Prevalence of Concurrent Balantidosis and Giardiosis among Captive Chimpanzees (*Pan troglodytes*) and Drills (*Mandrillus leucophaeus*) at the Afi Mountain Primate Sanctuary in Calabar, Nigeria

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ABSTRACT
A study on the prevalence of concurrent balantidosis and giardiosis and associated parasitic load among captive chimpanzees (*Pan troglodytes*) and drills (*Mandrillus leucophaeus*) was carried out at the Drill Ranch located in the Afi mountain primate conservation area in Calabar, Nigeria. Out of the 65 primates examined 16 (88.89%) of the drills (*Mandrillus leucophaeus*) had significantly ($P < 0.05$) higher prevalence of infection than 27 (57.45%) of the chimpanzees (*Pan troglodytes*). Oocyst counts (opg) 850 ± 0.09 due to *B. coli* was significantly higher ($P < 0.05$) among the chimpanzees (*Pan troglodytes*) than a count of 600.2 ± 0.35 among the drills (*Mandrillus leucophaeus*). Similarly, on one hand, trophozoite counts due to *B. coli* was higher ($P < 0.05$) among the chimpanzees (*Pan troglodytes*) than among the drills (*Mandrillus leucophaeus*) while on the other hand, oocyst or trophozoite counts due to *G. lamblia* was moderate among the two species of primates. There was no variation ($P > 0.05$) among sex or age groups except in the young chimpanzees (< 12 months) of age that showed higher prevalence of infection ($P < 0.05$) than the adults. From the foregoing, the results show that concurrent balantidosis and giardiosis can occur synergistically in captive primates and may also be a source of parasitic zoonosis to human attendants on one hand and tourist on the other hand.
Key words: Balantidosis, giardiosis, concurrent infection, chimpanzees, drills

INTRODUCTION

Gastrointestinal infections due to *Balantidium coli* have been reported in several domestic animals and primates including man (Flyn, 1973; Levine, 1973; Smyth, 1996; Mbaya *et al*., 2006a), with little information on the occurrence of concurrent infection with *Giardia lamblia* among primates, susceptible hosts usually get infected by ingesting trophozoites or cysts (Lynn and David, 2005).

Although it has been reported that balantidosis is non clinical and self -limiting (Smyth, 1996), most researchers have shown that tissue invasion caused by trophozoites of *B. coli* often lead to severe infections when immunity is compromised or deficient with resultant perforative colitis, appendicitis, hepatic abscesses and peritonitis in human and non human primates (Wenger, 1976; Zaman, 1978; Smyth, 1996; Mbaya *et al*., 2006a). The pet trade in new world monkeys or the close association of man and primates through (*ex-situ*) conservations in zoological gardens or captive breeding centres have been responsible for maintaining the zoonotic cycle between human and non-human primates (Mbaya *et al*., 2006b).

Outbreaks of balantidosis in a colony of captive chimpanzees (*Pan troglodytes*) in Sanda Kyarimi zoo located in the arid zone of north-eastern Nigeria (Mbaya, *et al*., 2006a) or concurrently with helminthosis in a red pattas monkey (*Erythrocebus pattas*) in the University of Ibadan Zoological Garden have been reported (Adedokun *et al*., 2002). Following sporadic diarrhoea of unknown origin among captive chimpanzees (*Pan troglodytes*) and drills (*Mandrillus leucophaeus*) in the Afi mountain Conservation area, this study was designed to investigate the prevalence of balantidosis and giardiosis and their possible zoonotic implications.

MATERIALS AND METHODS

Study area

The Drill ranch located in the Afi mountain wildlife sanctuary where this study was conducted, occupies an area of about 1.6 km square and lies between latitude 5' N and longitude 8' E in Boki local Government Area, North of Calabar and contains a number of spatially separate captive or free roaming primate colonies, each of which consist of multiple primate species such as the chimpanzee (*Pan troglodytes*), and the drill (*Mandrillus leucophaeus*) among others in a very rich biodiversity of undisturbed ecosystem.

Collection and faecal examination

Fresh faecal droppings from a total of 47 chimpanzees (*Pan troglodytes*) and 18 drills (*Mandrillus leucophaeus*) were collected during routine cleaning of their cages. These samples were examined at Cercopan Diagnostic Laboratory for oocysts and trophozoites of *B. coli* and *G. lamblia* by the direct faecal smear and floatation technique using saturated sodium chloride as floatation medium (Anon, 1977). A standard technique of Lynn and David, (2005) was used to differentiate the oocysts and trophozoites of the two protozoan parasites. The ciliated trophozoites of *B. coli* measured between 50 -100µm with small micronuclei located in indentations of the large kidney shaped macronuclei while the cysts were oval and un-ciliated. The trophozoites of *G. lamblia* appeared pear shaped and measured between 10 - 20µm long with 4 lateral, 2 ventral and 2 caudal flagella while the cysts were ellipsoidal with longitudinal fibrils. The oocyst counts were performed by the modified McMaster technique using saturated sodium chloride solution as floating medium while trophozoite counts were performed per microscopic field (Anon, 1977).

Statistical analysis

The Chi square test X^2 ICC (adjusted for intra-cluster correlation) was used to judge differences in risks between various strata (Donald and Donner, 1988).

RESULTS

The prevalence of concurrent balantidosis, giardiosis and associated parasitic load among captive chimpanzees (*Pan troglodytes*) and drills (*Mandrillus leucophaeus*) examined at the Drill Ranch in Calabar, Nigeria is presented in Table 1. Out of a total of the 65 primates examined, 43 (66.15%) were found to be shedding the oocysts or trophozoites of *Balantidium coli* and *Giardia lamblia* in their faeces.

Although the prevalence of infection with both parasites was generally high among the two species of primates examined, infection among the drills (*Mandrillus leucophaeus*) 16 (88.89%) was statistically ($P < 0.05$) higher than the 27 (57.45%) of the chimpanzees (*Pan troglodytes*). On one hand, out of the 27 (57.45%) recorded for chimpanzees (*Pan troglodytes*), The mean ± SD oocyst counts (opg) for *Balantidium coli* (850 ± 0.09) was significantly higher ($P <0.05$) among the chimpanzees (*Pan troglodytes*) than (600.2 ± 0.35) among the drills (*Mandrillus leucophaeus*). Also, a trophozoite count of 500.4 ± 0.07 due to *B. coli* was higher among the chimpanzees (*Pan troglodytes*) than 300.4 ± 0.25 encountered among the drills (*Mandrillus leucophaeus*). Oocyst or trophozoite counts for *G. lamblia* were however moderate among the two primate colonies.

The prevalence of infection between sex and age among the primates are presented in Table 2. No variation ($P > 0.05$) in the prevalence of infection between sexes was observed among the chimpanzees (*Pan troglodytes*) and drills (*Mandrillus leucophaeus*), similarly, the young drills (*Mandrillus leucophaeus*) (< 12 months) and adults (> 12 months) had no significant ($P > 0.05$) variation in the prevalence of infection. The young chimpanzees (*Pan troglodytes*) (< 12 months) however, had a significantly ($P < 0.05$) higher prevalence of infection than the adults (> 12 months).

DISCUSSION AND CONCLUSSION

Although balantidosis is considered a self limiting gastrointestinal infection of man and animals (Chivers and Ford, 1978), there is a paucity of information regarding single or concurrent infections with giardiosis among primates. This study however showed that concurrent infections of balantidosis and giardiosis exist among captive primates with severe parasitic load due to *B. coli* which might have been the primary cause of non clinical diarrhoea among the drills (*Mandrillus leucophaeus*) and clinically among the chimpanzees (*Pan troglodytes*) on the ranch. The overt manifestations of balantidosis among the chimpanzees (*Pan troglodytes*) were probably potentiated by the presence of concurrent infections with *G. lamblia* which had moderate parasitic load. Several workers have reported that the synergistic effect of concurrent balantidosis with other gastrointestinal protozoa or helminths often result in additive effects in the host (Brock-Utne *et al*., 1988; Adedokun *et al*., 2002). Such synergistic interactions usually result in the additive effects by making the host environment more favourable for the other parasite or the suppression of the immune responses of the host to one parasite by another (Christensen *et al*., 1987; Nwosu *et al*., 2001; Nwosu *et al*., 2006).

The reason why the chimpanzees (*Pan troglodytes*) had higher prevalence of infection than the lower primates, might be associated with the fact that *B. coli* is a serious pathogen among large primates such as the lowland gorillas (*Gorilla gorilla*), chimpanzees (*Pan troglodytes*) and orangatun (*Pongo pymaeus*) elsewhere in the world (Flyn, 1973; Levine, 1973; Smyth, 1996). Its occurrence in a reservoir status or in the form of an outbreak in a colony of captive chimpanzees (*Pan troglodytes*) was reported from north-eastern Nigeria (Mbaya *et al*., 2006a; Mbaya *et al*., 2006b) and concurrently with helminthosis in a red pattas monkey (*Erythrocebus pattas*) in Western Nigeria (Adedokun *et al*., 2002).

The survey at the Drill Ranch was necessary due to the relative importance of the Ranch in the conservation of orphaned primates in Nigeria on one hand and the zoonotic implication to the conservationists or animal handlers on the other hand. Balantidosis had been reported by several workers as a zoonosis (Okon and Dipeolu, 1975; Chivers and Ford, 1978; Kumar *et al*., 1978; Nwosu, 1995; Mbaya *et al*., 2006b). The mode of transmission between the two primate species living in separate but adjacent cages might be associated with the fact that the same attendants were responsible for cleaning the cages and thereby disseminating infection from one cage to the other. This mode of transmission has been established as one of the methods of transmission among captive wild animal species in the semi-arid region of North-eastern Nigeria (Mbaya *et al*., 2006b).

The effect of age on the infection however, showed that young chimpanzees (*Pan troglodytes*) of (< 12 months) old had a higher prevalence of infection than the older ones (>12 months). This is in consonance with earlier studies conducted in an outbreak of balantidosis among captive chimpanzees in Maiduguri (Mbaya *et al*., 2006a) which was associated to age susceptibility and lack of premunity among the young (Soulsby, 1982). From the foregoing, it is evident that concurrent balantidosis and giardiosis may pose a serious health problem to captive primates and may serve as a zoonosis to humans associated with handling these primates.

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Table 1. Prevalence of *Balantidium coli* and *Giardia lamblia* among captive chimpanzees (*Pan troglodytes*) and drills (*Mandrillus leucophaeus*) at the Afi mountain Primate Sanctuary in Calabar, Nigeria

Species of primates	No. exam.	No. infected (%)	Parasites encountered	Mean opg ± S.D.	Trophozoite / field ± S.D.
Chimpanzees (*Pan troglodytes*)	47	27(57.45)^{a}	(i) *B. coli* 20 (74.1)^{a}	850 ± 0.09^{a}	500.4 ± 0.07^{a}
			(ii) *G. lamblia* 7(25.9)^{b}	104.2 ± 1.51^{b}	250 ± 0.05^{b}
Drills (*Mandrillus leucophaeus*)	18	16(88.89)^{b}	(i) *B. coli* 10 (62.5)^{a}	600.2 ± 0.35^{a}	300.4 ± 0.25^{a}
			(ii) *G. lamblia* 6 (37.5)^{b}	150 ± 0.17^{b}	150.2 ± 0.17^{b}
All primates	65	43 (66.15)		1704.4 ± 5.16	1201 ± 4.33

$^{a, b}$ superscripted values in columns differed significantly ($P < 0.05$)

Table 2. Prevalence of *Balantidium coli* and *Giardia lambiala* among captive chimpanzees (*Pan troglodytes*) and drills (*Mandrillus leucophaeus*) at the Afi mountain Primate Sanctuary in Calabar, Nigeria according to sex and age

Parameters		Chimpanzees (*Pan troglodytes*)		Drills (*Mandrillus leucophaeus*)	
		No. examined	No. infected (%)	No. examined	No. infected (%)
Age	<12 months	17	14 (82.35)^{a}	6	6 (100)^{a}
	> 12 months	30	13 (43.33)^{b}	12	10 (83.33)^{a}
Total		47	27 (57.45)^{a}	18	16 (88.89)^{b}
Sex	Male	25	13 (52)^{a}	10	8 (80)^{a}
	Female	22	14 (63.64)^{a}	8	8 (100)^{a}
Total		47	27 (57.45)^{a}	18	16 (88.89)^{b}

[a, b] superscripted values in columns differed significantly ($P < 0.05$)