

BLOOD PARASITES OF SOME WILD BOVIDAE IN BOTSWANA

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ABSTRACT

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Blood smears from a total of 282 wild Bovidae from Ngamiland, Botswana were examined for the presence of blood parasites. The following species were sampled: 190 African buffalo, 23 impala, 10 blue wildebeest, 18 tsessebe, 1 eland, 13 lechwe, 16 kudu and 11 sable antelope. In addition, blood from 36 of the above antelope and from a further 48 buffalo was inoculated into rodents to test for the presence of trypanosomes.

An anaplasma morphologically indistinguishable from *Anaplasma marginale* Theiler, 1910 was found in 28.4% of buffalo. The incidence of detectable cases of *A. marginale* infection in buffalo less than 5 years of age was significantly higher than in those 5-10 years of age ($P < 0.02$). Furthermore, the level of parasitaemia was higher in young than in old buffalo.

Theilerial piroplasms were found in all 8 species examined and were detected in 16.3% of buffalo. Two morphological types were found in impala; clinical cytauxzoonosis was suspected in 1 impala.

A large *Babesia* occurred in the erythrocytes of 1 blue wildebeest. Erythrocytic dyscrasia, associated with the presence of a small *Babesia* was found in 1 tsessebe.

Trypanosoma (Nannomonas) congolense was found in blood smears from 4 buffalo, 1 impala, 1 lechwe and 1 kudu and *T. (Trypanozoon) brucei* occurred in smears from 2 buffalo and 1 kudu, but all 84 rodent inoculations were negative. The overall incidence of trypanosome infections detected was 2.5% in buffalo and 4.3% in the other species.

Protozoa resembling the cyst organisms of *Sarcocystis* spp., probably originating from cysts ruptured accidentally, occurred in the blood films of 2 impala and 1 tsessebe.

The parasite *Haematoxenus* was not detected in any of the blood smears.

The findings are compared with those of workers in other African countries and the importance of blood parasites in wild animals is discussed.

INTRODUCTION

Anaplasmosis and babesiosis of cattle are widespread in Botswana and outbreaks of these diseases are common (Dawe, 1950). North-western Botswana (Ngamiland) is historically associated with trypanosomiasis (Curson, 1932). Theilerial piroplasms are commonly found in cattle in Botswana but have not been proved to cause disease. There are, however, no published reports on the incidence of haematozoa in wild animals in Botswana and consequently their importance as a cause of disease in wild animals and the possible role of wild animals in the epizootiology of disease of stock cannot be assessed. This paper is an attempt to remedy the situation. It records studies on the incidence of these parasites in 8 species of wild Bovidae in Ngamiland.

MATERIALS AND METHODS

During October–November 1972 and September–October 1973 blood films were made from the jugular blood of the following animals: 190 African buffalo (*Syncerus caffer*), 23 impala (*Aepyceros melampus*), 10 blue wildebeest (*Connochaetes taurinus*), 18 tsessebe (*Damaliscus lunatus*), 1 eland (*Taurotragus oryx*), 13 lechwe (*Kobus leche*), 16 kudu (*Tragelaphus strepsiceros*) and 11 sable antelope (*Hippotragus niger*).

The buffalo and sable antelope were immobilized using M99* and the other species were shot.

The age of each buffalo was estimated according to the criteria described by Pienaar (1969). The samples were collected from wild animal populations at Savuti-Linyanti, Matsebe and Magwe (Fig. 1).

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This investigation was conducted whilst I. H. Carmichael was employed by the Australian Government as a technical assistant in Botswana and Elizabeth Hobday was stationed at the Veterinary Research Laboratory, Gaborone, Botswana

* Etorphine hydrochloride, Reckitt and Coleman, United Kingdom

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The blood films were fixed in methanol and stained with Giemsa. At least 100 fields were examined for intracellular parasites under 400× magnification. The entire film was then scanned for trypanosomes. Parasitaemia, when observed, was classified as follows:

–/+ Less than 20 parasites per 100 fields

+/- More than 20 parasites per 100 fields

+ Multiple parasitism in individual fields and occasionally in individual erythrocytes

++ Multiple parasitism with evidence of erythrocytic disturbance (anisocytosis, poikilocytosis, basophilic stippling, polychromasia).

Since only the intra-erythrocytic stages of the piroplasms were seen, their grouping in either the family Babesiidae Poche, 1913 or the family Theileriidae du Toit, 1918 was according to the differences in size, shape, distribution and density of nuclear chromatin described by Barnett (1968).

Specific identification of the *Babesia* species merely on the basis of the morphology of the intra-erythrocytic stages present was considered impossible. For simplicity's sake they were therefore classified as either "large" [indistinguishable from *B. bigemina* (Smith and Kilborne, 1893)] or "small" [indistinguishable from *B. bovis* (Babés, 1888)].

No attempt was made to differentiate between *Theileria* and *Cytauxzoon* because their intra-erythrocytic forms are indistinguishable and, according to Levine (1971), they may be synonymous. These organisms are therefore referred to simply as theilerial piroplasms.

Trypanosomes were classified morphologically according to Hoare (1972). Organisms of the subgenus *Nannomonas* were identified as *Trypanosoma (N.) congolense* and those of the subgenus *Trypanozoon* as *Trypanosoma (T.) brucei*.

The Savuti-Linyanti buffalo population, from which blood smears alone were examined in October 1972, was re-examined for trypanosomes by rodent inoculation, in October 1973. Mice were inoculated intraperitoneally (i.p.) with 0.5 ml of freshly collected heparinized blood from a further 48 buffalo. Two mice were used for each blood sample.

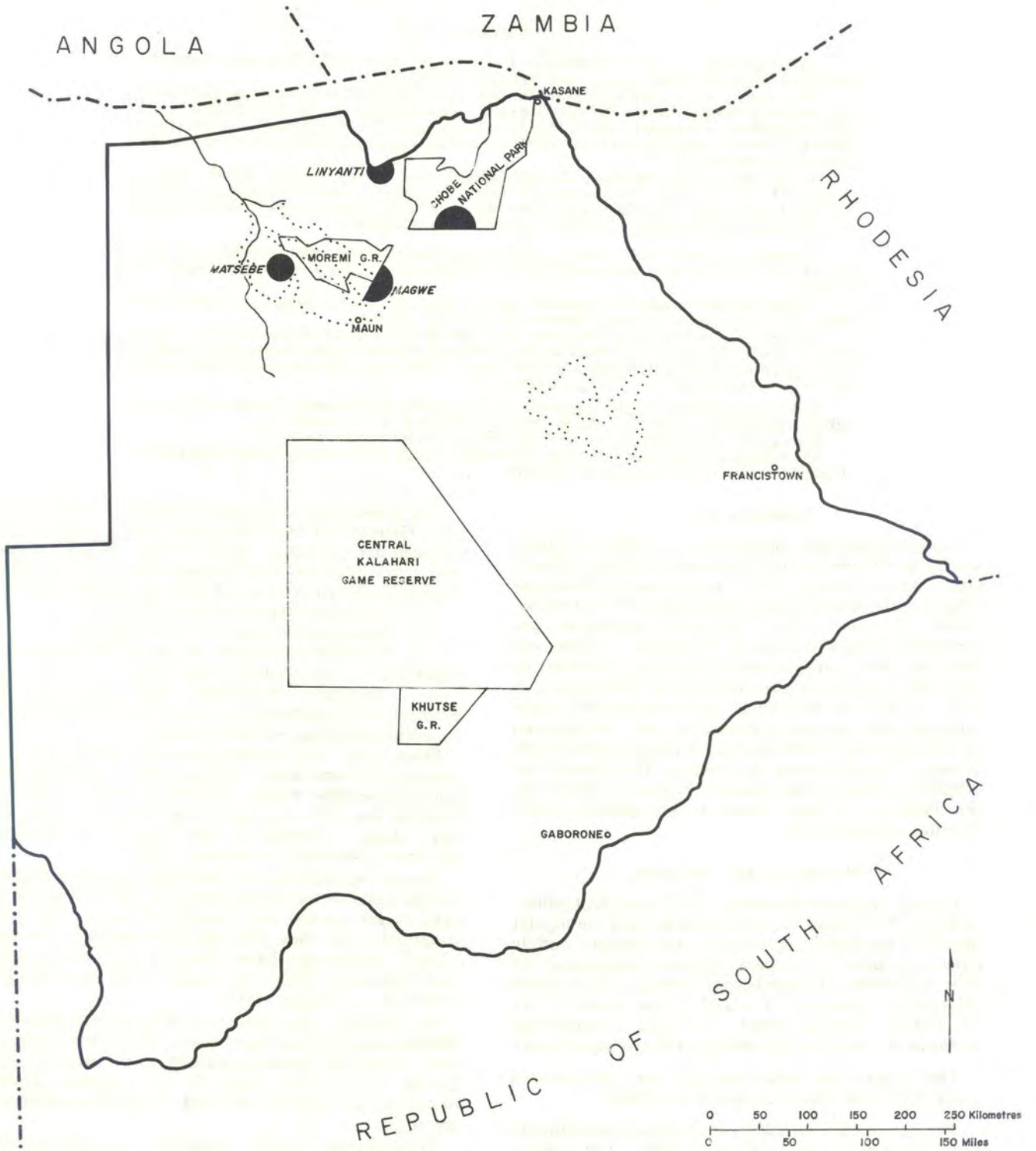


Fig.1 Sketch map of Botswana showing areas from which game was sampled. Areas indicated thus

In October 1973 1.0 ml of heparinized blood from 10 sable antelope was inoculated i.p. into guinea pigs and 0.5 ml of heparinized blood from 12 kudu, 6 lechwe and 8 impala was inoculated i.p. into white mice. The guinea pigs received freshly collected blood in the field, while that for the white mice was transported at ambient temperatures and injected within 3 hours of collection. One rodent was used in each test.

Wet films and dry, stained films of peripheral blood from inoculated rodents were then examined regularly for 6 weeks for the presence of trypanosomes.

RESULTS

The blood parasites seen in stained blood films from the 8 species sampled are summarized in Table 1.

1. *Anaplasma*

Anaplasms were found only in buffalo, 27.8% of which were positive. According to the criterion established by Kuttler (1966) to designate anaplasms, approximately 75% were situated marginally and hence the organism was *A. marginale* Theiler, 1910.

Intra-erythrocytic bodies, morphologically very similar to *Anaplasma* bodies, were found in 3 kudu, 2 lechwe, 2 impala and 2 sable antelope. Although these bodies were extremely difficult to differentiate they were classified as Howell-Jolly bodies on the following characteristics:

- (i) They stained with a light reddish tinge whereas *Anaplasma* usually stain more intensely
- (ii) They were always round and smooth-edged
- (iii) They were usually slightly larger than *Anaplasma* (diameter approximately 1 μ m)

These bodies were not accompanied by any other signs of erythrocytic disturbance and the significance of their presence is not known.

The incidence of detectable cases of *A. marginale* infection and the level of parasitaemia in buffalo of different age groups are summarized in Table 2.

Anaplasms were detectable in 40% of buffalo less than 5 years of age and in 21% of buffalo 5-10 years of age. The difference is statistically significant ($X^2=6.17$; $P<0.02$). No anaplasms were found in buffalo older than 10 years.

The level of parasitaemia was higher in young than in old buffalo. Moderate and heavy infections (+ and ++ groupings) occurred in 2 of 8 (25%) buffalo less than 1 year old and in 2 of 82 (2.4%) of those 1-4 years of age but in none of the 100 animals over 4 years old.

No infections were severe enough to cause marked anaemia and no clinical signs other than those of erythrocytic disturbance were apparent even in those animals with relatively heavy infections.

2. *Tiroplasms*

(a) *Theileria* and/or *Cytauxzoon*

Theilerial piroplasms were found in 31 buffalo (16.3%), all age-groups being equally affected. They were also found in 3 of 10 blue wildebeest, 8 of 18 tsessebe, 1 of 13 lechwe, 6 of 23 impala, 4 of 11 sable antelope, 9 of 16 kudu and in the only eland examined.

TABLE 1 Blood parasites diagnosed in wild Bovidae

Animal Species	No. examined	<i>Anaplasma</i>	<i>Babesia</i>	<i>Sarcocystis</i>	<i>Theileria</i> and/or <i>Cytauxzoon</i> ³	<i>Trypanosoma</i>	
						<i>T. (T.) brucei</i>	<i>T. (N.) congolense</i>
Buffalo.....	190	54	—	—	29 (2)	2	4
Impala.....	23	2*	—	2	6 (1)	—	1
Wildebeest.....	10	—	1 ¹	—	3	—	—
Tsessebe.....	18	—	1 ²	1	8 (1)	—	—
Eland.....	1	—	—	—	1	—	—
Lechwe.....	13	2*	—	—	1	—	1
Kudu.....	16	3*	—	—	9 (4)	1	1
Sable antelope.....	11	2*	—	—	4	—	—

* Classified as Howell-Jolly bodies (see text)

¹ Parasitaemia -/+

² Parasitaemia ++

³ Figures in brackets denote number of animals with parasitaemias in excess of -/+. See text for particulars

TABLE 2 Incidence and level of parasitaemia in *A. marginale* infection in African buffalo of different age groups

Age (Years)	No. of animals in group	Positive results				Percentage positive
		-/+	+/-	+	++	
<1.....	8	3	—	1	1	63 } 40%
1 & 2.....	49	12	6	—	1	
3 & 4.....	33	11	—	1	—	36 } 21%
5 & 6.....	26	7	—	—	—	27 } 21%
7 & 8.....	32	5	—	—	—	16 } 21%
9 & 10.....	29	6	—	—	—	21 } 21%
>10.....	13	0	—	—	—	0 } 0%

Theilerial piroplasms in impala were of 2 morphological types. Usually they were small, pale-staining "signet-ring", "acorn" or round forms, but in 3 impala larger, darker-staining, pear-shaped and oval forms were found; these closely resembled a small *Babesia* and were classified as theilerial piroplasms solely on their dense nuclear chromatin which formed a cap or demilune (Barnett, 1968).

Only 2 of all the infected animals had parasitaemias in excess of +/- viz., a kudu (+) and an impala (++) . Evidence of clinical disease was found in this impala. The animal was thin and anaemic, piroplasms of both types were present in the blood film and reticulocytes and Howell-Jolly bodies were plentiful; no schizonts were seen.

(b) *Babesia*

Babesias were not found in buffalo in this survey.

A large *Babesia* was found in 1 blue wildebeest and a small *Babesia* in association with large numbers of Howell-Jolly bodies was found in the erythrocytes of 1 tsessebe.

(c) *Haematoxenus*

No parasites of this genus were detected.

3. *Sarcocystis*

Protozoa resembling the cyst organisms of *Sarcocystis* spp. were found in the blood films of 2 impala and 1 tsessebe. They probably originated from cysts ruptured during the process of exsanguination.

4. *Trypanosoma*

The overall incidence of trypanosome infection was 2,5% in buffalo and 4,3% in the other species.

T. (N.) congolense was found in the blood smears of 4 buffalo and *T. (T.) brucei* was found in 2 buffalo. Positive buffalo were found in all 3 of the populations sampled.

The incidence of trypanosome infection in buffalo from the Savuti-Linyanti population in 1972 and 1973 is summarized in Table 3. A low incidence of infection (1,5%) was demonstrated in blood smears from this population in 1972 and was apparently confirmed in 1973 when no positive results were obtained from 48 rodent inoculations.

TABLE 3 The incidence of trypanosome infection in African buffalo from the Savuti-Linyanti population in 1972 and 1973

Date	No. of animals examined	Diagnostic technique	No. positive	Percentage positive
October 1972	112	blood smear	2	1,5
October 1973	48	mouse inoculation	0	0

T. (N.) congolense was found in the blood smears of 1 lechwe, 1 impala and 1 kudu; another kudu was infected with *T. (T.) brucei*. None of the guinea pigs inoculated with blood from sable antelope developed a detectable parasitaemia and similarly all of the mouse inoculations from lechwe, kudu and impala were negative.

The incidence of trypanosomiasis in 4 species in different areas of Africa is compared in Table 4. There are differences between areas in the recorded incidence of infection.

DISCUSSION AND CONCLUSIONS

Blood parasites are usually easily detected in stained blood films from clinically affected animals. There are, however, obvious limitations if this technique is used to determine latent or subclinical infections with small or fluctuating numbers of parasites. The true incidence of blood parasites is therefore probably higher than that recorded in our results.

TABLE 4 The incidence of trypanosome infection in 4 species in different areas

Country or region	Host								Authorities
	Kudu		Impala		Buffalo		Wildebeest		
	examined	positive	examined	positive	examined	positive	examined	positive	
Central and East Africa	18	11	170	21	51	5	45	7	Ashcroft, 1959; Baker, Sachs & Laufer, 1967; Keymer, 1969b; Geigy, Mwambu & Kaufmann, 1971; Mwambu & Woodford, 1972; Allsopp, 1972
Moçambique.....	520	18	46	0	312	8	213	6	Ashcroft, 1959
South Africa.....	31	9	9	0	2	0	65	0	Neitz, 1931; Kluge, 1945
Botswana.....	15	2	23	1	238	6	10	0	This paper

1. *Anaplasma*

It is surprising that anaplasmas have rarely been described in the African buffalo. Kuttler (1965) in Kenya, found 1 of 6 buffalo positive to the complement-fixation test. Brocklesby & Vidler (1966) saw an organism "morphologically indistinguishable from *Anaplasma centrale*" in a buffalo in Kenya, but failed to reproduce the disease in susceptible splenectomized calves. Anaplasmas were found more often than other parasites in the present survey, although a diligent search was usually required to find them. They were plentiful, however, in 4 young buffalo and in 2 cases several parasitized cells were seen in most microscopic fields, together with anisocytosis, poikilocytosis and reticulocytosis; this may indicate that these 2 animals were clinically affected.

According to Blood & Henderson (1963) young cattle, although susceptible to infection with *A. marginalis*, are relatively resistant to the clinical disease; nevertheless they can develop quite high parasitaemias. The infection usually persists for life, older animals harbouring the parasite but at a lower, often subpatent, level. This probably happened in the case of the buffaloes. It is interesting, however, that such a high level of infection existed despite the fact that tick burdens (predominantly *Hyalomma* and *Rhipicephalus* spp.) were low (I. Carmichael, 1972 unpublished data).

The negative findings in the antelope species were not unexpected. Only recently, Löhr & Meyer (1973) isolated for the first time an *Anaplasma* organism (morphologically indistinguishable from and antigenically similar to *A. marginalis*?) from 3 species of naturally-infected antelope.

2. *Piroplasms*

Keymer (1969a) reported that he had examined blood films of 153 Artiodactyla belonging to 16 species in Rhodesia and found no piroplasms. However, theilerial piroplasms have been reported from at least 18 species of Artiodactyla in Rhodesia (Hill, Condy & Matson, 1969) South Africa (Neitz, 1955) and East Africa (Brocklesby & Vidler, 1966). This paper reports their occurrence in 8 species of Bovidae in Botswana. This is the first report of piroplasms in lechwe or tsessebe. Further studies will probably reveal many more new hosts.

(a) *Theileria* and/or *Cytauxzoon*

The incidence of theilerial piroplasms found in buffalo in this survey (16.3%) is much lower than the incidence recorded by Dinnik, Walker, Barnett & Brocklesby (1963) in Ugandan buffalo (88%), or that found in South African buffalo (97%) by Basson, McCully, Kruger, Van Niekerk, Young & De Vos (1970). The latter authors also reported clinical theileriosis and a higher incidence of infection in younger animals. Our investigation did not confirm these findings.

Ticks are responsible for the transmission of theileriosis and the differences in incidence may be due in part to differences in tick burdens of the buffalo sampled. Dinnik *et al.* (1963) remarked that the buffalo "were so heavily parasitized (with ticks) that it proved impracticable to make total collections of these parasites". Basson *et al.* (1970) did not mention ticks on the buffalo they examined, but buffalo in the Kruger National Park are often very heavily infested (U. de V. Pienaar, Chief Biologist,

Kruger National Park, personal communication, 1974). In contrast, as mentioned previously, buffalo in Botswana usually carry small numbers of ticks.

Not only can the African buffalo harbour *T. lawrencei*, *T. mutans* (Neitz, 1965) and *T. parva* (Barnett & Brocklesby, 1966a), but strains of theilerial piroplasm may vary in virulence (Neitz, 1956; Barnett & Brocklesby, 1966b). Furthermore, although Neitz (1957) noted differences in the epizootiology of *T. lawrencei* and *T. parva*, Barnett & Brocklesby (1966c) produced substantial evidence of the synonymy and interchangeability of these piroplasms.

The different findings in the present survey are therefore possibly due to one or a combination of these factors.

Lawrence (1936) first mentioned an association between theileriosis in cattle (as distinct at that stage from East Coast fever) and the presence of buffalo in Rhodesia. Since then the buffalo has been confirmed as a host of theilerial parasites pathogenic to cattle in South Africa (Neitz, 1955), Kenya (Barnett & Brocklesby, 1966c) and Tanzania (Young, Branagan, Brown, Burrige, Cunningham & Purnell, 1973). Theileriosis in Angolan cattle has been attributed to *Theileria* spp. transmitted by buffalo (Da Graça & Serrano, 1971) and this has also been suspected in Botswana (J. Falconer, Director of Veterinary Services, Botswana, personal communication, 1973). In view of these findings the African buffalo should not be overlooked as a potential reservoir of bovine theileriosis in Botswana.

Neitz (1957) found anaemia to be a prominent feature of cytauxzoonosis in a kudu. Brocklesby (1962) made the same observation in an eland (*Taurotragus oryx pattersonianus*) and McCully, Keep & Basson (1970) described severe anaemia in a giraffe (*Giraffa camelopardus*) with this disease. We suspect that the heavily-infected, anaemic, impala found in the present survey was suffering from cytauxzoonosis.

The finding of 2 morphological types of theilerial piroplasm in 3 impala confirms the observations of Irvin, Omwoyo, Purnell, Peirce & Schiemann (1973) who noted considerable morphologic variation in theilerial piroplasms of impala in Tanzania and occasional large *Babesia*-like ring forms in 3 of 84 animals.

(b) *Babesia*

Mohan & Gotts (1970) state that information concerning the occurrence of *Babesia* spp. in the African buffalo is not clear, but they suggest that this host is possibly infected with 4 species. Mammerrickx (1960) says that *Babesia* have been demonstrated in the African buffalo but does not give any reference. We can find no conclusive evidence that babesias occur in the African buffalo.

This is the first report of *Babesia* spp. in both tsessebe and wildebeest, but, as stressed earlier, more information is necessary for specific identification than can be obtained from the intra-erythrocytic forms alone. Howell-Jolly bodies were rarely encountered in the erythrocytes of other tsessebe and their presence in large numbers in the only infected tsessebe was probably a manifestation of clinical babesiosis.

(c) *Haematoxenus*

Our failure to detect *Haematoxenus* in this survey is not surprising. *Haematoxenus* has been described in impala in Tanzania (Irvin, *et al.* 1973) and in African buffalo in the Central African Republic (Uilenberg, 1970) and Uganda (Young, Irvin & Woodford, 1973). Young *et al.* (1973) suggest, however, that *Haematoxenus* may be restricted in distribution as both they and Brocklesby & Vidler (1966) failed to detect it in large numbers of buffalo examined in other areas of East Africa.

3. *Trypanosoma*

The overall incidence of trypanosomes recorded in buffalo in this survey was 2.5%. Ashcroft (1959) summarized annual records for Moçambique for the period 1948-1954 and reported a similar incidence (2.6%).

We found trypanosomes in 10 (3.0%) of a grand total of 330 animals; this is a lower incidence than that reported by Ashcroft (1959), who summarized the results of some previous investigations in Zambia, Malawi, Tanzania, Moçambique and South Africa. It is also a much lower overall incidence than that reported recently from Uganda (11.0%, Mwambu & Woodford, 1972), southern Tanzania (38.2%, Geigy, Mwambu & Kaufmann, 1971), northern Tanzania (30.0%, Baker, Sachs & Laufer, 1967), Kenya (16.4%, Allsopp, 1972) and Zambia (23.0%, Keymer, 1969b). The recorded incidence of trypanosome infection depends, however, upon the species sampled, their origin, the season and the diagnostic technique used.

The above surveys included species such as reedbuck (*Redunca arundinum*), waterbuck (*Kobus ellipsiprymnus*) and bushbuck (*Tragelaphus scriptus*), which usually had a high incidence of infection; none of these species were included in our survey.

The higher incidence of infection recorded in East and Central Africa than in Moçambique, South Africa or Botswana (Table 4) is only partly due to the use there of a combination of diagnostic techniques; the origin of the animals sampled plays an equally important role. Six of the 7 positive East African wildebeest were found in 1 survey of 22 wildebeest in northern Tanzania (Baker *et al.*, 1967); using similar techniques Geigy *et al.* (1971) found only 1 of 10 wildebeest positive in southern Tanzania and Kluge (1945) found 0 of 10 infected in South Africa. Vanderplank (1947) found 16% of blood smears from impala in Zambia positive whereas the same method revealed an incidence of only 1.3% in Moçambique, South Africa and Botswana collectively (Table 4). Furthermore Vanderplank (1947) found a higher incidence of infection than East African workers (Baker *et al.*, 1967; Geigy *et al.*, 1971; Allsopp, 1972) who used blood smear examinations plus a number of other diagnostic techniques.

Vanderplank (1947) demonstrated the marked influence of season on the incidence of trypanosome infection in wild animals by recording infection rates of 7.7% at the end of the dry season compared with 35.3% during the rainy season; he also found large variations in annual incidence.

The importance of rodent-inoculation as a means of diagnosing *T. (T.) brucei* infections was stressed by Baker *et al.* (1967) who missed half of the *T. (T.) brucei* infections in game when blood smears alone were used.

Although Geigy *et al.* (1971) were able to confirm all cases of *T. (N.) congolense* infection seen in blood smears by inoculating mice, it was necessary to inoculate 6-10 mice for each test and frequently only one produced a detectable parasitaemia. Allsopp (1972), using the latex agglutination test for trypanosomiasis antibodies, found a higher incidence of trypanosomiasis in game animals than had been shown by combined mouse-inoculation and blood smear examinations. Our investigations did not make use of the latex agglutination test and in some instances either rodent inoculation or blood smear examination was omitted. Consequently we may have missed some infections.

The failure of rodent inoculations to detect infections with *T. (T.) brucei* in 84 animals of 5 species confirms, however, that the incidence was not high and that our findings give an approximation of the true incidence of trypanosomiasis in these species at the end of the 1972 and 1973 dry seasons. The incidence may, however, be different in other areas, in other years, or at other times of the year.

Trypanosomes in lechwe, kudu and impala were all detected in blood smears; none were cultured in inoculated mice. Unfortunately only 2 animals with positive smears could be checked biologically as well. In one case (lechwe), the mouse died of heat exhaustion the following day; the other (inoculated with blood from the kudu infected with *T. (N.) congolense* failed to develop a detectable parasitaemia.

Buffalo migrate extensively and 2 infected migratory buffalo, part of the Sa'uti-Linyanti population were found in an area free from tsetse flies. There is no proof, however, that buffalo contribute to the mechanical (non-cyclical) spread of trypanosomiasis in Botswana, as contact between resident cattle populations and migratory buffalo is restricted by fences, human settlements and hunting.

The popular opinion that wild animals are resistant to arthropod-borne diseases is based on the assumption that disease does not exist because no clinically-affected animals are seen. The removal of diseased animals by predators or their unrecorded deaths in isolated areas probably obscures the true incidence of disease.

There is ample proof that wild animals are susceptible to many arthropod-borne diseases. Although non-clinical anaplasmosis has been recorded in experimental duiker (*Sylvicapra grimmia*) and blesbok (*Damaliscus dorcas phillipsi*) by Neitz & Du Toit (1932) and in black wildebeest (*Connochaetes gnu*) by Neitz (1935), Löhr & Meyer (1973) suspected naturally-acquired anaplasmosis as the cause of death of a giraffe. Martinaglia (1930) recorded the death of a captive sable antelope due to babesiosis. Fatal cytauxzoonosis has been described by Neitz & Thomas (1948) in a duiker, by Brocklesby (1962) in an eland and by McCully *et al.* (1970) in a giraffe. Basson *et al.* (1970) saw clinical and histopathological evidence of theileriosis in young buffalo. A number of wild animals experimentally infected with *T. (T.) brucei* and *T. (N.) congolense* by Ashcroft, Burt & Fairbairn (1959) died of the disease and Lossos & Gwamaka (1973) recorded mild encephalitis and myocarditis in wild animals with naturally-acquired trypanosomiasis. In this paper we record blood dyscrasias caused by *A. marginale* in buffalo and by unidentified piroplasms in impala and tsessebe.

Apart from being affected themselves, wild animals are often hosts for blood parasites which are pathogenic to domestic animals or man.

The suggestion by Neitz & Du Toit (1932) that antelope may be a reservoir of anaplasmosis for cattle was re-affirmed by Löhr & Meyer (1973), who successfully transmitted *Anaplasma* organisms from naturally-infected African game to cattle. These authors commented: "It seems reasonable to assume that transmission of *Anaplasma* organisms from game to cattle occurred not only in this transmission experiment but occurs also in nature". The significance of the buffalo as a reservoir of theileriosis in many African countries has already been discussed. Furthermore, Willett (1970) said "there can be no doubt that the main reservoir of trypanosomiasis is in the wild animals". Control of tsetse fly in Africa has usually resulted in encroachment of civilization, cross-transmission of trypanosomiasis and other diseases to man and domestic animals and the slaughter or removal of this reservoir. Unless great care is taken this will be the fate of the wild animals in Ngamiland.

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