決するために科学的手法と在来•地域知とが相互に貢献してきた。本研究では、カメルーン東南部ンキ国立公園でのマンドリル（*Mandrillus sphinx*）の単独オス1頭の新たなカメラトラップ記録について報告するとともに、マンドリルとの遭遇に関する同地域のバカの人々へのインタビューについて報告する。私たちは計481台の自動撮影カメラをのべ32,644日間稼働させ、2021年4月19日に、ジャー川から北に20.2キロメートルの位置で、1頭のオトナオスのマンドリルのビデオ1ファイルを取得した。また、私たちは2つの近隣村に暮らす30名のバカに対し、マンドリルの観察経験について聞き取りをおこなった。その結果、7名がマンドリルを同地域で見たことがあると回答した（3名はヒトリオスの観察、4名は大きな群れの観察）。すべての観察は、村から30キロメートル以上南に離れた地域で20年以上前になされていた。これらの結果は、この地域にマンドリルが生息することを示唆しているが、同時にその希少性も示唆している。単独オスだけがこの種の地理的分布の外側を、おそらく一時的に遊動している可能性がある。しかしながら、群れがこの地域に存在していないと結論づけることはできない。なぜなら、国立公園内では宿泊が許されておら

ず、村から遠い場所に関するバカの知識は、とても限られているからである。霊長類の分布を正確に把握し、効果的な保全活動を展開するためには、先住民や地域住民と科学者とをさらに結びつけるような、共同研究•保全プラットフォームの設立が必要である。***The publisher did not copy edit the abstract translation.**

Introduction

How do we know where animals are present? Accurately identifying a species' geographic range is an essential basis for understanding its ecology and developing policies for its conservation and management (Marsh *et al.*, 2022). However, it is particularly challenging for some species, such as primates with cryptic features living in dense forests or with extensive ranges spanning multiple countries (Chen *et al.*, 2023). To overcome this conundrum, primatologists and conservation scientists have employed various approaches to map species distributions.

Science-based methods for confirming a primate's presence range from direct observations of individuals or calls (Schaffler & Kappeler, 2014) to genetic identification via fecal samples (Ferreira da Silva *et al.*, 2020). Moreover, the scientific contribution has been boosted by the use of camera traps (Burton *et al.*, 2015; Wevers *et al.*, 2021). Particularly in forested areas, studies incorporating terrestrial and arboreal camera traps are flourishing (Cordier *et al.*, 2022; Moore *et al.*, 2021), and new evidence for the presence of elusive or rare primate species is increasingly reported (dos Santos-Filho *et al.*, 2017; Lhota *et al.*, 2012; Schaffler & Kappeler, 2014). The advantages of camera traps in range determination include the accuracy of records with exact time and place, and reliable species identification based on images; the drawbacks include the very narrow search range (~10 m in dense forests), the high costs, and great labor in fieldwork and analysis (Glover-Kapfer *et al.*, 2019).

Primatologists have also long relied on the knowledge of Indigenous and local communities, who have broad experiences of animals on their lands. Indigenous and local knowledge remains vital in determining the geographic range of threatened primates and developing conservation plans (Estrada *et al.*, 2022). For example, a nationwide survey of drills (*Mandrillus leucophaeus*) in Cameroon actively incorporated interviews with local hunters alongside field censuses by researchers to estimate the distribution and conservation status of this endangered primate (Morgan *et al.*, 2013). Primatologists in Brazil interviewed local communities to update distribution maps of Maranhão red-handed howlers (*Malouatta ululata*) and information on their interactions with local people (Freire Filho *et al.*, 2018). The inclusion of ethnographic interviews with local community members has benefits in providing a different perspective to the subject of research interest than that provided by quantitative datasets, thereby increasing the relevance of conclusions (Remis & Jost Robinson, 2017). Ethnographic surveys are also advantageous in that they can achieve broad coverage in a short time (Radhakrishna, 2017), provide the retrospective estimation of animal distribution based on the memory of local people (van Vliet *et al.*, 2018), and incur comparatively low survey costs. Nevertheless, there are also potential challenges, including the ambiguity of the observation time and place, doubts about the

reliability of species identification and accuracy of memory, and the need for a deep understanding of local languages and contexts (Ellwanger *et al.*, 2017).

Mandrills (*Mandrillus sphinx*) live in large groups of 300–850 animals (Abernethy *et al.*, 2002; Hongo, 2014) in dense rainforests of Central West Africa. Group density is very low (White, 1994), as they travel long distances in large home ranges: the groups typically move 2–10 km per day (Hongo *et al.*, 2022b; Hoshino, 1985; White *et al.*, 2010), and a group living in the forest–savannah mosaic in Lopé National Park, Gabon, had a home range of 118 km^2, of which 46 km^2 was in forested areas (White *et al.*, 2010). The poor visibility of rainforest habitats, low group densities, and high mobility make it extremely difficult to determine the presence and distribution of the species. However, conservation is urgently needed—this primate is on the International Union for Conservation of Nature (IUCN) Red List as "Vulnerable", and its population size is considered to be declining, mainly due to hunting and habitat loss (Abernethy & Maisels, 2019).

The geographic range of mandrills has historically been determined using a combination of both qualitative and quantitative methods (Fig. 1). The distribution of mandrills was initially surveyed on the basis of field observations (Jouventin, 1975; Sabater Pi, 1971) and museum specimens (Grubb, 1973). A field survey in southeast Cameroon from 1988 to 1989 employed both direct observations by the researcher and interviews with local people, concluding that they occur only on the south bank of the Dja River (Mitani, 1990). These early studies helped delineate the first IUCN geographic range map (Oates & Butsynski, 2008). More recently, camera-trap surveys conducted outside their conventional distribution have found mandrills (Table I). These camera-trap observations expanded the distribution map (Abernethy & Maisels, 2019). Following this update, another camera-trap detection of a solitary male was reported on the east bank of the Ogooué River in eastern Gabon (Fonteyn *et al.*, 2022).

Here, we report on a new camera-trap record of a solitary mandrill in Nki National Park on the north bank of the Dja River in southeast Cameroon. We also report on encounters with mandrills by the Baka people, an Indigenous ethnic group living in the surrounding area. The Baka in the northern periphery of Nki rely heavily on wildlife hunting and plant gathering for their livelihoods and culture, having inherited and reproduced a wealth of knowledge about their forests and animals (Hattori, 2006; Yasuoka, 2006a). Following the by-catch "discovery" of a camera trap, we conducted local interviews with Baka people to reinforce the image record with Indigenous knowledge. Recent studies have combined camera traps and local interviews to accurately determine the distribution of forest-living primates and other mammals, showing that interviews are particularly beneficial in accurately determining rare species (Alempijevic *et al.*, 2021; Brittain *et al.*, 2022a, 2022b; van Vliet *et al.*, 2023). We aimed to draw comprehensive inferences about the presence of mandrills in this area by linking the two approaches.

Methods

We carried out three camera-trap surveys between 2018 and 2021 in and around Nki and Boumba-Bek National Parks, East Region, Cameroon (Fig. 2). We originally designed all surveys to estimate the population densities of medium-sized terrestrial

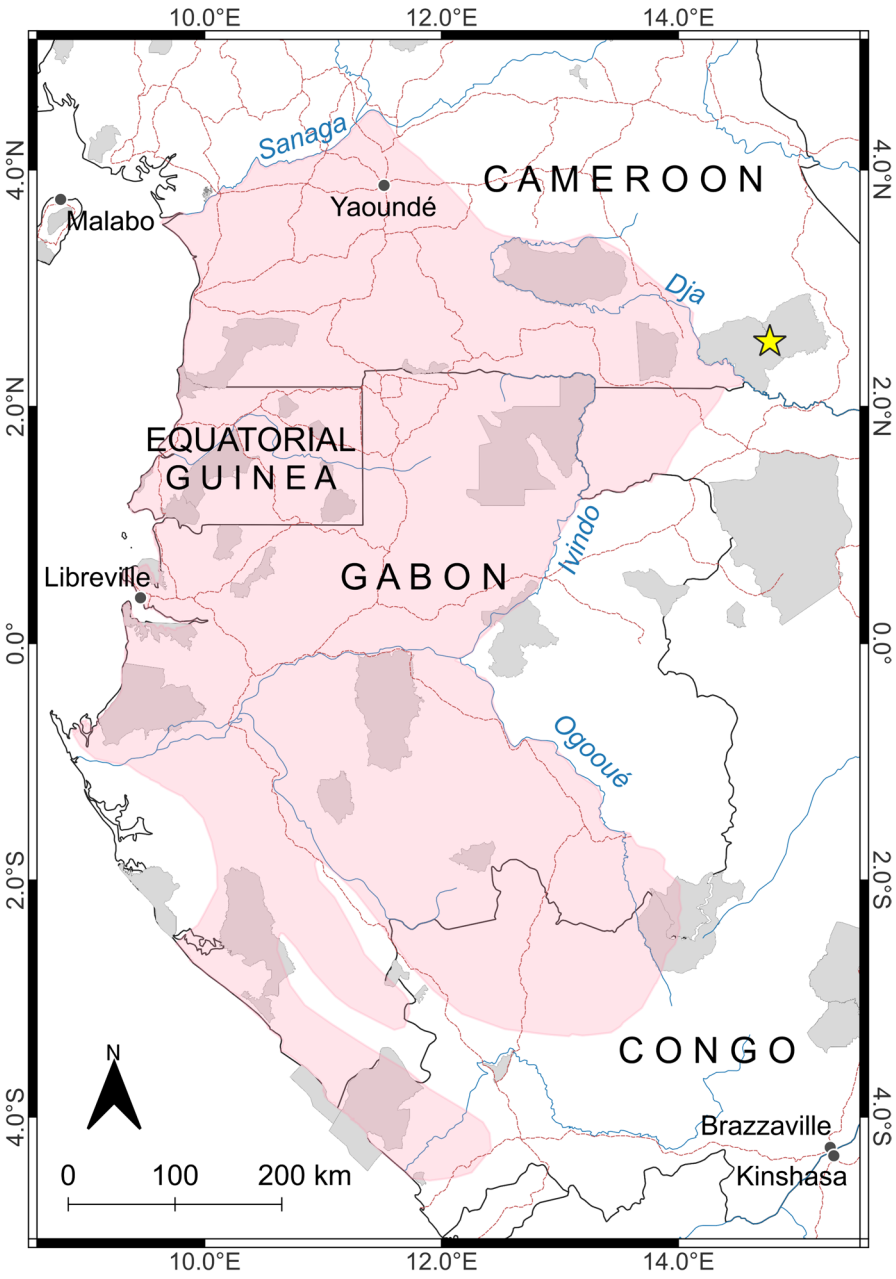

Fig. 1 Distribution of *Mandrillus sphinx* (*pink shadow*), with the location of camera-trap observation in this study (*yellow star*), protected areas (*grey shadow*), large rivers (*blue line*), and main roads (*brown dashed line*).

mammals hunted for meat, such as forest duikers and large rodents (Hongo *et al.*, 2022a). Thus, systematic camera-placement designs were employed for all surveys, without placing cameras along animal trails and not using baits or lures. We

Table I Recent reports of camera trap observations of mandrills (*Mandrillus sphinx*) outside the 2008 IUCN distribution map.

Dates	Site	Social organisation	Source
September 2014–June 2015; 2018 (periods of survey)	Djoua–Ivindo Forest, northwest Congo Republic	Large groups	Allam *et al.* (2016); Anthelme Allam, personal communication
March and April 2016 (periods of record)	Dja Biosphere Reserve, south Cameroon	Solitary adult male	Ngo Bata *et al.* (2017)
June 2014–May 2015 (period of survey)	Batéké Plateau National Park, southeast Gabon	Solitary subadult male	Hedwig *et al.* (2018)
May 2019, July 2021 (periods of record)	Lastoursville, east Gabon	Solitary adult male	Fonteyn *et al.* (2022)

used Browning® Strike Force HD series cameras (models BTC-5HDP and BTC-5HDPX) configured to record 10- or 20-s video footage in response to animal passage, with minimal intervals between the footage. The first survey was multi-layered, from September 2018 to February 2019 in three rectangular sites of 128 km^2 each, with 88 terrestrial and 150 arboreal cameras deployed (Hongo *et al.*, 2020). The second survey was over a large area, from December 2019 to April 2020, covering ca. 3400 km^2 with 214 terrestrial cameras. The third survey, in which we found a solitary mandrill, was longer-term, from May 2019 to August 2021, employing 49 terrestrial cameras in a 49-km^2 area of the Nki National Park. In total, 481 cameras—337 terrestrial and 144 arboreal cameras—were operational for at least one day. The total sampling effort was 32,644 camera days.

The first author conducted semi-structured interviews with the Baka people living in GB and ZB villages in August 2022 (Fig. 2). We chose these villages because the people there customarily use the large areas between the villages and the Dja River (Baka of Dimgba *et al.*, 2021; Yasuoka, 2006b). The first author explained the research objectives to each interviewee and how the data would be used immediately before commencing the interview. All participants gave free, prior and informed consent—they knew that they could withdraw from participation at any time, and that their anonymity would be assured. We tried to conduct individual interviews as much as possible, but this artificial situation sometimes made interviewees uncomfortable. In such cases, we interviewed people in groups of two or three but asked for answers from each individual.

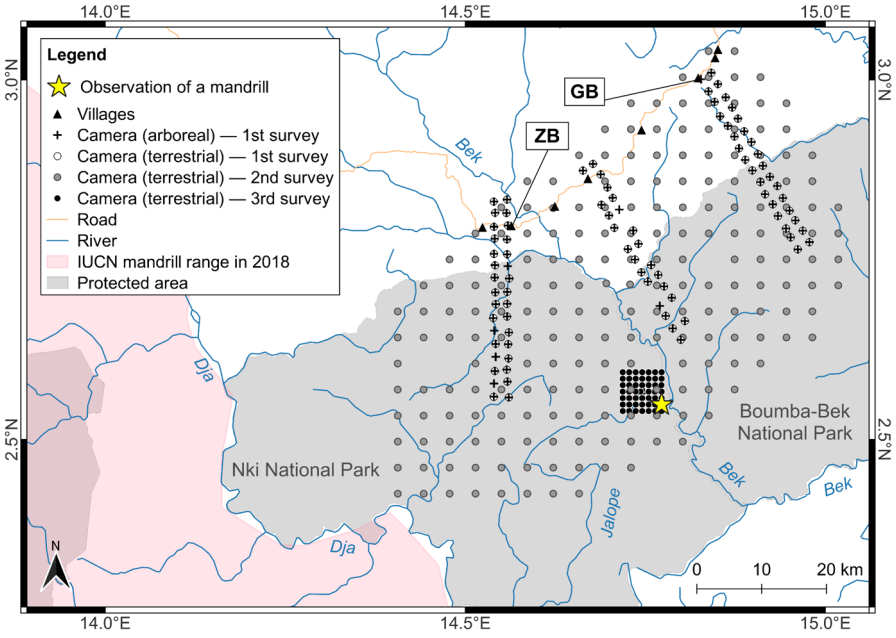

Fig. 2 Map of the study area in southeast Cameroon, showing camera-trap locations (placed in 2018–2021) and villages where we conducted interviews in August 2022 (GB and ZB).

Interviews lasted 15–30 minutes in French and Baka languages, with the help of local assistants. We first asked about the interviewee's personal information (name, gender, age, birthplace, and the time they came to the current village). Then, we showed the camera-trap footage of the solitary male recorded in this study and asked if they had seen a similar animal: "*Est-ce que tu as déjà vu cet animal en forêt ?* (Have you ever seen this animal in the forest?)". If the interviewee answered yes, we then questioned them about the time of the last observation: "*C'était quand ?* (When was it?)", "*C'était de quelle saison ?* (What season was it?)", "*sɔkɔ yaka ? sɔkɔ dùngà ?* (Dry season? Rainy season?)", "*C'était quand tu étais encore petite ?* (Was it when you were still a child?)", "*C'était avant que XX arrive à ce village pour la première fois, ou après ?* (Was this before XX [name of a long-term researcher] arrived in the village for the first time, or after?)" We also asked about the location of the last observation, which we determined using river names: "*Tu étais à coté de quelle rivière ?* (What river were you by?)" To check the reliability of the responses, we further asked interviewees to describe the detailed context of the observation: "*Qu'est-ce que tu étais en train de faire à ce moment-là ?* (What were you doing at that time?)", "*Tu l'as vu avec qui ?* (Who did you see it with?)" We also asked them to describe the morphology of the animals observed (size, color pattern, tail length) to see if they could describe the observed animal in detail. After completing all the questions about solitary males, we asked all interviewees about mandrill groups with the same interview procedure, using a video of a mandrill group recorded at another site.

After the interview, the first author gave each participant a small gift that cost around 250 CFA franc (chosen by the participant from candies, peanuts, and cigarettes). The gift items were chosen according to local customs; the gift quantity was determined so as not to be an undue incentive to participate or respond to the interviews.

Ethical note

This study complied with the laws of the Republic of Cameroon and was approved by the Ministry of Scientific Research and Innovation (No. 0190/ MINRESI/Projet COMECA/PM/07/2018) and the Ministry of Forestry and Wildlife (No. 1527/L/MINFOF/SETAT/SG/DFAP/SDCF/SEP/EP). Our interview survey was approved by the Center for African Area Studies, Kyoto University (No. 19-01B).

Data availability Camera-trap data are not publicly available due to their use in future papers. However, the mandrill video is available on the Projet Coméca YouTube Channel (https://youtu.be/6gJxyDb_Ekc). The questionnaire sheet used for the interview survey and the anonymized dataset are in Supplementary Materials S1 and Supplementary S2 respectively.

Results

On 19 April 2021, at the start of the rainy season, a camera trap (at 2° 32′ 54″ N, 14° 46′ 22″ E) in the third survey recorded a mandrill moving on the ground (Fig. 3). The observation was made 20.2 km north of the Dja River, southwest of the

confluence of the Jalope and Bek Rivers. We estimated it to be an adult male of > 9 years old from its fully-grown body size and morphological traits of its body and rump (Setchell & Dixson, 2002). This is the only camera-trap record of the mandrill in the study area, and no groups were recorded.

In total, 30 Baka adults participated in the interviews (Table II). Based on their responses, we evaluated the responses of 29 out of the 30 participants as being reliable. The 29 interviewees understood the meaning of our questions correctly, described the observed situations and morphology of the animals observed in detail, and did not confuse mandrills with other similar-looking species, such as agile mangabeys (*Cercocebus agilis*). Answers from the remaining interviewee were vague

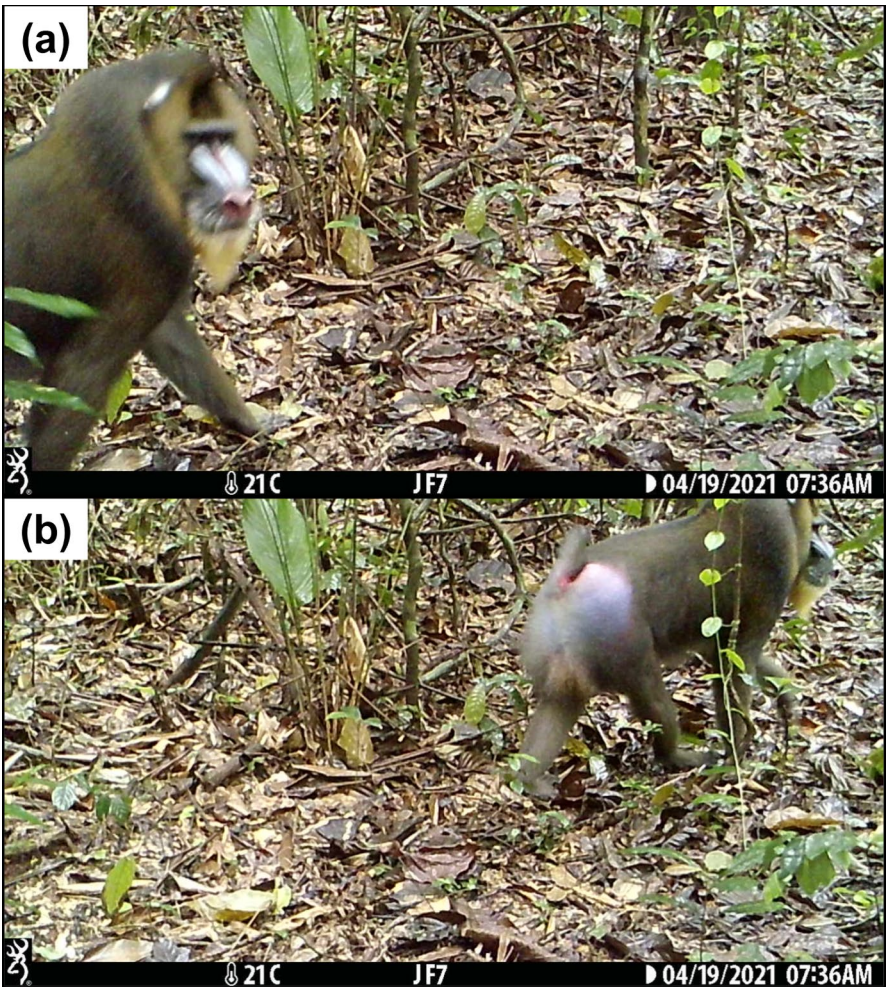

Fig. 3 Still frames from a camera-trap video of an adult male mandrill, showing his (**a**) face and (**b**) buttocks, recorded in Nki National Park, Cameroon, on 19 April 2021.

in their description of the mandrill morphology, so we excluded them from further analysis.

Of the 29 interviewees, seven (24%) reported having observed mandrills in this area. Their observations were all made in areas > 30 km from the villages, near the Bek or Jalope Rivers (Fig. 2). The ability of the interviewees to confirm the mandrill's current presence was likely to be limited by park regulations prohibiting people from staying within this area.

Two Baka interviewees in GB village (from the same interview group) and one in ZB village reported observations of solitary male mandrills. A female interviewee at GB said that her late spouse had hunted a solitary male 30–40 years ago near the Bek River. The only observer in ZB said he had only seen a male once near the Jalope River during the dry season, about 20 years ago.

Four Baka people from three different interview groups in GB reported having observed large groups of mandrills in the study area; no one at ZB reported seeing groups. All observations of large groups were made > 20 years ago near the Bek River, and two observers from separate interview groups stated that they had seen large groups of mandrills on the north bank of the Bek River 30 to 40 years ago.

Discussion

Our camera traps in Nki National Park recorded an adult male mandrill, demonstrating the presence of this Vulnerable primate on the north bank of the Dja River, which falls outside the current IUCN range of this species. Interviews with neighbouring Baka people also suggested the historical presence of mandrills in the same area.

Our results reveal the rarity, as well as the presence, of mandrills in the area: 481 camera traps working 32,644 days in total recorded only one adult male; less than one-fourth of Baka interviewees reported having seen mandrills in the area. Recent camera-trap observations in other areas outside the 2008 version of the IUCN distribution map have also recorded mostly adult or subadult males; groups have only been observed in the northwest of the Republic of Congo (Table I). These reports, including the present one, suggest that solitary males travel outside the geographic range of large groups, perhaps temporarily. In contrast to females, which form large

Table II Demographic information of interviewees and descriptive statistics of interviews conducted with Baka people in two villages of southeast Cameroon.

	Village	
	GB	ZB
Number of interviewees (female, male)	16 (6, 10)	14 (4, 10)
Number of interviewees born in the current village of residence (female, male)	14 (6, 8)	12 (3, 9)
Range of estimated age (years)	20s – >60s	20s – >60s
Number of interview groups	11	10
Median number of interviewees in the interview group (range)	1 (1–2)	1 (1–3)

groups throughout the year, many male mandrills live in groups only during the mating season and move alone during the rest of the year (Abernethy *et al.*, 2002; Brockmeyer *et al.*, 2015; Hongo *et al.*, 2016). It would, therefore, be more relevant to determine geographic ranges for males and females separately than to create a single distribution map for both sexes, particularly for widely-ranging primates such as mandrills. Sex-specific geographic maps would also benefit conservation planning and are proposed in an upcoming IUCN Action Plan (Dempsey *et al.,* (in press)).

In contrast to solitary males, whose presence was confirmed by both camera traps and Baka interviewees, the presence of mixed-sex groups was not shown by camera traps but was reported by four interviewees in three separate interview groups. All observers report that the last observation was > 20 years ago, which may suggest that mandrills have declined in the study area in recent years. However, it would be premature to suggest the recent disappearance of mandrills in the area from our results. Human activities within Nki National Park have been strictly limited since its creation in 2005 (Hattori, 2014), so the Baka's knowledge about remote parts of the park has probably been updated less regularly since then than previously. Therefore, we cannot conclude as to whether the geographic range of mixed-sex groups has shrunk recently or whether groups are still present in the study area but are too low in density to be detected by our camera traps.

Our study shows the effectiveness of the integration of camera trapping and local interviews in examining the presence of an elusive animal. Video images from the camera traps were decisively helpful for unambiguous communications between researchers and the Baka people, which might have been more difficult with photos and illustrations alone. Also, we have learned from local people about the basics of the Baka language, the names and locations of rivers, and past events in the study villages prior to this study, which helped us to determine the location and time of the Baka interviewees' past observations. Locally based methods such as our study contribute to sharing the capacity between local people and non-local researchers (Camino *et al.*, 2020) and illustrate the importance of exchanging knowledge in wildlife conservation (Copete *et al.*, 2023; Haris *et al.*, 2024). To make knowledge of primate distribution more accurate and their conservation actions more relevant to local conditions, we need collaborative research and conservation platforms that further connect Indigenous and local people with scientists.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10764-024-00451-5.

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Author Contributions SH, HY and CD-L conceived the study. ZCBD, VVMD, MANA, HY and SH conducted camera-trap surveys. SH carried out the interviews. KM, YH and SH analyzed the camera trap videos. SH wrote the manuscript, and the other authors provided editorial advice.

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Declarations

Inclusion and Diversity Statement While citing references scientifically relevant to this work, we also actively worked to promote gender balance in our reference list. The author list includes contributors from the country where the research was conducted and who participated in study design and data collection.

Conflict interest The authors declare that they have no conflict of interest.

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