The African Journal of MEDICAL SCIENCES

Volume 3

1972

BLACKWELL SCIENTIFIC PUBLICATIONS
Oxford London Edinburgh Melbourne

Afr. J. med. Sci. (1972) **3**, 283–293.

Parasitic Infection of Animals in the University of Ibadan Zoo

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(*Received* 23 *June* 1971; *accepted* 21 *September* 1971)

Summary. Examinations of faecal specimens from animals in the University of Ibadan Zoo and post-mortem findings on some dead animals between July 1966 and March 1971 have revealed a number of protozoan and helminth infections. These range from such zoonoses as amoebiasis (*Entamoeba histolytica* infection) in *Gorilla gorilla gorilla* (gorilla), and *Pan troglodytes* (chimpanzee) and hydatidosis (*Echinococcus granulosus* cyst) in *Camelus dromedarius* (camel) to such common infections as ancylostomiasis, oesophagostomiasis and strongyloidiasis in *Erythrocebus patas* (Patas monkey), the gorilla, chimpanzee and *Panthera leo* (lion). Cases of ascariasis in apes, lions and fatal cases of trichuriasis and malaria in Patas monkeys are recorded. The frequency of re-infection after treatment and the public health importance of the zoonoses are discussed.

Résumé. Des autopsies et des examens d'échantillons de matières fécales d'animaux du Zoo de l'Université d'Ibadan pratiqués entre Juillet 1966 et Mars 1971 ont révélé des infections de protozoaires et d'helminthes. Ces infections vont de zoonoses telles que l'amibiase (*Entamoeba histolytica*) chez *Gorilla gorilla gorilla* (le gorille) et *Pan troglodytes* (le chimpanzé) et l'hydatidose (kyste *Echinococcus granulosus*) chez *Camelus dromedarius* (le Dromadaire) jusqu'à des infections répandues comme l'ancylostomiasis, l'oesophagostomose et la strongylose chez *Erythrocebus patas* (le singe Patas), le gorille, le chimpanzé et *Panthera leo* (le lion). Des cas d'ascaridiose chez des singes et des lions et des cas mortels de trichuriasis et de malaria chez des patas sont enregistrés. La fréquence et les voies de réinfection après traitement, ainsi que l'incidence des zoonoses sur la santé publique, sont discutés.

INTRODUCTION

Animals in zoos all over the world are popular among tourists and local people. In Ibadan

* Paper read at the Twelfth Annual Conference of the Science Association of Nigeria, Ile-Ife, 22–26 March 1971.

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the collections of animals in the Agodi gardens, the University of Ibadan Zoo and the University of Ife Zoological garden attract thousands of visitors (Fig. 1) from Ibadan city and the environs at week-ends and public holidays. The animals which interest the visitors most are the primates such as monkeys, baboons, chimpanzees and gorillas. Despite regulations at these zoos forbidding visitors feeding these apes, they were often observed offering gifts to the animals, who amuse them in the way they mimic human beings. The possible consequencies of this contact between humans and the apes prompted the author to undertake a study of the parasitic infections of these animals with particular reference to certain known zoonotic diseases. The observations reported in this paper are those carried out during the past 5 years at the University of Ibadan Zoo.

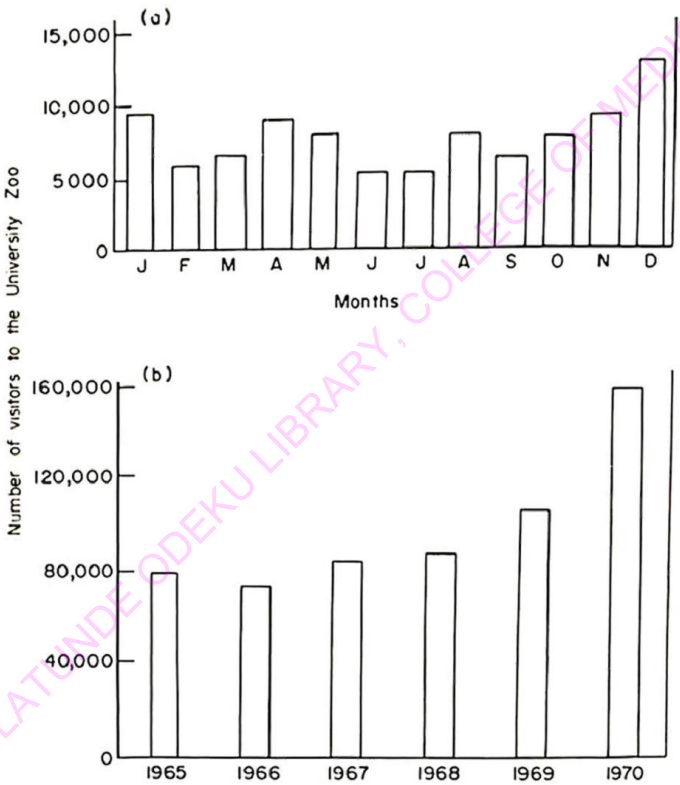

FIG. 1. Visitors to the University of Ibadan Zoo from 1965 to 1970. (a) Average monthly visitors. (b) Total yearly visitors.

MATERIALS AND METHODS

Faecal specimens from sick animals in the University of Ibadan Zoo handed over to the parasitology laboratory of the Department of Veterinary Pathology for diagnostic purposes were processed by a combination of the saline flotation method, Levine's (1961) modification of Faust *et al.* (1938) zinc sulphate flotation technique and Ridley & Hawgood's (1956) modification of Ritchie's (1948) formol-ether concentration technique for protozoal cysts and helminth eggs. For differential identification of *E. histolytica* cysts, the faecal smears

were fixed in Schaudinn's fluid and stained with Heidenhain's iron haematoxylin to bring out the nuclei and the chromatoid bodies. Also, fresh faeces were examined by the direct saline smear method for trophozoites of protozoan parasites. From time to time, faeces were collected from individual animals in the zoo and routine checks using the above methods were carried out.

The animals under observation were eutherian mammals belonging to the orders, Artiodactyla, Proboscidea, Carnivora and Primates given in Table 1.

TABLE 1. Eutherian mammals in the University of Ibadan Zoo examined for parasites

Order	Species	Common name
Artiodactyla	*Phachochoerus aethiopicus*	Wart hog
	Camelus dromedarius	Camel
	Tragelaphus spekii	Situtunga antelope
	Cephalophus maxwelli	Maxwell's duiker
Proboscoidea	*Loxodonta africana*	African elephant
Carnivora	*Civettictis civetta*	Civet cat
	Genetta sp.	Genet
	Crocuta crocuta	Spotted hyaena
	Meles	Badger
	Felis caracal	Caracal
	Panthera leo	Lion
Primates	*Lemur mongoz*	Lemur
	Cercopithecus mona	Mona monkey
	Erythrocebus patas	Patas monkey
	Cebus albifrons	Capuchin monkey
	Mandrillus leucophaeus	Mandrill
	Papio papio	Baboon
	Pan troglodytes	Chimpanzee
	Gorilla gorilla gorilla	Gorilla

Carcasses of dead animals including a chimpanzee, Patas monkeys and a camel were submitted for post-mortem examination and the parasitic findings were recorded. Abnormal tissues showing infections were fixed in 10% formalin, dehydrated through different grades of alcohol and waxed sections cut at 6 μm were stained with haematoxylin and eosin. Liver, lungs and spleen of the camel infected with *Echinococcus granulosus* cysts were treated in this way. Diagnosis was by means of microscope and photomicrographs produced from the histopathology sections.

Animals found to be infected with parasites by the methods described above were treated with the appropriate drugs as indicated in Tables 2–4 and post-treatment checks were carried out to assess the effectiveness of the curative treatment. Regular examinations of the healthy and sick animals gave indications of the frequency of re-infection.

RESULTS

The parasites which have been found to infect different hosts are summarized in Table 2

TABLE 2. Parasites of animals in the University of Ibadan Zoo

Parasites	Hosts							
	Camel	Badger	Lion	Monkeys	Baboon	Chimpanzee	Gorilla	Human
Entamoeba histolytica	−	−	−	−	−	+	+	*
Entamoeba coli	−	−	−	−	−	+	−	*
Coccidia	−	−	+	−	−	−	+	*
Hepatocystis kochi	−	−	−	+	−	−	−	*
Ascaris lumbricoides	−	−	−	−	−	+	+	*
Toxocara and *Toxascaris* sp.	−	−	+	−	−	−	−	0
Trichuris sp.	−	−	−	+	+	+	+	*
Ancylostoma duodenale	−	−	−	−	−	+	+	*
Ancylostoma caninum	−	−	+	−	−	−	−	0
Oesophagostomum apiostomum	−	−	−	+	−	−	−	0
Strongyloides sp.	+	+	+	+	−	+	+	*
Echinococcus granulosus cyst	+	−	−	−	−	−	−	*
Acanthocephala	−	−	−	+	−	−	−	0

−, Negative; +, positive; 0, not normally present; *, normally present.

TABLE 3. History of parasitic infections of lions and their cubs

Dates	Diagnosis	Treatment and remarks
28.2.69	Ascarid (male) *Ancylostoma* (female)	No treatment
18.3.69	Coccidia (male) Ascarid (female)	New infection
24.3.69	Coccidia (male) Ascarid (female)	Both lions were treated with thiabendazole (Equizole) at 25 mg/lb body weight. Male—a total of 11·25 g in 3 days Female—a total of 16·5 g in 3 days
1.5.69	*Strongyloides* (female) Negative (male)	New infection Treatment effective
24.9.70	Ascarid, *Ancylostoma* *Strongyloides* Coccidia (male)	Re-infection
26.9.70	Ascarid, *Ancylostoma* *Strongyloides* Coccidia (male)	Male lion treated for ascariasis with 3600 mg piperazine adipate (Copane) in meat scraps (quarter therapeutic dose)
28.9.70	Ascarid, *Ancylostoma* (female)	Re-infection
21.10.70	Ascarid (male cubs)	New infection
22.10.70	*Ancylostoma*, coccidia (male)	Re-infection
17.12.70	Ascarid, *Ancylostoma* (Female)	Still patent
2.3.71	Ascarid, *Strongyloides* (cubs) *Ancylostoma*, *Strongyloides* (male)	New infection with *Strongyloides* Re-infection with *Strongyloides*

TABLE 4. History of parasitic infections of Suzie, a young female chimpanzee

Dates	Diagnosis	Treatment and remarks
7.12.70	*Ascaris*, *Entamoeba histolytica*, *E. coli*, *Ancylostoma*, *Strongyloides*	—
15.12.70	*Ascaris*, *Entamoeba histolytica*, *E. coli*, *Ancylostoma*, *Strongyloides*	Piperazine adipate (Copane) in food at a dosage of 1 tablet/10 lb body weight for ascariasis. Aureomycin capsules (4 capsules daily for 2 days) given in Fanta orange for amoebiasis. Alcopar 5 g single dose given in Fanta orange for ancylostomiasis
28.12.70	*Ancylostoma*	Treatment ineffective for ancylostomiasis, but effective for amoebiasis, ascariasis and strongyloidiasis.
12.1.71	*Ancylostoma*, *Strongyloides*	Re-infection with *Strongyloides*
20.10.71	*Ancylostoma*, *Stronglyoides*	—
22.1.71	*Ancylostoma*, *Strongyloides*	A repeat treatment with 5 g Alcopar successfully given in Fanta orange
17.2.71	*Ancylostoma*, *Strongyloides*	Treatment either ineffective or re-infection is taking place
10.3.71	*Ancylostoma*, *Strongyloides*	
20.3.71	*Ancylostoma*, *Strongyloides*	

TABLE 5. History of parasitic infections of two adult gorillas, Aruna (male) and Imade (female)

Dates	Diagnosis	Treatment and remarks
26.5.69	*Ascaris lumbricoides*, *E. histolytica*, Coccidia (male) *E. histolytica*, Coccidia (female)	—
4.6.69	*Ascaris lumbricoides*, *E. histolytica*, Coccidia (male) *E. histolytica*, Coccidia (female)	Both gorillas were treated for ascariasis with piperazine citrate (Antepar) at 75 mg/kg body weight (a child's dose)
6.6.69	—	Both gorillas were treated for amoebiasis with chloroquine sulphate at dosage of 2 teaspoonfuls initially, repeated after 6 hr daily for 2 days
26.6.69	Coccidia, *Strongyloides* (male Coccidia (female)	New infection with *Strongyloides*; treatment effective for ascariasis and amoebiasis
30.6.69	—	Both gorillas were treated for coccidiosis with 16% sulphamezathine solution, 3 : 2 : 3 days course (1 oz in drinking water)
15.7.69	Coccidia (male) Coccidia (female)	—
8.12.69	*Ancylostoma* (female) *Strongyloides* (male)	Treatment for coccidiosis effective but female has new infection with *Ancylostoma*
19.12.69	*Ancylostoma* (female)	—
22.12.69	*Ancylostoma* (male)	New infection in male
[illegible].1.70		Both gorillas treated for ancylostomiasis
[illegible].70	*Ascaris* (male)	Daily examination of faeces
[illegible]70	*Ascaris* (female)	
[illegible]70	*E. histolytica*, *Ascaris* (male) *E. histolytica*, *Ascaris* (female)	Both gorillas are re-infected with *E. histolytica* after being freed of amoebiasis for about 8 months

TABLE 6. Post-mortem findings on dead zoo animals

Dates	Species	Parasites
19.1.67	*Pan troglodytes*	Ancylostoma duodenale (over 500)
15.8.67	*Erythrocebus patas*	*Hepatocystis kochi*
12.12.68	*Erythrocebus patas*	*Oesophagostomum apiostomum* (over 300)
		Trichuris trichuris (1571)
		Acanthocephala (1)
2.10.69	*Camelus dromedarius*	*Echinococcus granulosus* cysts (several cysts in liver, lungs and spleen)

which also indicates the normal human parasites which have been found in these animals. Table 3 shows the pattern of infection as shown in the case history of two adult lions and their cubs. Table 4 shows the case history of parasitic infections of a young chimpanzee, Suzie, while Table 5 depicts the picture of infections and re-infections in the male (Aruna) and female (Imade) gorillas which are kept together in the zoo. The parasitic infections found at post-mortem of the dead Patas monkeys, a chimpanzee and a camel are shown in Table 6. Figure 2 shows the histopathology of the lungs of the camel which died of hydatidosis (*Echinococcus granulosus* cyst) of the liver, lungs, and spleen.

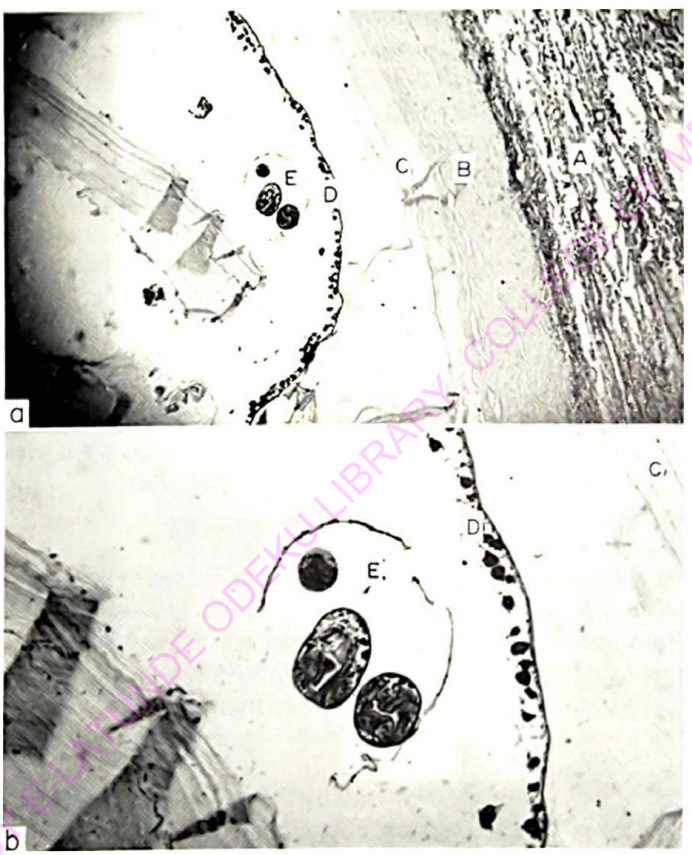

FIG. 2 (a) Section of lung tissue of camel infected with *Echinococcus granulosus* cyst. A, Host tissue showing extreme cellular infiltration; B, connective tissue capsule formed by reaction of host; C, external circular membrane of the cyst wall; D, internal germinal layer of cyst wall; E, a brood capsule containing three scolices. (b) An enlarged view of C, D and E showing details of the scolices.

DISCUSSION

Carnivores

The findings are of interest to both the zoo keepers and members of the public who are

keenly interested in visiting this collection of animals. It is interesting that the incidence of infection and re-infection is higher in those animals the public show greater interest in than in those which do not normally attract crowds at this zoo. But for strongyloidiasis (Table 2) which is found to be very common among most of the animals, most members of the orders Artiodactyla and Proboscidea are comparatively free of parasitic infections. Only the camel which is a domesticated artiodactyle brought in contact with domestic dogs and other carnivores was found to be infected with hydatid cysts of *E. granulosus*.

The lions which are allowed to range freely in their enclosure all day and night during the dry season but locked up at night during the rainy season have been found to harbour such infections as ascariasis, coccidiosis, ancylostomiasis and strongyloidiasis (Table 3). These infections are very common in *Canis familiaris* (dogs) and cats attending the Department of Veterinary Medicine clinic. Of the twenty-two cats belonging to senior members of the University which were treated at the Veterinary Medicine clinic during the period March 1968 to March 1971 two (9%), two (9%), one (5%), and ten (45·4%) were cases of coccidiosis, ascariasis, strongyloidiasis, and ancylostomiasis respectively. Since ancylostomiasis results from skin penetration of the lions by third stage larvae of *Ancylostoma caninum*, the infections and re-infections as shown in Table 3, is the result of contact with these larvae in the enclosure. After the removal of the first infection during the dry season (March 1969), re-infection did not occur again until during the rains (September) which as shown by Enyenihi (1969) starts in Ibadan from April and continues till October. Strongyloidiasis was not observed until the beginning of the rains in May 1969 and after treatment in September 1970 was absent during the dry months of October to December 1970, but showed up again during the early part of March. This pattern of infection with *Strongyloides* may not be unconnected with the fact that pathenogenetic parasitic forms may give rise to a free-living generation which may be better suited for dry season conditions.

The apes

The cases of the chimpanzee and gorillas as shown in Tables 3 and 4 respectively support the well known fact that domestication of wild animals and the attendant contact with human beings promote a high incidence of parasitic and other infections which would not occur if these animals were allowed to range freely as in their natural habitats. This is the case with amoebiasis, ancylostomiasis, strongyloidiasis and ascariasis caused by *Entamoeba histolytica*, *Ancylostoma duodenale*, *Strongyloides stercoralis* and *Ascaris lumbricoides* respectively in these animals. As shown in Fig. 1a an average of 7885 persons, half of which are children have been visiting this zoo monthly from 1965 to the present day. The yearly total visitors (Fig. 1b) is on the increase with a yearly average of 94,629. The figure for 1970 alone was 157,860 and a good number of these visited the zoo in December when Suzie was acquired and isolated in a cage in the old ape house. Since the public had access to her where they could shake hands with her and offer food, the chances are that many of the visitors were likely to be infected by Suzie. Between 5 and 15 December when she was treated (Table 4) about 10,000 people from different homes in Ibadan visited the zoo. From the records at the zoo (Fig. 1b) about 0·6 million visitors have visited this zoo from January 1965 to March 1971. A large number of Ibadan citizens have visited the Agodi gardens and University of Ife biological gardens, during the same period. Evidence of amoebiasis in humans in Ibadan is given by Abioye (1971) who in two surveys involving a total of 1597 inhabitants of Ibadan, found by the gel diffusion technique that 14·71% of 306 school

children are infected. These are cases in which tissue invasions have taken place. By stool examination, he found 19·6% of 1291 inhabitants of Ibadan infected, most of them cyst passers. The infections in the gorillas and the chimpanzee were symptomless, and the three hosts were cyst passers. It is certain that these infections were of human origin. The young chimpanzee Suzie, who was acquired from a private owner in Lagos, was infected before arriving at the zoo. The re-infection of the two gorillas in January 1970 (Table 5) after the two apes had been treated and freed of the infection in June 1969 is evidence of re-infection from human sources as there was no other animal carrier other than human visitors and zoo keepers. It is therefore important that such animals as the chimpanzee which are capable of carrying such zoonosis as amoebiasis should not be kept by private individuals as was the case with Suzie. It is equally important that such new acquisitions in public zoos should be treated and the law prohibiting offering of gifts by visitors to such animals in these zoos be strictly observed. This will prevent human infections to be passed on to animals and vice versa. Ancylostomiasis in the three apes were of human origin as the human species *Ancylostoma duodenale* was identified in the dead chimpanzee at post-mortem in 1967 (Table 6). Since infection and re-infection of the gorillas occurs through skin penetration, control may be very difficult. It is the practice to allow the gorillas to bath in the pool around their lawn. The eggs of hookworms contained in faeces deposited on the lawn develop to the infective larvae within a few days and re-infect them when they rest on the grass lawn.

Patas monkeys

The case of fatal trichuriasis and oesophagostomiasis in the Patas monkey is the result of constant re-infection of these monkeys with these parasites particularly in the rainy season. The patas monkey enclosure is an open field where they defecate freely on the ground where conditions for development of *Trichuris* and *Oesophagostomum* eggs to the infective stages are at their maximum between late March and October which constitute the rainy season at Ibadan. Since there is no routine way of removing the faeces of infected animals, the whole pasture is virtually a rich culture medium for these worms during this period and so very heavy and fatal burdens result. The infection of the same monkey by an acanthocephalid worm (Table 6) is significant. The 'thorny headed worms' are normally parasites of aquatic vertebrates, mainly fishes and birds. They also occur in pigs, and are known to be very pathogenic because their spiny heads are usually used for piercing the alimentary canal of their hosts resulting in peritonitis. Although a large number of *Oesophagostomum apiostomum* were found in the instestine of the dead animal, the activity of the acanthocephalid worm might have contributed to the numerous nodules which were found on the walls of the intestine. This problem requires further investigation.

Camel

The camel which died of hydatidosis in 1969 (Table 6) was in a shed located near the enclosures of carnivores (civet, genet, caracal and hyaena) which Nelson & Rausch (1963) have reported to harbour adult *E. granulosus* in East Africa. It was brought to the zoo in 1960 from Lagos where it had been for about a year. It originated from Kontagora in the North Western State in 1959.

The histopathological changes (Fig. 2) in the lungs shows considerable host reaction. The involvement of lungs, liver and spleen indicates that this is an old infection which must have spread from the liver when the exogenous cyst arose from the original liver cyst. Nigeria is

not considered an area of endemic hydatidosis although Eisa, Mustafa & Soliman (1962) have reported 86·5% infection of dogs, 19·4% incidence in sheep, and 25% in cattle, in the Southern Sudan where the disease has been known to be endemic in the Taposan tribe of the Kapoeta district. Fourre & Imbert (1965) have reported this in a human in the Chad Republic. In Nigeria, Duncan (1961) and Alabi & De la Cruz (1970) have reported cases of hydatidosis in humans at Kano and Ibadan respectively. In the Kano case the young Housa lad had been working with sheep for 5 years and sheep, goats and cattle are known intermediate hosts of *Echinococcus granulosus*. In the Ibadan case the girl had contact with goats which is also an intermediate host. Camels are slaughtered in Kano in increasingly large numbers for meat and cases of cysts in liver and lungs have been recorded by the meat inspectors. The chances are that the infection in the zoo camel was acquired locally around Ibadan from stray dogs which must have left eggs of the worm on the fields where this camel used to graze. The reported case of pulmonary hydatidosis in the girl who has lived all alone at Ibadan by Alabi & De la Cruz confirms the author's suspicion that hydatidosis may well be a common infection among cattle rearers and pet (dogs and cats) owners in Nigeria. However, attempts by the author to pick up adult infections in the carnivores in the University of Ibadan Zoo by examining their faecal samples and also in stray dogs from Ibadan at autopsy have not met with success so far. It may well be that search for the adults in dogs in the sheep, cattle and camel rearing areas of Kano, North Eastern and North Western States, which are in direct contact with Chad Republic and through trade routes, the Sudan where animal and human infections are common may reveal more cases. Also the use of immunodiagnostic tests for human cases in hospital patients presented for liver and lung infections may reveal more cases of hydatidosis in humans in this country.

ACKNOWLEDGMENTS

I am grateful to the Zoo Curator Mr R. R. Golding and his staff for co-operation. My thanks are due to Dr B. O. Ikede of the Department of Veterinary Pathology who did the post-mortem on the dead camel and for Fig. 2; the staff of the Department of Veterinary Medicine for maximum co-operation and finally my wife Victoria U. Enyenihi who assisted in producing Fig. 1.

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