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Gastrointestinal parasites of blue monkeys (*Cercopithecus mitis*) and grey-cheeked mangabeys (*Lophocebus albigena*) at the Ngogo Research Site in Kibale National Park, Uganda

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Abstract

There has been persistent decline in blue monkey (***Cercopithecus mitis***) population at Ngogo research site in the past 40 years for no clear reasons. In contrast, the populations of other nonhuman primates like the grey-cheeked mangabeys (***Lophocebus albigena***) which share identical home ranges with blue monkeys have not been obviously affected. However, stakeholders attribute this decline to gastrointestinal parasitic diseases, hence the need to determine the profile of parasitic infections in blue monkeys and compare them to that of grey-cheeked mangabeys within a shared home range. Faecal samples (n = 241) were subjected to diagnostic tests, namely sodium nitrate floatation and formol-ether sedimentation before microscopic examination. 227 (94%) samples were parasite positive; six protozoa and 21 helminths were present. This implies that Ngogo hosts a high diversity of parasites which poses health risks to nonhuman primates. There was no significant statistical difference in the prevalence of the overall main pathogenic parasites between the two studied nonhuman primate species. Therefore, gastrointestinal parasites may not be the obvious cause of the proclaimed blue monkey population decline at Ngogo research site.

Résumé

Il a été constaté un déclin persistant de la population de singe bleu (*Cercopithecus mitis*) sur le site de recherche de Ngogo depuis les 40 dernières années sans raison claire. En revanche, les populations d'autres primates non humains comme les mangabeys à joues grises (*Lophocebus albigeois*) qui partagent des domaines vitaux identiques avec les singes bleus, n'ont pas été affectées à l'évidence. Cependant, les parties concernées attribuent ce déclin aux maladies parasitaires gastro-intestinales, d'où la nécessité de déterminer le profil des infections parasitaires chez les singes bleus et de les comparer à celui des mangabeys à joues grises dans un domaine vital partagé. Des échantillons de matières fécales (n = 241) ont été soumis à des tests pour diagnostic, à savoir, flottation au nitrate de sodium et sédimentation au formol-éther avant l'examen microscopique. 227 (94%) échantillons étaient positifs aux parasites; six protozoaires et 21 helminthes étaient présents. Cela signifie que Ngogo héberge une grande diversité de parasites présentant tous des risques pour la santé des primates non humains. Il n'y avait pas de différence statistique significative dans la prévalence globale des principaux parasites pathogènes entre les deux espèces de primates non humains étudiées. Par conséquent, les parasites gastro-intestinaux peuvent ne pas être la cause évidente du déclin constaté de la population de singes bleus sur le site de recherche de Ngogo.

KEYWORDS

Gastrointestinal parasites, Kibale National Park, Nonhuman primates, Uganda

1 | INTRODUCTION

Parasites play a central role in ecosystems by affecting hosts' ecology and evolution of inter-specific interactions, population growth and regulation, fitness increasing their vulnerability to diseases and predation (Esch & Fernandez, 1993; Hudson et al., 1998, 2002). Gastrointestinal parasites, among other pathogens, have far-reaching implications for the conservation of nonhuman primates in African tropical rain forests (Gillespie et al., 2004; Hudson et al., 2002; Lilly et al., 2002). Studies have shown that gastrointestinal parasites contribute significantly to patterns of nonhuman primates' morbidity and mortality (Chapman, Gillespie, & Goldberg, 2005; Chapman, Gillespie, & Speirs, 2005; Gillespie, Chapman, et al., 2005; Goldberg et al., 2008; Scott, 1988). The rate of gastrointestinal parasites spread in nonhuman primates greatly increase with group size and levels of social contacts within and among groups (Loehle, 1995). Parasites spread also varies with host's behavioural ecology such as intensive territorial patterns that promote continuous exposure to parasites already present in the habitat (Ezenwa, 2004; Ott-Joslin, 1993; Stoner, 1996).

In Africa, most related parasitological research has focused on apes and other endangered species of nonhuman primates (Ashford et al., 1990, 2000; Kalema-Zikusoka et al., 2005; Lilly et al., 2002; McGrew et al., 1989; Standley et al., 2011; Woodford et al., 2002), baboons (Bezjian et al., 2008; Eley et al., 1989; Hahn et al., 2003; Mafuyai et al., 2013), guenons (Kouassi et al., 2015) and vervets (Valenta et al., 2017). In Uganda, research on chimpanzees, nonape and nonendangered species of nonhuman primates, namely red colobus, black-and-white colobus and red-tailed monkeys, has been conducted at the periphery of National parks, including Kanyawara research site in Kibale National park (Chapman et al., 2010, 2018; Chapman, Gillespie, & Goldberg, 2005; Chapman, Gillespie, & Speirs, 2005; Gillespie, Chapman, et al., 2005; Gillespie, Greiner, et al., 2005; Goldberg et al., 2008). To date, little is known about the gastrointestinal parasites infecting nonhuman primate species that live in the absence of human villages, specifically at the interior of National parks such as the Ngogo research site in Kibale National park (Chapman, Gillespie, & Goldberg, 2005; Chapman, Gillespie, & Speirs, 2005; Park, 2005).

There has been persistent decline in blue monkey population at Ngogo research site in the past 40 years (Angedakin & Lwanga, 2011; Butynski, 1990; Chapman, Struhsaker, et al., 2005; Chapman et al., 2010, 2018; Lwanga et al., 2011; Mitani et al., 2000). Yet, in contrast, the populations of other nonhuman primates such as the grey-cheeked mangabeys, which closely share identical home ranges with the blue monkeys at Ngogo research site, have not obviously been affected. Furthermore, Chapman, Struhsaker, et al. (2005), Chapman et al. (2018) reported population stability in red colobus monkeys, black-and-white colobus monkeys and grey-cheeked mangabeys which is contrary to blue monkeys. The cause of this decline is not well known. Wildlife stakeholders attribute it to diseases, particularly due to gastrointestinal parasites (Butynski, 1990; Goldberg et al., 2008).

The current study aims to determine the profile of parasitic infections burden in blue monkeys compared to the one in grey-cheeked mangabeys within a shared home range and within species in order to deepen our understanding on health status and disease risks among the former. In addition, this study will help generate new information on the parasite diversity in blue monkeys at Ngogo research site.

2 | MATERIALS AND METHODS

2.1 | Study site and nonhuman primate species

Kibale National Park (795 km^2; 0°13′–0°41′N, and 30°19′–30°32′E) in western Uganda (Figure 1) is a mid-altitude (920–1,590 m), tropical, moist evergreen forest intermixed with swamps, secondary forests and grasslands (Chapman et al., 2018; Swift, 2012). Annual rainfall averages at 1,700 mm and daily temperature range is 14–27°C. The area annually experiences two rainy periods (March–May and September–November) with slightly more rain in the north of the park than in the south and two dry periods (June–August and December–February) (Chapman et al., 2018; Watts et al., 2012).

Kibale National Park contains fauna of tropical rain forests, including nine diurnal nonhuman primate species (chimpanzees [*Pan troglodytes*], grey-cheeked mangabeys [*Lophocebus albigena*], blue monkeys [*Cercopithecus mitis*], red-tailed monkeys [*C. ascanius*], olive baboons [*Papio anubis*], eastern black-and-white colobus [*Colobus guereza*], red colobus [*Piliocolobus tephrosceles*], L'Hoest's monkeys [*Allochrocebus lhoesti*] and vervet monkeys [*Chlorocebus pygerythrus*]) (Chapman, Gillespie, & Speirs, 2005; Chapman, Struhsaker, et al., 2005; Gillespie, Chapman, et al., 2005; Goldberg et al., 2008; Park, 2005; Swift, 2012). The park also has smaller nocturnal species

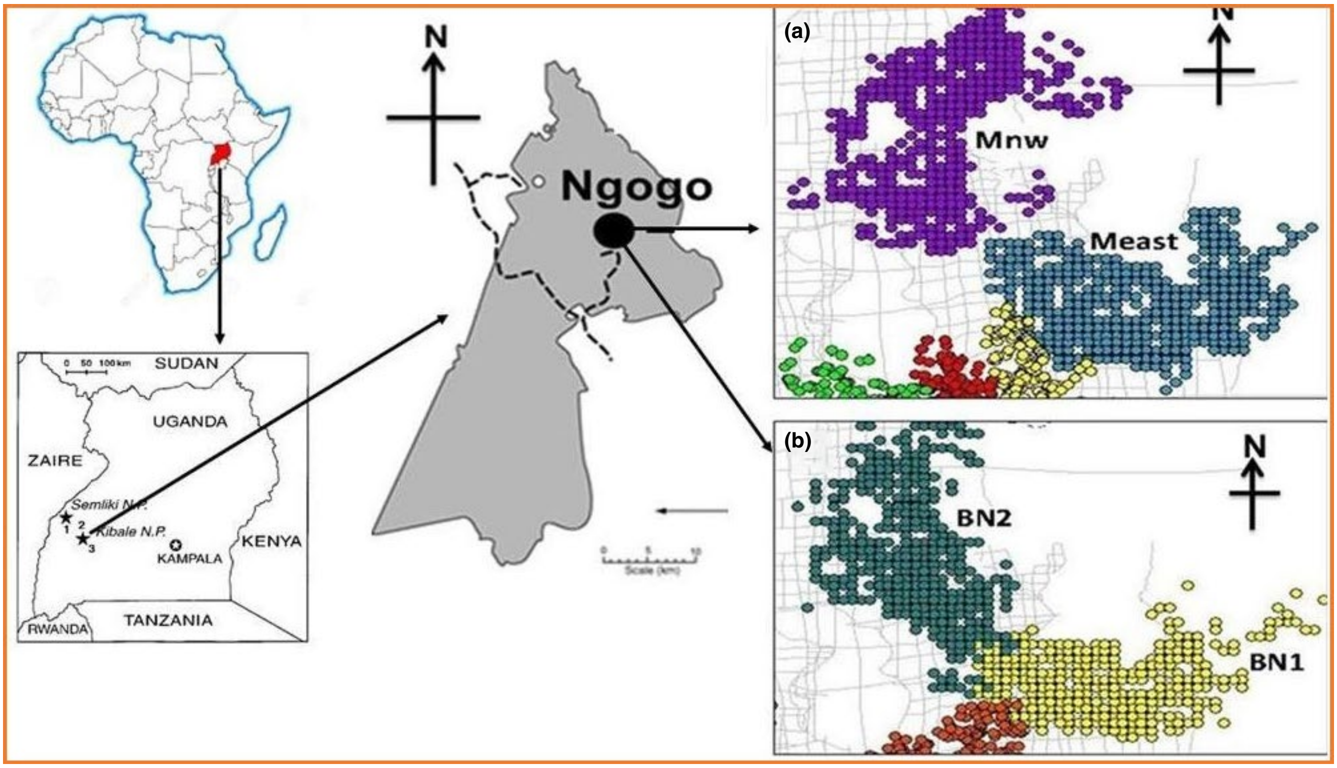

FIGURE 1 Kibale National Park showing (a) the habituated grey-cheeked mangabey (Mnw and Meast) groups 'home range area' and (b) the habituated blue monkey (BN1 and BN2) groups 'home range area' at Ngogo research site. BN1, blue monkey Group 1; BN2, blue monkey Group 2; Meast, grey-cheeked mangabey East Group; Mnw, grey-cheeked mangabey Northwest Group

such as bushbabies (*Galago demidoff*), Thomas' galago (*Galago thomasi*) and pottos (*Perodicticus potto*) (Swift, 2012).

The Ngogo research site is centrally located in the northern sector of the park and contains an unusually high density of chimpanzees (Mitani, 2006) and grey-cheeked mangabeys, but a low density of blue monkeys (Angedakin & Lwanga, 2011; Chapman, Struhsaker, et al., 2005; Chapman et al., 2010, 2018; Lwanga et al., 2011). Seven groups of grey-cheeked mangabeys and five groups of blue monkeys have been studied intermittently at this site by Michelle Brown and a team of local field assistants since 2007 and 2013, respectively. All individuals in the study groups are identified on the basis of unique characteristics, including scars, stiff fingers, nipple size and colour, and tail shape. During follows, observers recorded the location of the group's centre-of-mass every half an hour. These data were then mapped to determine the home range of each group. For reasons that remain unclear, the home range of each blue monkey group aligns closely with that of one grey-cheeked mangabey group (Figure 1), though the dyads spent relatively little time in close (<50 m) proximity (10% of observation time for the M5-B2 dyad and 44% of observation time for the M3-B1 dyad).

2.2 | Sample collection and examination

Faecal samples were collected from identified adult and subadult individuals of blue monkey Group 1 (n = 68), blue monkey Group 2 (n = 53), grey-cheeked mangabey North west (n = 56) and grey-cheeked mangabey East (n = 64) averagely twice per month from March 2016 to August 2016. One g of each faecal sample was mixed with 8ml of 10% formalin in a 20ml vial and stored at room temperature until laboratory analysis. Each sample was divided into two portions for floatation with sodium nitrate and sedimentation with formol-ether standard methods as described by Broussard (2003), Gillespie (2006) and Ahmadi and Damraj (2009). Parasite cysts and eggs were identified on the basis of size, colour, shape, contents, thickness of the shell and the presence or absence of specialised structures such as spines, knobs or opercula. A calibrated ocular micrometre was used to measure the length and width of individual cyst(s) and/or egg(s) as outlined by Gillespie (2006). Representative micrographs were taken using a single-lens reflex digital camera, model 1600F. The cysts and eggs were counted before subjection to micrometry and photography.

2.3 | Statistical analysis

Diversity denoted the number of parasite species and the relative abundance of each species in the nonhuman primates per site. Species richness denoted the number of different parasite species in nonhuman primates per site. Evenness denoted the relative abundance of parasite species present in nonhuman primates per site. The Shannon–Wiener

TABLE 1 Prevalence (%) of gastrointestinal parasites recovered from faecal samples of blue monkeys and grey-cheeked mangabeys at Ngogo research site

	Grey-cheeked mangabey North west ($n = 56$)	Grey-cheeked mangabey East ($n = 64$)	Blue monkey Group 1 ($n = 68$)	Blue monkey Group 2 ($n = 53$)	Pearson Chi-square test	
Parasites	*n* (%)	*n* (%)	*n* (%)	*n* (%)	χ^2	*p*-value
Entamoeba coli	38 (67.9)	45 (70.3)	32 (47.1)	20 (37.7)	17.90	***
Entamoeba histolytica	17 (30.4)	13 (20.3)	1 (1.5)	2 (3.8)	28.54	***
Eimeria sp.	18 (32.1)	33 (51.6)	8 (11.8)	12 (22.6)	26.73	***
Cryptosporidium sp.	35 (62.5)	41 (64.1)	21 (30.9)	16 (30.2)	22.35	***
Iodamoeba sp.	0 (0.0)	0 (0.0)	26 (38.2)	11 (20.8)	50.35	***
Endolimax sp.	11 (19.6)	7 (10.9)	0 (0.0)	2 (3.8)	17.64	***
Fasciolopsis sp.	8 (14.3)	14 (21.9)	2 (2.9)	6 (11.3)	11.09	**
Fasciola sp.	5 (8.9)	2 (3.1)	1 (1.5)	1 (1.9)	5.74	0.13
Schistosoma sp.	8 (14.3)	2 (3.1)	2 (2.9)	4 (7.5)	8.13	*
Paragonimus sp.	9 (16.1)	0 (0.0)	7 (10.3)	9 (17.0)	11.85	**
Clonorchis sp.	1 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	-	-
Dicrocoelium sp.	1 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	-	-
Unidentified trematode sp.	2 (3.6)	19 (29.7)	7 (10.3)	10 (18.9)	17.53	***
Taenia sp.	7 (12.5)	14 (21.9)	0 (0.0)	3 (5.7)	19.15	***
Hymenolepis sp.	2 (3.6)	0 (0.0)	0 (0.0)	0 (0.0)	-	-
Diphylobotherium sp.	8 (14.3)	6 (9.4)	7 (10.3)	14 (26.4)	8.39	*
Ascaris sp.	25 (44.6)	23 (35.9)	26 (38.2)	26 (49.1)	2.59	0.46
Strongyloides sp.	0 (0.0)	0 (0.0)	1 (1.5)	2 (3.8)	4.30	0.23
Ancyclostoma sp.	2 (3.6)	0 (0.0)	1 (1.5)	1 (1.9)	2.37	0.50
Trichuris sp.	4 (7.1)	5 (7.8)	16 (23.5)	15 (28.3)	14.79	**
Trichostrongylus sp.	0 (0.0)	0 (0.0)	20 (29.4)	12 (22.6)	37.78	***
Anatrichosoma sp.	0 (0.0)	0 (0.0)	5 (7.4)	0 (0.0)	-	-
Chitwoodspirura sp.	2 (3.6)	0 (0.0)	0 (0.0)	0 (0.0)	-	-
Oesophagostomum sp.	1 (1.8)	1 (1.6)	0 (0.0)	0 (0.0)	2.05	0.56
Enterobius sp.	4 (7.1)	0 (0.0)	4 (5.9)	0 (0.0)	7.96	*
Necator sp.	0 (0.0)	0 (0.0)	1 (1.5)	8 (15.1)	24.65	***
Unidentified nematode sp.	25 (44.6)	11 (17.2)	0 (0.0)	2 (3.8)	53.72	***

Abbreviations: '-' no chi-square test performed because more than two groups had zero prevalence; *n*, number of faecal samples collected from each nonhuman primate group; *p*-value, chi-square *p*-value; χ^2, Pearson chi-square value.

*p-value < 0.05.

**p-value < 0.01.

***p-value < 0.001, respectively.

diversity index was used to calculate the parasite species diversity (H′) and evenness (J′) (Shannon, 1948). Pearson chi-square test was used to compare the prevalence rate of each parasite species across the four nonhuman primate groups (Table 1) and the prevalence rate of the main pathogenic parasites between the two nonhuman primate species (Table 3). It was also used to assess the overall parasites prevalence rates across the four nonhuman primate groups and the main pathogenic parasites between the two nonhuman primate species during the six months of study. IBM SPSS Statistics 23 package and *p*-value of 0.05 were used to analyse the data and determine level of significance, respectively.

3 | RESULTS

A total of 27 parasites comprised of six protozoa and 21 helminths (Table 1) were recorded. Of the 241 nonhuman primates screened, 227 (94%) were infected with one or more parasite species. Eleven

TABLE 2 Gastrointestinal parasite diversity, species richness and evenness in different nonhuman primate groups from Ngogo research site in Kibale National Park between March and August 2016

Nonhuman primate groups	Number of parasite species	Parasite richness	Diversity index (H*Δ*)	Evenness (J')
Grey-cheeked mangabey NW	22	22/27 (81.5%)	2.55	0.65
Grey-cheeked mangabey East	15	15/27 (55.6%)	2.13	0.79
Blue monkey Group 1	19	19/27 (70.4%)	2.44	0.83
Blue monkey Group 2	20	20/27 (74.1%)	2.65	0.88

Abbreviations: J', Pielou's evenness; NW, Northwest.

(41%) of the parasite species were shared among the four nonhuman primate groups, and sixteen (59%) of the parasites were only detected in specific nonhuman primate groups (Table 1).

Grey-cheeked mangabey North west, grey-cheeked mangabey East, blue monkey Group 1 and blue monkey Group 2 were found infected with 22, fifteen, nineteen and twenty parasite species, respectively (Table 2). The gastrointestinal parasite species richness ranged from 55.6% to 81.5%, and the parasite species diversity ranged between $2.13 \le H' \le 2.65$ (Table 2). This lies at the normal standard range $1.5 \le H' \le 3.5$ (Clarke & Warwick, 2001). Parasite species evenness was $0.65 \le J' \le 0.88$ (Table 2), and this lies within the normal range ($0 \le J' \le 1$), indicating more uniformity in parasite species among the four nonhuman primate groups (Clarke & Warwick, 2001; Shannon, 1948).

There was a significant statistical difference ($p < 0.05$) in the prevalence of 17 (63%) individual parasites (Table 1), but no significant statistical difference (Pearson chi-square = 4.618, $df = 3$, $p = 0.202$) in the overall parasites prevalence rate across the four nonhuman

TABLE 3 Prevalence (%) of the main pathogenic parasites of blue monkeys and grey-cheeked mangabeys at Ngogo research site in Kibale National Park

	Grey-cheeked mangabeys	Blue monkeys	Pearson Chi-square test	
	(*n* = 120)	(*n* = 121)		
Parasites	*n* (%)	*n* (%)	χ^2	*p*-value
Entamoeba histolytica	30 (25.0)	3 (2.5)	25.86	***
Cryptosporidium sp.	76 (63.3)	37 (30.6)	25.96	***
Fasciolopsis sp.	22 (18.3)	8 (6.6)	7.60	**
Fasciola sp.	7 (5.8)	2 (1.7)	2.93	0.09
Schistosoma sp.	10 (8.3)	6 (5.0)	1.11	0.29
Paragonimus sp.	9 (7.5)	16 (13.2)	2.12	0.15
Taenia sp.	21 (17.5)	3 (2.5)	15.16	***
Hymenolepis sp.	2 (1.7)	0 (0.0)	2.03	0.15
Diphylobotherium sp.	14 (11.7)	21 (17.4)	1.57	0.21
Ascaris sp.	48 (40.0)	52 (43.0)	0.22	0.64
Strongyloides sp.	0 (0.0)	3 (2.5)	3.01	0.08
Ancyclostoma sp.	2 (1.7)	2 (1.7)	0	1
Trichuris sp.	9 (7.5)	31 (25.6)	14.29	***
Trichostrongylus sp.	0 (0.0)	32 (26.4)	36.60	***
Chitwoodspirura sp.	2 (1.7)	0 (0.0)	2.03	0.15
Oesophagostomum sp.	2 (1.7)	0 (0.0)	2.03	0.15
Enterobius sp.	4 (3.3)	4 (3.3)	0	1
Necator sp.	0 (0.0)	9 (7.4)	9.27	**

Abbreviations: *n*, number of faecal samples collected from each nonhuman primate species; *p*-value, chi-square *p*-value; χ^2, Pearson chi-square value.

*p-value < 0.05.

**p-value < 0.01.

***p-value < 0.001, respectively.

primate groups. The most prevalent parasite was *Entamoeba coli* followed by *Cryptosporidium* sp. and *Ascaris* sp. The least prevalent parasites were *Clonorchis* sp. and *Dicrocoelium* sp. (Table 1).

There was a significant statistical difference ($p < 0.05$) in the prevalence rate of seven (39%) out of the fifteen main pathogenic parasites (Table 3), but no significant statistical difference (Pearson chi-square = 0.00, $df = 1$, $p = 1.00$) in the overall prevalence rate of the main pathogenic parasites between the two nonhuman primate species. For no clear reason, the prevalence of *Entamoeba histolytica*, *Cryptosporidium* sp., *Fasciolopsis* sp. and *Taenia* sp. was significantly higher in grey-cheeked mangabeys, while that of *Trichuris* sp., *Trichostrongylus* sp. and *Necator* sp. was significantly higher in blue monkeys (Table 3).

4 | DISCUSSION

The current study reports what we believe is the first finding of *Anatrichosoma* sp., *Chitwoodspirura* sp., *Hymenolepis* sp., *Fasciolopsis* sp.,*Paragonimus* sp. and *Schistosoma* sp. in Ugandan free-ranging nonhuman primates in addition to other previously detected parasites in related studies (Table 1). The observed Ngogo research site parasite species diversity index and evenness indicate equal distribution of the gastrointestinal parasites among the four nonhuman primate groups. This could be due to sharing of basic resources like food and water among the studied nonhuman primate groups.

The most pathogenic parasites recorded in this study can confer a combination of pathogenic effects that have been documented elsewhere to the Ngogo nonhuman primates including increased abnormal behaviours like reduced movement and increased inactivity, reduced appetite, inability to avoid predators and reduction inbreeding success (Mafuyai et al., 2013). Other pathogenic effects are intestinal ulceration, anaemia, tissue damage, delay in puberty onset, spontaneous abortion, congenital malformation and mortality if not treated (Chapman, Gillespie, & Speirs, 2005; Kalema-Zikusoka et al., 2005; Mafuyai et al., 2013). These health complications may affect Ngogo research site nonhuman primates' ecology and evolution of specific interactions, population growth and regulations (Hudson et al., 2002). This is potentially so for the blue monkeys that are known to be generally weak and less competitive for basic resources compared to other nonhuman primate species (Butynski, 1990; Chapman et al., 2018; Swift, 2012).

Given the short span of six months and only two host species studied within a range of 30 km^2 area, the 27 parasite species recorded in this study is indeed high diversity compared to the work of Lilly et al. (2002) in Central African Republic, Kooriyama et al. (2012) in Tanzania and Kouassi et al. (2015) in Cote d'Ivoire where up to seven nonhuman primate host species were sampled for a longer time frame of up to five years in over 50 km^2 area. These studies recorded eleven, thirteen and 23 parasite species, respectively.

The Ngogo research site high parasite species diversity can be explained by behavioural ecology of the two nonhuman primate host species which is characterised by intensive territoriality patterns that promote continuous exposure and susceptibility to parasites already present and/ or that accumulate within their home range (Ott-Joslin, 1993). This exposes the young, old, sick and pregnant nonhuman primates whose immunity is yet to develop or low to parasitic infections. In addition, the high nonhuman primate population density at Ngogo may cause food shortage thus nutritional stress which leads to poor immunity allowing multiple pathogenicity and reduced cure (Chapman, Gillespie, & Goldberg, 2005; Chapman, Gillespie, & Speirs, 2005; Chapman et al., 2010; Lilly et al., 2002; Mafuyai et al., 2013).

The most prevalent parasites like *E. coli*, *Cryptosporidium*, *Eimeria* and *Ascaris* have direct life cycles and exhibit horizontal direct mode of transmission. They also have several reservoir hosts, namely insects (cockroaches, dung beetles), amphibians, reptiles, rodents, birds and livestock (Symth, 1994; Wallace & Gilles, 1995) that are either found or contiguous to Ngogo research site. These facilitate their quick transmission. These reservoir hosts contaminate food, water and soil with their parasites-infected faeces, and since feeding is the critical daily activity carried out by nonhuman primates (Gillespie, Chapman, et al., 2005; Gillespie, Greiner, et al., 2005; Goldberg et al., 2008), there are high chances of oral ingestion of parasite cysts and eggs together with food or water. This is contrary to the other parasites that have indirect life cycles and fewer intermediate hosts, which therefore incur ranges of environmental resistance like unfavourable moisture/temperature during their free-living stages (Symth, 1994; Wallace & Gilles, 1995). The low prevalence of *Schistosoma* sp. and *Paragonimus* sp. may be due to limited and uneven distribution of water streams at Ngogo research site. Limited water streams lower the abundance of *Bulinus senegalensis* and *B. globosus* snails that serve as intermediate hosts for *S. intercalatum*, and *Semisulcospiral* sp. snails, the intermediate hosts for *Paragonimus* sp. (Symth, 1994; Wallace & Gilles, 1995).

5 | CONCLUSIONS AND RECOMMENDATIONS

The present research marks the first finding of *Anatrichosoma* sp., *Chitwoodspirura* sp., *Hymenolepis* sp., *Fasciolopsis* sp.,*Paragonimus* sp. and *Schistosoma* sp. in Ugandan free-ranging nonhuman primates. This calls for further inventorying of parasites in nonhuman primate species in all gazetted areas in the country. The fact that the two nonhuman primate species have similar parasite species diversity, and no significant statistical difference in the overall parasite prevalence both across the four groups and between the two nonhuman primate species indicates that gastrointestinal parasites are not the obvious cause of the proclaimed blue monkey population decline at Ngogo research site. This dictates the assessment of other types of parasites and pathogens as potential candidates for the blue monkey population decline at Ngogo research site, Kibale National park.

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CONFLICT OF INTEREST

The authors state that there is no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are not shared due to ethical reasons.

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